

दिल्लीविश्वविद्यालय

UNIVERSITY OF DELHI

Bachelor of Science Programme in Life Sciences
(CBCS)

(Botany Component)

(Effective from Academic Year 2019-20)



Revised Syllabus as approved by

Academic Council

Date:

No:

Executive Council

Date:

No:

**Applicable for students registered with Regular Colleges, Non Collegiate
Women's Education Board and School of Open Learning**

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Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. Life Sciences offer essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core and elective papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

The University of Delhi hopes the LOCF approach of the B.Sc. Programme in Life Sciences will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

B.Sc. Programme in Life Sciences (CBCS) (Botany Component)

INTRODUCTION

B.Sc. Programme in Life Sciences is designed to afford a skeletal structure within which the programme can be developed to suit the need of the hour, in keeping with the emergence of new areas of life sciences through interdisciplinary approach. The B.Sc. Programme in Life Sciences programme covers a wide range of basic and applied aspects of botany, zoology and chemistry courses as well as courses of interdisciplinary nature. The core courses that are a part of the programme are designed to build knowledge base in the student, and furthermore, acquaints the students with the applied aspects of this fascinating discipline as well. The student is thus equipped to pursue higher studies, and to apply the skills learnt in the programme to solving practical societal problems. The programme offers a wide range of elective courses of botany, zoology and chemistry. These include skill enhancement courses that prepare the student for an eventual job in academia or industry.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. It offers flexibility of programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge of all aspects of the field. The Learning outcomes-based curriculum framework is designed around the CBCS and is intended to suit the present day needs of the student in terms of securing their path towards higher studies or employment.

The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Design of Program:

The teaching-learning will involve theory classes (Lectures) of one hour duration and practical classes. The curriculum will be delivered through various methods including chalk and talk, power-point presentations, audio, video tools, E-learning/E-content, virtual labs, simulations, field trips/Industry visits, seminars (talks by experts), workshops, projects, models and class discussions. The assessment broadly will comprise of Internal Assessment (Continuous Evaluation) and End Semester Examination. The internal Assessment will be through MCQ, test, assignment, oral presentation, worksheets and short project.

Outline of Choice Based Credit System:

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1. Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course: The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on -training, competencies, skills, etc.

3.1 AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.

3.2 AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

LEARNING OUTCOME–BASED APPROACH TO CURRICULUM PLANNING:

The Learning Outcomes-based Curriculum Framework (LOCF) for the B.Sc. degree in Life Sciences is designed to afford a skeletal structure within which the programme can be developed to suit the need of the hour, in keeping with the emergence of new areas of life sciences. The framework is architected to allow for flexibility in programme design and course content development, while at the same time maintaining a basic uniformity in

structure in comparison with other universities across the country. The B.Sc. Life Sciences programme covers a wide range of basic and applied aspects of botany, zoology and chemistry courses as well as courses of interdisciplinary nature. The core courses that are a part of the programme are designed to build sound knowledge in the student, and furthermore, acquaints the students with the applied aspects of this fascinating discipline as well. The student is thus equipped to pursue higher studies in an institution of her/his choice, and to apply the skills learnt in the programme to solving practical societal problems. The programme offers a wide range of elective courses to the student. These include skill enhancement courses that prepare the student for an eventual job in academia or industry.

LEARNING OUTCOME BASED CURRICULUM FRAMEWORK

Nature and extent of the B.Sc Programme in Life Sciences

Content: Botany is the broad discipline encompassing various subjects involved with the study of plants. The Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. Present trend has been shifted to frontier areas of plant sciences at the cost of traditional botany. There is need to maintain a balance of the traditional botany and modern science and applied approach. This syllabus has been drafted to enable the learners to prepare them for future employment in various fields including academics as well as competitive exams. Students would gain wide knowledge as follow:

1. Diversity of plants and microbes their habitat, morphology, and reproduction.
2. Genetics and molecular biology of plants
3. Fungi and disease causing microbes and fungi
4. Economic value of plants and their use in Biotechnology

Plants are relevant to humans as they provide us with food, shelter, clothing, energy, health, aesthetic beauty, environment and even economy. This paper is relevant to ALL students. Introduction to Biodiversity ranging from Microbes (Viruses and Bacteria), to Fungi and to various plant groups (Algae and Archegoniates-Bryophytes, Pteridophytes and Gymnosperms) and information on the Ecological and Economic Importance of Microbes, Fungi and various plant groups to enable students understand and appreciate relevance of Microbes and Plants to environment and human well-being. Insight into the line of Plant Evolution on Earth and the consequent Biodiversity is instrumental in creating Awareness on the threats to biodiversity and sensitize young minds towards the Biodiversity Conservation for sustainable development. Combination of Theoretical and Practical components will provide comprehensive information and insight into the

1. Fascinating world of Microbes and Plants.
2. Hands on Training will help students learn use of microscope, mounting, section-cutting and staining techniques for the study of plant materials.
3. Making Drawings in Practical Records will enhance understanding morphological and structural details and related functional aspects in diverse plant groups.
4. Use of Illustrations, Photographs, Charts, Permanent Slides, Museum and Herbarium Specimens along with ICT Methods will provide an interesting insight into the beautiful world of microbes and plants.
5. Scope of Biodiversity includes Medicinal field, Industry, Agriculture, Research and Study, Job Opportunities and Environmental Conservation. This paper is both informative and

interesting and will enable students to learn about Biodiversity not only as a plant or nature lover, but also for higher academic pursuits, particularly in the field of Biological Sciences, Environment and Biodiversity Conservation.

6. The relationship between the properties of macromolecules, their cellular activities and biological responses.

7. Understanding of Cell metabolism, chemical composition, physiochemical and functional organization of organelles.

8. Contemporary approaches in modern cell and molecular biology.

9. Understand how plant sciences and microbiology is applied in manufacturing of industrial products

10. Know about design of bioreactors, factors affecting growth and production

11. Comprehend the techniques and the underlying principles in upstream and down- stream processing

12. Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection

13. Understand various biogeochemical cycles – Carbon and Nitrogen, and microbes involved

14. Understand the basic principles of organism and environment interaction and application of the same in solving environmental problems – waste water treatment and bioremediation

15. Learn the basic concepts, principles and processes in plant biotechnology.

16. Have the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical, ecological and agricultural applications.

17. Use basic biotechnological techniques to explore molecular biology of plants Explain how biotechnology is used to for plant improvement and discuss the biosefty concern and ethical issue of that use.

Aims of B.SC. Programme in Life Sciences

Content: 1. Provide an introduction to Biodiversity ranging from Microbes (Viruses and Bacteria), to Fungi, including diverse plant groups (Algae and Archegoniates-Bryophytes, Pteridophytes and Gymnosperms).

2. To enable students to understand and appreciate the relevance of Microbes and Plants to environment (ecological significance) and human well-being (economic importance).

3. Develop an understanding of Evolution of Plant forms and the consequent Biodiversity. These are instrumental in creating awareness on the threats to biodiversity and sensitize students towards the Conservation of Biodiversity for sustainable development.

4. To study the organization of cell, cell organelles and biomolecules (i.e protein, carbohydrate, lipid and nucleic acid) to gain knowledge on the activities in which the diverse macro molecules and microscopic structures inhabiting the cellular world of life are engaged. This will enable the students to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

5. To introduce students to application of microbes in Industrial production and Environmental remediation strategies.

6. New knowledge and widening of the knowledge acquired in by handling of classical and modern plant biotechnology processes, including tissue culture for healthy plants, plants with improved characteristics.
7. To explore the natural genetic variation in plants and to understand how diverse factors (at the cellular level) contribute to the expression of genotypes and hence to phenotypic variation.
8. Understanding of biotechnological processes such as recombinant DNA technology and its applicative value in pharmaceuticals (vaccines, antibodies, antibiotics etc.), food industry (transgenic crops with improved qualities (nutraceuticals, industrial enzymes etc.), agriculture (biotic and abiotic stress tolerant plants, disease and pest resistant plants, improved horticultural varieties etc.), ecology (plants role in bioremediation). This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture.
9. In the laboratory classes, students will perform some of the techniques currently used to generate information and detect genetic variation.
10. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various plants groups.
11. Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as human livelihood support system.
12. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and in the application of statistics to biological data
13. To provide new information, enhance core competency and discovery/inquiry based learning of learners. A botany graduate would be competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
14. To make students aware of most basic domain-independent knowledge, including critical thinking and communication.
15. To enable the graduate to prepare for national and International competitive examinations for employment.

GRADUATE ATTRIBUTES:

Some of the characteristic attributes of B.Sc Programme in Life Sciences include:

- Knowledge acquisition: gathers in-depth knowledge of basic and applied areas of Botany, zoology and Chemistry.
- Core subjects laboratory skills: understands various methods of safe handling, culturing and storage of plant and animal specimens and chemicals in the laboratory.

- Interdisciplinary approach: becomes aware of the role of life sciences in interdisciplinary research as well as in daily life.
- Environmental literacy: develops a basic understanding of the principles of life sciences that have environmental implications, and gains an awareness of regulatory requirements and their compliance in biotechnology and microbiological research.
- Scientific logic: develops scientific logic and approaches a problem with critical reasoning.
- Independence in thought: cultivates independent thinking and is able to integrate knowledge from other disciplines and fit that knowledge into the context of life sciences.
- Team work: understands the importance and strengths of interacting with and working alongside people from diverse backgrounds.
- Global perspective: becomes acquainted with standard international practices and emerging technologies used to study plants, animals and their structural components.
- Communication skills: develops effective communication skills through oral presentations of ongoing developments in the field and the compiling of information in the form of reports.
- Ethics: acquires an awareness of work ethics and ethical issues in scientific research as well as plagiarism policies.
- Self-motivation: develops self-discipline, planning and organization skills, and time management skills.

Qualification description: The qualification description for B.Sc. programme in Life Science include:

- Demonstration of a clear and exhaustive understanding of the basic concepts of Zoology, Botany and Chemistry, and an awareness of the emerging areas of the field.
- Acquisition of in-depth comprehension of the applied aspects of Zoology, botany and chemistry in day-to-day life.
- Enhancement of ability to read, assimilate and discuss scholarly articles and research papers showcasing subject of life sciences as well as interdisciplinary areas of life sciences.
- Sharpening of critical thinking skills facilitating the application of knowledge gained in the field of life sciences in the classroom to the practical solving of societal problems.
- Development of intellectual capabilities promoting the ability to formulate and test a hypothesis.
- Acquisition of practical laboratory skills, enabling the accurate design of an experiment and systematic collection of experimental data.
- Exhibition of ability to interpret and quantitatively analyze experimental data and maintain records of the same.
- Development of strong oral and written communication skills promoting the ability to present studies in the field of zoology, botany and chemistry using the concepts and knowledge acquired.
- Demonstration of the ability to work effectively and productively, independently or as part of a team.

QUALIFICATION DESCRIPTORS

For a graduate student in Life Sciences the qualification descriptors may include following:

- (i) To show a systematic, extensive, coherent knowledge and understanding of academic subjects and their applications, including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of Botany;
- (ii) To gain knowledge to produce professionals in the field of plant sciences in research and development, academics (teaching in Schools, Colleges and University), government and public services e.g. conservationist, plant explorer, ecologist, horticulturist, plant biochemist, genetics, nursery manager, molecular biologist, plant pathologist, taxonomist, farming consultant and environmental consultant. Further application of knowledge can enhance productivity of several economically important products. Knowledge of plant sciences is also necessary for the development and management of forests, parks, wastelands and sea wealth
- (iii) Display skills and ability to use knowledge efficiently in areas related to specializations and current updates in the subject.
- (iv) Provide knowledge about plants, current research, scholarly and professional literature of advanced learning areas of plant sciences
- (v) Use knowledge understanding and skills for critical assessment of wide range of ideas and problems in the field of Botany
- (vi) Communicate the outcomes of studies in the academic field of Botany through print and digital media.
- (vii) Apply one's knowledge and understanding of Botany to new/unfamiliar contexts and to identify problems and solutions in daily life
- (viii) Design and apply the knowledge of plant sciences in identifying the problems which can be solved through the use of plants
- (ix) To think of adopting expertise in plant structure, functions and solve the problems of environment, ecology, sustainable development and enhancing productivity.
- (x) Concept and significance of sustainable development and use of the plant resources

PROGRAM LEARNING OUTCOMES:

- Students of the B.Sc. Life Sciences programme will learn to use scientific logic as they explore a wide range of contemporary subjects spanning various basic and applied aspects life sciences
- Students will appreciate the biological diversity of plant and animals and compounds in them to be able to describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations. They will become aware of the important role of plant and animals in ecosystem functioning.
- Students will gain knowledge of various biotechnological applications of plants and animals and will learn of industrially important natural products produced by them.
- Students will become familiar with scientific methodology, hypothesis generation and testing, design and execution of experiments. Students will develop the ability to think critically and to read and analyze scientific literature.
- Students will acquire and demonstrate proficiency in good laboratory practices in biological sciences and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field.

- Students will develop proficiency in the quantitative skills necessary to analyze biological problems (e.g., arithmetic, algebra, and statistical methods as applied to biology)
- Students will develop strong oral and written communication skills through the effective Presentation of experimental results as well as through seminars.
- Graduates of the B.Sc. programme in Life Sciences will make the students to understand and evaluate the impact of new research discoveries in the life sciences, and will be able to stimulate to think on wide range of careers, including biological and medical research in higher education institutions as well as careers in public and global health, scientific writing, environmental organizations, and food, pharmaceuticals and biotechnology industries.

STRUCTURE B.SC. PROGRAMME IN LIFE SCIENCES

Credit Distribution

Course	*Credits	
	Theory+ Practical	Theory+Tutorials
I. Core Course (12 Papers)	12X4= 48	12X5=60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial* (12 Practical/ Tutorials*)	12X2=24	12X1=12
04 Courses from each of the 03 Disciplines of choice		
II. Elective Course (6 Papers)	6x4=24	6X5=30
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*6 X 2=12 (6 Practical / Tutorials*)		6X1=6
Two Papers from each discipline of choice including paper of interdisciplinary nature		
•Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6 th Semester		
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory 2X 2=4 (2 Papers of 2 credits each)		2X2=4
Environmental Science		
English/MIL Communication		
2. Ability Enhancement Elective 4 X 2=8 (Skill Based)	4 X 2=8	4 X 2=8
(4 Papers of 2 credits each)		
	Total credit= 120	Total credit= 120

Institute should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

*wherever there is practical there will be no tutorials and vice -versa

Semester wise distribution of Courses of B.Sc. Life Science under CBCS

[BOTANY COMPONENT]

Semester	Core Course	Ability Enhancement Compulsory Courses	Skill Enhancement Courses SEC 4	Discipline Specific Elective DSE(4)
I	Botany I: CC Biodiversity (Microbes, Algae, Fungi and Archegoniatae) CC Zoology I CC Chemistry I	English/MIL Communication/ Environmental Science		
II	Botany II: CC Plant Ecology and Taxonomy CC Zoology II CC Chemistry II	English/MIL Communication/ Environmental Science		
III	Botany III: CC Plant Anatomy and Embryology CC Zoology III CC Chemistry III		SEC –I 1. Biofertilizers	
IV	Botany IV: CC Plant Physiology and Metabolism CC Zoology III CC Chemistry III		SEC –II 2. Medicinal Botany	
V			3. Ethnobotany	DSE-I Botany (Any one) 1.Cell and Molecular Biology 2. Bioinformatics
VI			4. Intellectual Property Right	DSE-II Botany (Any one) 3. Economic Botany and Biotechnology 4. Analytical Techniques in Plant Sciences

Courses for Programme under B.Sc. Life Sciences

Core Courses —Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniatae)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

Discipline Specific Electives-Botany (Any two)

Semester V DSE-I	DSE-I (Any one) 1.Cell and Molecular Biology 2. Bioinformatics
Semester VI DSL-II	DSE-II (Any one) 3. Economic Botany and Biotechnology 4. Analytical Techniques in Plant Sciences
Ability Enhancement Compulsory Courses	
1. Environmental Science 2. English/M1L Communication	
Skill Enhancement Courses (four)	
Semester III SEC-I	1. Biofertilizers
Semester IV SEC-II	2. Medicinal Botany
Semester V SEC- III	3. Ethnobotany
Semester VI SEC-IV	4. Intellectual Property Right

COURSE LEARNING OBJECTIVES

The programme is designed to equip students with essential knowledge and technical skills to study plants and related subjects in a holistic manner. The main aim is to train the learners in all areas of plant biology using appropriate combinations of core and elective papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

COURSE LEARNING OUTCOME

The course learning outcomes are aligned with program learning outcomes but these are specific-to-specific courses offered in a program. The course level learning shall be reflected as program level learning. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach.

1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms. Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.

2. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data.

TEACHING-LEARNING PROCESS:

The B.Sc. programme in Life Sciences aims to make the student proficient in biology through the transfer of knowledge in the classroom as well as in the laboratory. In the classroom this will be done through blackboard and chalk lectures, charts, powerpoint presentations, and the use of audio-visual resources that are available on the internet such as virtual lab. An interactive mode of teaching will be used. The student will be encouraged to participate in discussions and deliver seminars on some topics. A problem-solving approach will be adopted wherever suitable. In the laboratory the student will first learn good laboratory practices and then get hands-on training on basic microbiological techniques and methods. Emphasis on laboratory work is particularly important keeping in mind the practical nature of the subject, and the time devoted to practicals will enable the student to better understand the applications of the different courses. Field exercises and field trips will be organized to nature and industries that will facilitate understanding of students on applied aspects of the subject and enable him to gain exposure to future places/areas of employment.

Assessment methods:

The student will be assessed over the duration of the programme by many different methods. These include short objectives-type quizzes, assignments, written and oral examinations, group discussions and presentations, problem-solving exercises, case study presentations, experimental design planning, execution of experiments, seminars, preparation of reports, and presentation of practical records. The wide range of assessment tasks aim to break the monotony of having a single assessment method

KEYWORDS

Plant Sciences, Biology, biodiversity, biotechnology, botany, bryophytes, fungi, algae, microbes, bacteria, plant pathology, plant reproduction, anatomy, developmental biology, molecular biology, genetics, systematics, taxonomy, plant physiology, biostatistics, bioinformatics, ecology, biochemistry,

CONTENTS OF COURSES OF THE PROGRAMME

Biodiversity (Microbes, Fungi, Algae and Archegoniatae)
(LSCC2)
Core Course - (CC) Credit:6

Course Objective (2-3)

This course aims at making a familiarity with special groups of Bacteria, Viruses, Fungi, algae and plants reproduction. Creating an understanding by observation and table study of representative members of phylogenetically important groups should be able to make students learn the process of evolution in a broad sense. Study of morphology, anatomy, reproduction and developmental changes therein through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants. To acquaint the students with external and internal basic structure and cellular composition of the Bacteria, Viruses, Fungi, Bryophytes and Pteridophytes and Gymnosperms. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms (Bacteria and algae). To introduce students with various fungal groups and lichens, their ecology, classification, characteristics, reproduction and economic importance.

1. To introduce students with the phytopathology, its concepts and principles
2. To acquaint with various plant diseases, causal organisms and their control
3. To correlate structure with important functions of different organs of the organisms. Study of various tissue systems and their development and functions in plants

Course Learning Outcomes

The students will be made aware of the various groups of organisms, Bacteria, viruses, algae bryophytes, pteridophytes and gymnosperms that have given rise to land habit. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. to my knowledge students should create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to these plants. Students would have understanding of the classification, characteristics features, cell structure and growth and reproduction in viruses, bacteria, and various groups of marine and fresh water algae and their ecological and economic importance.

Upon completion of this course, the students will be able to:

1. Understand the world of fungi, and pathogens of plants
2. Appreciate the characteristics of the fungi
3. Understand the ecological and economic significance of lichen
4. Understand the application of mycology in various fields of economic and ecological significance
5. Understand the economic and pathological importance of fungi, bacteria and viruses
6. Identify common plant diseases and their control measures

Unit 1

MICROBES (14 Lectures)

- a) Viruses – Discovery; General Structure- RNA virus (TMV) and DNA virus (Tphage); Replication-Lytic and Lysogenic Cycle; Economic Importance.
 - b) Bacteria – Discovery; General Characteristics and Cell Structure; Reproduction-Vegetative, Asexual and Genetic Recombination (Conjugation, Transformation and Transduction); Economic Importance.
-

Unit 2

ALGAE (8 Lectures)

General Characteristics; Outline Classification (Fritsch); Economic Importance; Thallus Organization and Reproduction in *Nostoc*, *Chlamydomonas*, *Vaucheria* and *Ectocarpus*

Unit 3

FUNGI (8 Lectures)

General Characteristics; Outline Classification (Webster); Economic Importance; Thallus Organization and Reproduction in *Rhizopus*, *Penicillium*, *Alternaria* and *Puccinia*

Unit 4

ARCHEGONIATAE (30 Lectures)

- a) Bryophytes (10 Lectures) General Characteristics; Outline Classification; Ecological and Economic Importance; Morphology, Structure and Reproduction in *Marchantia*, *Anthoceros* and *Funaria*.
-

Unit 5

- b) Pteridophytes (10 Lectures) General Characteristics; Outline Classification; Economic Importance; Morphology, Structure and Reproduction in *Selaginella*, *Equisetum* and *Pteris*.
-

Unit 6

- c) Gymnosperms (10 Lectures) General Characteristics; Outline Classification; Economic Importance; Morphology, Structure and Reproduction in *Cycas* and *Pinus*.
-

Practical

MICROBES

- a) Viruses- Structure of TMV and T-Phage (EMs/ Models/ Photographs); Lytic and Lysogenic Cycle (Line Drawings/ Photographs).
- b) Bacteria-Types and Structure (Permanent Slides/ Photographs); EM Bacterium; Binary Fission and Conjugation (Photographs).
- c) *Chlamydomonas*-E.M., *Nostoc*, *Vaucheria* and *Ectocarpus*- Study of Vegetative and Reproductive Structures through Temporary Preparations and Permanent Slides.
- d) *Rhizopus*, *Penicillium* and *Alternaria*- Asexual Stage from Temporary/ Tease Mounts, *Puccinia*-Black Stem Rust of Wheat and Infected Barberry Leaves (Herbarium)

- Specimens/ Photographs), Tease Mounts of Spores on Wheat, Section of infected portion of Wheat and Barberry (Permanent Slides).
- e) Bryophytes: *Marchantia*-Morphology of Thallus, W.M. Rhizoids, V.S. Thallus through Gemma Cup, W.M. Gemma (all Temporary Slides), L.S. Sporophyte (Permanent slide). *Anthoceros*- Morphology of Thallus, W.M. Rhizoids, L.S./ T.S. Capsule, W.M. Spores, W.M. Pseudoelaters, (all Temporary Slides), L.S. Sporophyte (Permanent slide). *Funaria*- Morphology of Gametophyte bearing Sporophyte, W.M. Rhizoids, W.M. Leaf, W.M. Operculum, W.M. Peristome, W.M. Spores (all Temporary Slides), L.S. Capsule (Permanent Slide).
 - f) Pteridophytes: *Selaginella*- Morphology, T.S. Stem, W.M. Strobilus, W.M. Microsporophyll and Megasporophyll (all Temporary Slides), L.S. Strobilus (Permanent Slide). *Equisetum*- Morphology, T.S. Stem (Internode), L.S./ T.S. Strobilus, W.M. Sporangiphore, W.M. Spores (Wet and Dry) (all Temporary Slides). *Pteris*- Morphology, V.S. Sporophyll, W.M. Sporangium, W.M. Spores (all Temporary Slides), W.M. Prothallus with Sex Organs (Permanent Slide).
 - g) Gymnosperms: *Cycas*- Morphology (Coralloid Roots, Leaf, Microsporophyll, Megasporophyll), T.S. Coralloid Root (Permanent Slide), V.S. Leaflet, V.S. Microsporophyll, W.M. Spores (all Temporary Slides), L.S. Ovule (Permanent Slide). *Pinus*- Morphology (Long and Dwarf Shoots, Male and Female Cones), W.M. Dwarf Shoot, T.S. Needle, L.S/ T.S. Male Cone, W.M. Microsporophyll, W.M. Microspores (all Temporary Slides), L.S Female Cone (Permanent Slide).

References

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). *Introductory Mycology*. Singapore, Singapore: John Wiley and Sons (Asia). (Chapters 1,4,9,13,18,20 for Unit 2)
2. Kumar, H.D. (1999). *Introductory Phycology*. New Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd. (Chapters 1,3,10,11,12,14 for Unit 3)
3. Kaur, I.D., Uniyal, P.L. (2019). *Text Book of Gymnosperms*. New Delhi, ND: Daya Publishing House, (Chapters 1,2,5, 6 for 4)
4. Parihar, N.S. (1972). *An Introduction to Embryophyta. Vol. II: Pteridophyta*. Allahabad, UP: Central Book depot. Chapters 1, 4, 5,9,for Unit 4)

Additional Resources:

1. Bhatnagar, S.P., Moitra, A. (1996). *Gymnosperms*. New Delhi, ND: New Age International (P) Ltd Publishers. (Chapters 1,6,13 for Unit 4)
2. Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2011). *Biology 9th edition*. San Francisco, SF: Pearson Benjamin Cummings. (Chapters 19,27 for Unit 1, Chapter 31 for Unit 2; Chapter for Unit 3))
3. Parihar, N.S. (1991). *An Introduction to Embryophyta. Vol. I. Bryophyta*. Allahabad, UP: Central Book Depot. (Chapters 1,3,6,9 for Unit 4)
4. Puri, P. (1985) *Bryophytes*. New Delhi, Delhi. Atma Ram and Sons, Delhi (Chapters 1,5,7,10 for Unit 4)
5. Tortora, G.J., Funke, B.R., Case, C.L. (2010). *Microbiology: An Introduction*. San Francisco, SF: Pearson Benjamin Cummings. (Chapters 13, 14 For Unit 1)
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). *Botany For Degree Students Pteridophyta*. New Delhi, Delhi: S. Chand Publication. (Chapters 1,4, 6, 9 for unit 4)

7. Vashistha, B.R., Sinha, A.K., Kumar, A. (2011). *Botany For Degree Students, Bryophyta*. New Delhi, Delhi: S Chand Publication.(Chapters 1,5,14, 18 for Unit 4)
8. Webster, J. and Weber, R. (2007). *Introduction to Fungi*. Cambridge, Cambridge University Press. Chapters 1,5, 7,22 Unit 2)

Teaching Learning Process

Visual media would be used for teaching. Botany Department, University of Delhi may be entrusted with preparation of good visual aids that would help students get a feel of the subject and they find the subject interesting. College teachers can form a group and work out these possibilities of visual aids that would enhance teaching learning process

Weekly lesson Plan

Week 1: Unit I

Week 2: Unit I

Week 3: Unit I

Week 4: Unit II

Week 5: Unit II

Week 6: Unit II

Week 7: Unit III

Week 8: Unit III

Week 9: Unit IV

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit IV

Week 13: Unit IV

Week 14: Unit IV

Assessment Methods

Making drawings from the temporary preparations as practical record books. We may ponder over making students involve in highlighting the salient features of the genera/ groups through digital media such as ppt and animations.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	a) Viruses – Discovery; General Structure- RNA virus (TMV) and DNA virus (T-phage); Replication-Lytic and Lysogenic Cycle; Economic Importance. b) Bacteria – Discovery; General Characteristics and Cell Structure; Reproduction-Vegetative, Asexual and Genetic Recombination (Conjugation, Transformation and Transduction); Economic Importance.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	FUNGI: General Characteristics; Outline Classification (Webster); Economic Importance;	Class room lectures and	Hands on exercises, PPT,

	Thallus Organization and Reproduction in <i>Rhizopus</i> , <i>Penicillium</i> , <i>Alternaria</i> and <i>Puccinia</i> .	Practical demonstration, experiments	assignments, tests
Unit III:	ALGAE: General Characteristics; Outline Classification (Fritsch); Economic Importance; Thallus Organization and Reproduction in <i>Nostoc</i> , <i>Chlamydomonas</i> , <i>Vaucheria</i> and <i>Ectocarpus</i> .	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Bryophytes : General Characteristics; Outline Classification; Ecological and Economic Importance; Morphology, Structure and Reproduction in <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> . b) Pteridophytes: General Characteristics; Outline Classification; Economic Importance; Morphology, Structure and Reproduction in <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> . c) Gymnosperms General Characteristics; Outline Classification; Economic Importance; Morphology, Structure and Reproduction in <i>Cycas</i> and <i>Pinus</i> .	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Bacteria, Viruses, Algae, Cyanobacteria, algal reproduction, viroids, bacterial reproduction, Fungi, Ascomycota, *Puccinia*, *Agaricus*, slime molds, symbiotic association, economic importance, Fungal disease, Bacterial disease, TMV

Plant Anatomy and Embryology
(LSCL4)
Core Course - (CC) Credit:6

Course Objective (2-3)

The Objective of this paper is to provide basic knowledge of plant internal architecture and cellular composition and reproduction. This will help them to understand how different plant tissue structures evolve and modify their functions with respect to their environment.

Course Learning Outcomes

Knowledge regarding anatomy equipped the students to identify different types of tissues and make them able to correlate their physiology in a better way. This will also help them to understand how different plant tissue evolve and modify their structure and functions with respect to their environment. Knowledge regarding embryology make them understand how reproduction play significant role in defining population structure, natural diversity and sustainability of ecosystem in a better way.

Unit 1

Meristematic and permanent tissues (8 lectures)

Simple (parenchyma, collenchyma, sclerenchyma) and complex tissues (xylem, phloem), Root and shoot apical meristems (describe theories in brief with special reference to Tunica Corpus and Korper-Kappe theory)

Unit 2

Organs (4 lectures)

Structure of dicot and monocot stem (include types of vascular bundles), root and leaf (including Kranz anatomy).

Unit 3

Secondary Growth (8 lectures)

Vascular cambium: structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood; Ring and diffuse porous wood; Early and late wood)

Unit 4

Adaptive and protective systems (8 lectures)

Epidermis (trichomes and hair), cuticle, stomata: structure and type (Metcalf and Chalk Classification); General account of adaptations in xerophytes and hydrophytes (Examples may be cited from *Nerium*, *Opuntia*, *Hydrilla* and *Nymphaea*).

Unit 5

Introduction to Plant Reproduction (5 lectures)

Modes of reproduction in plants: vegetative options - natural and artificial; introduction and Significance of sexual reproduction. History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison, and scope, Significance of Reproductive Biology studies.

Unit 6

Structural organization of flower (10 lectures)

Organization of flower; Structure: Anther (No developmental stage) and development of Pollen grains; Ovules: Structure and types; Embryo sac Types (monosporic, bisporic and tetrasporic) and development (with special reference to *Polygonum* type).

Unit 7

Pollination and fertilization (10 lectures)

Pollination types and adaptations; Double fertilization and triple fusion; Seed: Structure (Dicot and Monocot, No developmental stages) appendages and dispersal mechanisms (– Autochory, Anemochory, Hydrochory, Zoochory with 1 example each) Adaptations (aril, caruncle).

Unit 8:

Embryo and endosperm (10 lectures)

Endosperm types (one example of each type), structure and functions; Dicot and Monocot embryo (Brief account of dicot embryo development); Embryo endosperm relationship (General account).

Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*.
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*.
5. Leaf: Dicot and Monocot (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac (Permanent slides/photographs).

10. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) Photographs/specimens).
 11. Dissection of embryo/endosperm from developing seeds.
 12. Calculation of percentage of germinated pollen in a given medium.
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References

1. Bhojwani, S.S., Bhatnagar, S.P., Dantu P. K. (2015). *Embryology of Angiosperms*, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd. (chapter 1 for unit 5; chapters 2, 3, 4, 6 and 7 for unit 6; chapters 8, 9 for unit 7; chapters 11, 12 and 15 for unit 8)
2. Dickison, W.C. (2000). *Integrated Plant anatomy*. Cambridge, U.K.: Academic press Inc. (chapter 2 for unit 1; chapter 3 for unit 2; chapter 4 for unit 3; chapters 2 and 8 for unit 4)
3. Fahn, A. (1982). *Plant anatomy*. Oxford, U.K.: Pergamon Press. (chapters 3 to 8 for unit 1; chapters 11 to 13 for unit 2; chapters 13, 14 for unit 3; chapters 10 to 13 for unit 4)
4. Mauseth, J.D. (1988). *Plant Anatomy*. San Francisco, California: The Benjamin/Cummings Publisher. (chapters 3 to 8 for unit 1; chapters 11 to 13 for unit 2; chapters 14, 15 for unit 3; chapter 10 for unit 4)

Additional Resources

1. Evert F. R., Eichhorn S. E. (2008). *Raven Biology of Plants*. 8th Edition. New York, W.H. Freeman and Company Publishers. (chapters 23 to 26 for units 1 to 4, Chapter 19 for units 5 to 8)
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Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours. The students are asked to submit their record notebooks to the teacher/s for checking.

Weekly lesson plan

Week 1: Unit I

Week 2: Unit II

Week 3: Unit III

Week 4: Unit III

Week 5: Unit IV

Week 6: Unit IV

Week 7: Unit V
 Week 8: Unit VI
 Week 9: Unit VI
 Week 10: Mid semester Exam
 Week 11: Mid Semester Break
 Week 12: Unit VII
 Week 13: Unit VII
 Week 14: Unit VIII
 Week 15: Unit VIII

Assessment Methods

Theory:The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students. Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improve their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher. An assignment can be given in place of the presentation. The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Practicals:For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained are scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance. The Internal Assessment for practicals comprises 50 % of the total marks.

Assessment method

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
I	Meristematic and permanent tissues: Simple (parenchyma, collenchyma, sclerenchyma) and complex tissues (xylem, phloem), Root and shoot apical meristems (describe theories in brief with special reference to Tunica Corpus and Korper-Kappe theory)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
II	Organs: Structure of dicot and monocot root stem and leaf.	Class room lectures and Practical demonstration,	Hands on exercises, PPT, assignments, tests

		experiments	
III	Secondary Growth: Vascular cambium: structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
IV	Adaptive and protective systems: Epidermis (trichomes and hair), cuticle, stomata: structure and type (Metcalf and Chalk Classification); General account of adaptations in xerophytes and hydrophytes (Examples may be cited from <i>Nerium</i> , <i>Opuntia</i> , <i>Hydrilla</i> and <i>Nymphaea</i>).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
V	Introduction to Reproduction: Modes of reproduction in plants: vegetative options - natural and artificial; introduction and Significance of sexual reproduction.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VI	Structural organization of flower: Organization of flower, Structure; Anther and Pollen (No developmental stage); Ovules: Structure and types; Embryo sac: Types special reference to <i>Polygonum</i> type.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VII	Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization and triple fusion; Seed: Structure (Dicot and Monocot, No developmental stages) appendages and dispersal mechanisms.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VIII	Embryo and endosperm: Endosperm types (one example of each type), structure and functions; Dicot and Monocot embryo; Embryo endosperm relationship (General account).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Meristem, secondary growth, Vascular cambium, anther, embryo sac, pollination, double fertilization, endosperm, reproductive biology.

**Plant Ecology and Taxonomy
(LSCC3)
Core Course - (CC) Credit:6**

Course Objective (2-3)

To make students understand ecology and basic ecological concepts, interrelation between the living world and environment. Also to make them aware about identification, nomenclature and classification.

Course Learning Outcomes

After successful completion of the course the student shall have adequate knowledge about the basic principals of environment and taxonomy.

Unit 1

Introduction (1 lecture)

Inter-relation between the living world and environment

Unit 2

Ecological factors (11 lectures)

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance.

Unit 3

Plant communities (6 lectures)

Characters; Ecotone and edge effect; Succession; Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary and secondary)

Unit 4

Ecosystem (8 lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5

Phytogeography (4 lectures)

Principle biogeographical zones; Endemism (definition and types)

Unit 6

Introduction to plant taxonomy (1 lecture)

Identification, Classification, Nomenclature.

Unit 7

Identification (5 lectures)

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 8

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. (6 lectures)

Unit 9

Taxonomic hierarchy (2 lectures) Ranks, categories and taxonomic groups

Unit 10

Botanical nomenclature (6 lectures)

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11

Classification (6 lectures)

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (up to series), Engler and Prantl (up to series).

Unit 12

Biometrics, numerical taxonomy and cladistics (4 lectures)

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer, hygrometer, rain gauge and lux meter.
 2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
 1. 3 (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
 2. (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
 3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
 4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
 5. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae - *Brassica*, *Alyssum* / *Iberis*; Asteraceae - *Sonchus*/*Launaea*, *Vernonia*/*Ageratum*, *Eclipta*/*Tridax*; Solanaceae - *Solanum*/*nigrum*, *Withania*; Lamiaceae - *Salvia*, *Ocimum*; Liliaceae - *Asphodelus* / *Lilium* / *Allium*.
 6. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted on the herbarium sheet with appropriate label.)
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References

1. Kotpal, R.L., Bali, N.P. (1978). *Concepts of Ecology*. Jullundur, Punjab, Vishal Publications, (Chapter 1 for Unit 1; Chapter 3,4,5,6, for Unit 2: Chapter 12,13 for Unit 3. Chapter 7,8 for Unit 4)
 2. Sharma, P.D. (2010). *Ecology and Environment*. 8th edition Meerut, India: Rastogi Publications,..(Chapter 1 for Unit 1, Chapter 2,3,4 for Unit 2; Chapter 9,10 for Unit 3; Chapter 12,13 for Unit 4; Chapter 15 for Unit 5;
 3. Simpson, M.G. (2006). *Plant Systematics*. San Diego, CA: Elsevier Academic Press, (Chapter 1, 16 for Unit 6. Chapter 15,17,18 for Unit 7; Chapters 9-12,14, 18-21 for Unit 8; Chapter 1,2 for Unit 9; Chapter 16 for Unit 10; Chapter 7,8 for Unit 11);
 4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. New Delhi :Oxford & IBH Pvt. Ltd., (Chapter 1 for Unit 6; Chapter 5 for Unit 7; Chapter 7 for Unit 8; Chapter 3 for Unit 9; Chapter 2 for Unit 10; Chapter 10 for Unit 11).
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Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and talk and chalk method. Students are encouraged to ask questions. The reading list has been suitably upgraded. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours. The students are asked to submit their record notebooks to the teacher/s for checking and evaluation

Teaching Learning Plan

Week 1: Unit I and II
Week 2: Unit II
Week 3: Unit II
Week 4: Unit III
Week 5: Unit III, IV
Week 6: Unit IV
Week 7: Unit V
Week 8: Unit V
Week 9: Unit VI, VII
Week 10: Mid semester Exam
Week 11: Mid Semester Break
Week 12: Unit VII, VIII
Week 13: Unit IX, X
Week 14: Unit XI
Week 15: Unit XII

Assessment Methods

Theory: The students are continuously evaluated based on a written assignment, class test and/or presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students. Each student in a class is given a different topic to prepare an Assignment/PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improve their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher. An assignment can be given in place of the presentation. The Internal

Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Practicals: For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained are scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance. The Internal Assessment for practicals comprises 50 % of the total marks.

Assessment method

Unit No	Coure learning Outcome	Teaching and Learning Activity	Assessment Task
I	Inter-relation between the living world and environment	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
II	Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
III	Plant communities, Characters; Ecotone and edge effect; Succession; Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary and secondary)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
IV	Ecosystem structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
V	Phytogeography, Principle biogeographical zones; Endemism	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VI	Introduction to plant taxonomy, Identification, Classification, Nomenclature.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VII	Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

VIII	Taxonomic evidences from palynology, cytology, phytochemistry and molecular data	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IX	Taxonomic hierarchy, Ranks, categories and taxonomic groups	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit X	Botanical nomenclature, Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit XI	Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (up to series).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit XII	Biometrics, numerical taxonomy and cladistics, Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Environment, Soil, Water, Plant communities, Succession, Ecosystem, Phytogeography, Endemism, Plant taxonomy, Taxonomic hierarchy, Botanical Nomenclature, Classification, Biometrics

**Plant Physiology and Metabolism
(LSCC1)
Core Course - (CC) Credit:6**

Course Objective (2-3)

The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development; understand transport mechanisms and translocation in the phloem, and appreciate the commercial applications of plant physiology.

Course Learning Outcomes

The students are able to correlate morphology, anatomy, cell structure and biochemistry with plant functioning. The link between theory and practical syllabus is established, and the employability of youth would be enhanced. The youth can also begin small-scale enterprises.

Unit 1

Plant-water relations (8 Lectures)

Importance of water, water potential and its components, pathway of water movement, ascent of sap, transpiration and its significance, factors affecting transpiration, root pressure and guttation, stomatal movements – only ion theory.

Unit 2

Mineral nutrition (8 Lectures)

Essential elements, macro- and micronutrients, criteria of essentiality of elements, methods of studying mineral requirement (Hydroponics, Aeroponics), role of essential elements, transport of ions across membrane, active and passive transport, carriers, channels and pumps.

Unit 3

Translocation in phloem (6 lectures)

Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 4

Photosynthesis (10 Lectures)

Historical contribution of Julius von Sachs, Blackman, Emerson, Engelmann, Hill, Arnon; photosynthetic pigments (chlorophyll a and b, xanthophyll, carotene); photosystem I and II, reaction center, antenna molecules; electron transport and mechanism of ATP synthesis, C3 pathway; C4 and CAM plants (in brief, no pathways); photorespiration

Unit 5

Respiration (6 Lectures)

Glycolysis, anaerobic respiration, TCA cycle, oxidative phosphorylation, glyoxylate cycle, RQ.

Unit 6

Enzymes (4 Lectures)

Structure and properties, K_m (no derivation), mechanism of enzyme catalysis and enzyme inhibition.

Unit 7

Nitrogen metabolism (6 Lectures)

Biological nitrogen fixation - nodulation in detail, nitrate and ammonia assimilation, dinitrogenase, NR, NiR, transamination.

Unit 8

Plant growth regulators (6 Lectures)

Discovery, physiological roles of auxins, gibberellins, cytokinins and ethylene.

Unit 9

Plant response to light and temperature (6 Lectures)

Photoperiodism - discovery (SDP, LDP, day neutral plants); phytochrome (discovery and structure), red and far-red light response on photomorphogenesis (general account), florigen (brief account).

***NO STRUCTURES AND FORMULAE TO BE ASKED IN THE EXAM**

Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of the environmental factor light on transpiration by excised twig.
1. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
3. To Study Hill's reaction.
4. To study the activity of catalase and study the effect of pH and enzyme concentration.
5. To study the effect of light intensity on O₂ evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.

Demonstration experiments

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. Hydroponics (using a photograph).
5. To demonstrate the delay of senescence by cytokinins.
6. To study the phenomenon of seed germination (effect of light and darkness)

References

1. Bajracharya, D. (1999). *Experiments in Plant Physiology: A Laboratory Manual*. New Delhi, Delhi: Narosa Publishing House. (For Practicals)
2. Bhatla, S.C., Lal, M.A. (2018). *Plant Physiology, Development and Metabolism*. Singapore: Springer Nature, Singapore Pvt. Ltd. (Chapter 1 for Unit 1, Chapters 2 and 3 for Unit 2, Chapter 6 for Unit 3, Chapter 5 for Unit 4, Chapter 7 for Unit 5, Chapter 4 for Unit 6, Chapter 11 for Unit 7, Chapters 14 to 17, 19, and 27 for Unit 8, Chapters 13 and 25 for Unit 9)
3. Hopkins, W. G., Huner, N. P. A. (2009). *Introduction to Plant Physiology*, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd. (Chapters 1, 2 and 8 for Unit 1, Chapters 3 and 4 for Unit 2, Chapter 9 for Unit 3, Chapters 7 and 8 for Unit 4, Chapter 10 for Unit 5, Chapter 8 for Unit 6, Chapter 11 for Unit 7, Chapters 18 to 21, and 23 for Unit 8, Chapters 22 and 24 for Unit 9)
4. Kochhar, S.L., Gujral, S.K. (2017). *Plant Physiology: Theory and Applications*. New Delhi, Delhi: Foundation Books, imprint of Cambridge University Press India Pvt, Ltd. (Chapters 1 to 6 for Unit 1, Chapter 7 for Unit 2, Chapter 13 for Unit 3, Chapter 9 for Unit 4, Chapter 10 for Unit 5, Chapter 8 for Unit 6, Chapter 11 for Unit 7, Chapter 15 for Unit 8, Chapter 14 for Unit 9)

Additional Resources:

1. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). *Plant Physiology and Development International* 6th edition. New York, NY: Oxford University Press, Sinauer Associates. (Chapters 3 and 4 for Unit 1, Chapters 5 and 6 for Unit 2, Chapter 11 for Unit 3, Chapters 7 and 8 for Unit 4, Chapter 12 for Unit 5, Chapter 13 for Unit 7, Chapters 15, 18, 21 and 22 for Unit 8, Chapters 16 and 20 for Unit 9)

Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours. The students are asked to submit their record notebooks to the teacher/s for checking.

Weekly Plan

Week 1: Unit I

Week 2: Unit I

Week 3: Unit II

Week 4: Unit II

Week 5: Unit III

Week 6: Unit IV

Week 7: Unit IV

Week 8: Unit IV

Week 9: Unit V

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit VI

Week 13: Unit VII

Week 14: Unit VIII

Week 15: Unit IX

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. The question paper is suitably modified for such students. Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improve their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher. An assignment can be given in place of the presentation. The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Importance of water, water potential and its components, pathway of water movement,	Class room lectures and Practical	Hands on exercises, PPT,

	ascent of sap, transpiration and its significance, factors affecting transpiration, root pressure and guttation, stomatal movements – only ion theory..	demonstration, experiments	assignments, tests
Unit II:	Essential elements, macro- and micronutrients, criteria of essentiality of elements, methods of studying mineral requirement (Hydroponics, Aeroponics), role of essential elements, transport of ions across membrane, active and passive transport, carriers, channels and pumps.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Historical contribution of Julius von Sachs, Blackman, Emerson, Engelmann, Hill. Arnon; photosynthetic pigments (chlorophyll a and b, xanthophyll, carotene); photosystem I and II, reaction centre, antenna molecules; electron transport and mechanism of ATP synthesis, C3 pathway; C4 and CAM plants (in brief, no pathways); photorespiration	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V	Glycolysis, anaerobic respiration, TCA cycle, oxidative phosphorylation, glyoxylate cycle, RQ.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI	Structure and properties, Km (no derivation), mechanism of enzyme catalysis and enzyme inhibition.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VII	Biological nitrogen fixation - nodulation in detail, nitrate and ammonia assimilation, dinitrogenase, NR, NiR, transamination.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VIII	Discovery, physiological roles of auxins, gibberellins, cytokinins and ethylene.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IX	Photoperiodism - discovery (SDP, LDP, day neutral plants); phytochrome (discovery and structure), red and far-red light response on photomorphogenesis (general account), florigen (brief account)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Movement of water, ascent of sap, transpiration, stomatal movements, mineral nutrients, active and passive transport, translocation, enzymes, photosynthesis, respiration, nitrogen metabolism, plant growth regulators, photoperiodism, photomorphogenesis.

**Analytical Techniques in Plant Sciences
(LSDS3)
Discipline Specific Elective - (DSE) Credit:6**

Course Objective (2-3)

To gain the knowledge on various techniques and instruments used for the study of plant biology

Course Learning Outcomes

Understanding of principles and use various methods, tools and techniques used in plant sciences such as light microscopy, confocal transmission and electron microscopy, centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques

Unit 1

Imaging and related techniques (15 lectures)

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2

Cell fractionation (8 lectures)

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CaCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3

Radioisotopes (4 lectures)

Use in biological research, auto-radiography, pulse chase experiment.

Unit 4

Spectrophotometry (4 lectures)

Principle and its application in biological research.

Unit 5

Chromatography (8 lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6

Characterization of proteins and nucleic acids (6 lectures)

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAG

Practical

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
 2. Demonstration of ELISA.
 3. To separate nitrogenous bases by paper chromatography.
 4. To separate sugars by thin layer chromatography.
 5. Isolation of chloroplasts by differential centrifugation.
 6. To separate chloroplast pigments by column chromatography.
 7. To estimate protein concentration through Lowry's methods.
 8. To separate proteins using PAGE.
 9. To separation DNA (marker) using AGE.
 10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
 11. Preparation of permanent slides (double staining).
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References

1. Cooper, G.M., Hausman, R.E. (2009). *The Cell: A Molecular Approach*, 5th edition. Washington, D.C.: ASM Press & Sunderland, Sinauer Associates, MA. (Chapter 1 for Unit 1;
2. Iwasa, J, Marshall, W. (2016). *Karps's Cell and Molecular Biology ; Concepts and experiments*. New Jersey, U.S.A.: John Wiley & Sons. Chapter 18 for Unit 1,2,3,5,)

Teaching Learning Process

- 1) Lectures and seminars
- 2) Problem oriented learning
- 3) Individual seminar
- 4) Presentation and interpretation to other students
- 5) Discussion of published research articles on the selected topics
- 6) Practical will introduce the students to a range of tools and techniques of biotechnology

Week 1: Unit I

Week 2: Unit I

Week 3: Unit I

Week 4: Unit II

Week 5: Unit II

Week 6: Unit III

Week 7: Unit III

Week 8: Unit IV

Week 9: Instrumentation lab visit

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit V

Week 13: Unit VI

Week 14: Unit VI

Assessment Methods

Assessment must encourage and reinforce learning. It will enable robust and fair judgments about student performance. It gives the opportunity demonstrate what they have learned.

It will be done through a academic standard procedures. Assessment will be by written class test, assignment, project work, viva for internal assessment and written theory and practical examination for university evaluation.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Unit II:	Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (RasMol, J mol).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Scoring Matrices/ Amino acid substitution matrices (PAM and BLOSUM), and CLUSTALW.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Functional genomics (genome-wide and high throughput approaches to gene and protein function), Protein structure prediction and analysis- Levels of protein structure. gene prediction methods and tools. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Biological Databases, Sequence Alignment, Phylogenetics Analysis, Protein Structure prediction and analysis.

Bioinformatics
(LSDS4)
Discipline Specific Elective - (DSE) Credit:6

Course Objective (2-3)

A computer-based approach is now central to biological research. Bioinformatics operates at the intersection of biology and informatics and has a strong mathematical component. Training students in various aspects of Bioinformatics is the objective of this course.

Course Learning Outcomes

With a working knowledge of the practical and theoretical concepts of bioinformatics, you will be well qualified to progress onto advanced graduate study. The portfolio of skills developed on the programme is also suited to academic research or work within the bioinformatics industry as well as range of commercial settings.

Unit 1

Introduction to Bioinformatics (10 lectures)

Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.

Unit 2

Biological databases (10 lectures)

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol).

Unit 3

Data Generation and Data Retrieval (8 lectures)

Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA,

GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

Unit 4

Basic concepts of Sequence alignment (8 lectures)

Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Scoring Matrices/ Amino acid substitution matrices (PAM and BLOSUM), and CLUSTALW.

Unit 5

Phylogenetic analysis (8 lectures)

Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.

Unit 6

Applications of Bioinformatics (16 lectures)

Functional genomics (genome-wide and high throughput approaches to gene and protein function), Protein structure prediction and analysis- Levels of protein structure. gene prediction methods and tools. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Practical

1. Sequence retrieval (protein and gene) from NCBI.
 2. Structure download (protein and DNA) from PDB.
 3. Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR.
 4. Molecular viewer by visualization software.
 5. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences.
 6. Predict the structure of protein from its amino acid sequence.
 7. BLAST suite of tools for pairwise alignment.
 8. Sequence homology and Gene annotation.
 9. Construction of phylogenetic tree.
 10. Generating phylogenetic tree using PHYLIP.
 11. Gene prediction using GENSCAN and GLIMMER.
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References

1. Ghosh, Z., Mallick, B. (2008). *Bioinformatics – Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.(chapters 1-11 of Unit 1, chapters 1-7 Of Unit 2, chapters 1-5 Of Unit 3, chapters 1-7 of Unit 4, chapters 1-4 of Unit 5, chapters 1-8 of Unit 6.
2. Knight Regan (2017) *An Introduction to Bioinformatics*, Larsen & Keller Education, United States. (chapters 1-7 Of Unit 2, chapters 1-5 Of Unit 3).

3. Mount D.W.(2004). *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbour Laboratory Press, New York, USA. (chapters 1-5 Of Unit 3, chapters 1-7 of Unit 4, chapters 1-4 of Unit 5) .

4. Sharma, V, Munjal, A, Shankar A. (2018). *A Text Book of Bioinformatics*. Rastogi Publications, Meerut, India. (chapters 1-4 Of Unit 2, chapters 1-5 Of Unit 3, chapters 1-7 of Unit 4, chapters 1-4 of Unit 5, chapters 1-8 of Unit 6.)

Teaching Learning Process

Multimedia tutorials and hands on training over biological data using world wide web services.

Interactive classroom teaching of mathematical modelings and Computer programs.

Weekly Lesson Plan

Week 1: Unit I

Week 2: Unit I

Week 3: Unit I

Week 4: Unit II

Week 5: Unit II

Week 6: Unit III

Week 7: Unit III

Week 8: Unit IV

Week 9: Unit V

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit V

Week 13: Unit VI

Week 14: Unit VI

Assessment Methods

Theoretical tests with the help of assignments, project works, presentations, and through practical examinations.

Assessment Task

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	Class room lectures and Practical demonstration, experiments , gene ration and analysis of data	Hands on exercises, PPT, assignments, tests,
Unit II:	Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG,	Class room lectures and Practical demonstration, experiments, gener	Hands on exercises, PPT, assignments, tests

	EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol).	ation and analysis of data	
Unit III:	Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	Class room lectures and Practical demonstration, experiments, generation and analysis of data	Hands on exercises, PPT, assignments, tests
Unit IV:	Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Scoring Matrices/ Amino acid substitution matrices (PAM and BLOSUM), and CLUSTALW.	Class room lectures and Practical demonstration, experiments, generation and analysis of data	Hands on exercises, PPT, assignments, tests
Unit V:	Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.	Class room lectures and Practical demonstration, experiments, generation and analysis of data	Hands on exercises, PPT, assignments, tests
Unit VI:	Functional genomics (genome-wide and high throughput approaches to gene and protein function), Protein structure prediction and analysis- Levels of protein structure. gene prediction methods and tools. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.	Class room lectures and Practical demonstration, experiments, generation and analysis of data	Hands on exercises, PPT, assignments, tests

Keywords

Biological Databases, Sequence Alignment, Phylogenetics Analysis, Protein Structure prediction and analysis.

Cell and Molecular Biology
(LSDS2)
Discipline Specific Elective - (DSE) Credit:6

Course Objective (2-3)

Cell biology study will help the students to gain knowledge on the activities in which the giant molecules and minuscule structures that inhabit the cellular world of life are engaged. This will provide inside into the organization of cell, its features and regulation at different levels. Through the study of biomolecules (i.e. protein, carbohydrate, lipid and nucleic acid) and cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life. It would help in gaining the knowledge of structure and functions of DNA and RNA

Course Learning Outcomes

This course will be able to demonstrate foundational knowledge in understanding of: The relationship between the properties of macromolecules, their cellular activities and biological responses Understanding of Cell metabolism, chemical composition, physiochemical and functional organization of organelle Contemporary approaches in modern cell and molecular biology. Understanding of nucleic acid, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process. Processing and modification of RNA and translation process, function and regulation of expression. Application in biotechnology

Unit 1

Techniques in Biology (8 Lectures)

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2

Cell as a unit of Life (2 Lectures)

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3

Cell Organelles (20 Lectures)

Mitochondria:- Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA. Chloroplast-Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes:-Structures and roles. Peroxisomes and Glyoxisomes:_Structures, composition, functions in animals and plants and biogenesis. Nucleus:- Nuclear Envelope-structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief)

Unit 4

Cell Membrane and Cell Wall (6 Lectures)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5

Cell Cycle (6 Lectures)

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6

Genetic material (6 Lectures)

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi—conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, ds-DNA, replicating the 5' end of linear chromosome including replication enzymes.

Unit 7

Transcription (Prokaryotes and Eukaryotes) (6 Lectures) Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Unit 8

Regulation of gene expression (6 Lectures) Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Practical

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs or cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
7. Study of mitosis and meiosis (temporary mounts and permanent slides).
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene&lampbrush) either by slides or photographs.
13. Study DNA packaging by micrographs.
14. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

References

1. Becker, W.M., Kleinsmith, L.J., Hardin. J., Bertoni, G. P. (2009). *The World of the Cell*, 7th edition. San Francisco, California: Pearson Benjamin Cummings Publishing. (Ch 4 for unit 2, Ch. 21, 22 for unit 7, Ch. 23 for unit 8).
2. Cooper, G.M., Hausman, R.E. (2009). *The Cell: A Molecular Approach*, 5th edition. Sunderland, Massachusetts: Sinauer Associates, MA. (Ch. 9-11 for unit 3, Ch. 13, 14 for unit 4, Ch. 16 for unit 5, Ch. 6 for unit 6, Ch. 7,8 for unit 7).
3. De Robertis, E.D.P., De Robertis, E.M.F. (2006). *Cell and Molecular Biology*, 8th edition. Philadelphia, Pennsylvania: Lippincott Williams and Wilkins. (Ch3 for unit 1, Ch. 1 for unit 2, Ch. 8-13 for unit 3, Ch. 4 for unit 4, Ch. 14-16 for unit 5, Ch. 22 for unit 8).
4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*, 6th Edition. New Jersey, U.S.: John Wiley & Sons. Inc.(Ch18 for unit 1, Ch. 1 for unit 2, Ch. 6,9,10,12 for unit 3, Ch. 8,11for unit 4, Ch. 14 for unit 5, Ch. 4, 7 for unit 6, Ch. 6 for unit 7, Ch. 6 for unit 8).

Teaching Learning Process

Visual media would be helpful. Botany Department, University of Delhi may be entrusted with preparation of good visual aids that would help students get a feel of the subject and they find the subject interesting. College teachers can form a group and work out these possibilities of visual aids that would enhance teaching learning process.

Weekly lesson Plan

Week 1: Unit I
 Week 2: Unit I
 Week 3: Unit II
 Week 4: Unit III
 Week 5: Unit IV
 Week 6: Unit IV
 Week 7: Unit V
 Week 8: Unit VI
 Week 9: Unit VI
 Week 10: Mid semester Exam
 Week 11: Mid Semester Break
 Week 12: Unit VII
 Week 13: Unit VII
 Week 14: Unit VIII

Assessment Methods

Making drawings may be made a compulsory part of practical record books, We may ponder over making students involve in highlighting the salient features of the genera/ groups through digital media such as ppt and animations.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Mitochondria:- Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA. Chloroplast-Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes:-Structures and roles. Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis. Nucleus:- Nuclear Envelope- structure of	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

	nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure		
Unit IV:	The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V	Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI	DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ mode of replication, replication of linear, ds-DNA, replicating the 5 end of linear chromosome including replication enzymes.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VII	Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VIII	Regulation of gene expression	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Microscopy, X-ray diffraction, eukaryotic cell, mitochondria, chloroplast, Golgi body, nucleus, chromatin, membrane protein, meiosis, ribosomes, DNA replication, transcription, gene expression

**Economic Botany and Biotechnology
(LSDS1)
Discipline Specific Elective - (DSE) Credit:6**

Course Objective (2-3)

To gain the knowledge on the economically important of plants, their life cycle, processing, plant part used, application of biotechnology for the production of plant resources and production of new varieties

Course Learning Outcomes

Understanding of morphology and processing and economic value of plant sources of cereals, legumes,spices, oil,rubber, timber and medicines

Unit 1

Origin of Cultivated Plants (4 lectures)

Concept of centres of origin, their importance with reference to Vavilov's work.

Unit 2

Cereals (4lectures)

Wheat -Origin, morphology, uses

Unit 3

Legumes (6 lectures)

General account with special reference to Gram and soybean

Unit 4

Spices (6 lectures)

General account with special reference to clove and black pepper(Botanical name, family, part used, morphology and uses)

Unit 5

Beverages (4 lectures)
Tea (morphology, processing, uses)

Unit 6

Oils and Fats (4lectures)
General description with special reference to groundnut

Unit 7

Fibre Yielding Plants (4lectures)
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 8

Introduction to Plant Biotechnology (1 lecture)

Unit 9

Tissue Culture Technology (9 lectures)
Introduction; nutrient media; aseptic and culture conditions; developmental pathways: direct and indirect organogenesis and embryogenesis; single cell and protoplast culture.

Unit 10

Recombinant Technology (18 lectures)
Molecular techniques: Blotting techniques (Southern, Northern and Western); PCR; Molecular DNA markers (RAPD, RFLP, SNPs) and DNA fingerprinting in plants, Genetic Engineering Techniques: Gene cloning vectors (pUC 18, pBR322, BAC, YAC, Tiplasmid); construction of genomic and C-DNA libraries; screening for gene of interest by DNA probe hybridisation, complementation; Insertion of genes into plant tissues (Agrobacterium mediated, electroporation, micro-projectile bombardment); selection of recombinants by selectable marker and reporter genes (GUS, luciferase, GFP). Applications: Bt cotton, Roundup ready soybean, Golden rice, Flavr-Savr tomato, edible vaccines, industrial enzyme production, Bioreactors Applications: Micropropagation, androgenesis, gynogenesis, embryo and endosperm culture, secondary metabolite production, germplasm conservation.

Practical

1. Study of economically important plants: Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and micro chemical tests
 2. Familiarization with basic equipment's in tissue culture.
 3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
 4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.
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References

1. Kochhar, S.L. (2011). *Economic Botany in Tropics*. New Delhi, India: MacMillan & Co. (Chapter 1 for Unit 1; Chapter 3 for Unit 2; Chapter 5 for Unit 3; Chapter 9 for Unit 4; Chapter 11 for Unit 5; Chapter 6 for Unit 6; Chapter 2 for Unit 7);
 2. Bhojwani, S.S., Razdan, M.K. (1996). *Plant Tissue Culture: Theory and Practice*. Amsterdam, Netherlands: Elsevier Science. (Chapter 3, 4, 5, 6,12 for Unit 9)
 3. Glick, B.R., Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications*. Washington, U.S.: ASM Press. (Chapter 1 for Unit 8; Chapter 3 for Unit 10)
 4. Gupta , R., Rajpal , T., (2012) *Concise Notes on Biotechnology*. Delhi: Mc Graw Hill Publication. (Chapter 1 for Unit 8; chapter 8 for Unit 9; chapter 4 for unit 10)
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Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours. The students are asked to submit their record notebooks to the teacher/s for checking.

Weekly lesson plan

Week 1: Unit I

Week 2: Unit II

Week 3: Unit III

Week 4: Unit IV

Week 5: Unit V

Week 6: Unit VI

Week 7: Unit VII

Week 8: Unit VII

Week 9: Unit VIII

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit IX

Week 13: Unit X

Week 14: Unit X

Week 15: Unit X

Assessment Methods

The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students. Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improve their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Concept of centres of origin, their importance with reference to Vavilov's work.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	Cereals : Wheat -Origin, morphology, uses	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Legumes, general account with special reference to Gram and soybean	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Spices ,general account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Beverages, Tea (morphology, processing, uses)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Oils and Fats, general description with special reference to groundnut	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VII:	General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VIII:	Introduction to Plant Biotechnology	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IX:	Nutrient media; aseptic and culture conditions; developmental pathways: direct and indirect organogenesis and embryogenesis; single cell and protoplast culture.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit X:	Molecular techniques: Blotting techniques (Southern, Northern and Western); PCR; Molecular DNA markers (RAPD, RFLP, SNPs) and	Class room lectures and Practical demonstration, experiments	exercises, PPT, assignments, tests

<p>DNA fingerprinting in plants. Gene cloning vectors (pUC 18, pBR322, BAC, YAC, Ti plasmid); construction of genomic and C-DNA libraries; screening for gene of interest by DNA probe hybridisation, complementation; Insertion of genes into plant tissues (<i>Agrobacterium</i> mediated, electroporation, micro-projectile bombardment); selection of recombinants by selectable marker and reporter genes (GUS, luciferase, GFP). Applications: Bt cotton, Roundup ready soybean, Golden rice, Flavr-Savr tomato, edible vaccines, industrial enzyme production, Bioreactors Micropropagation, androgenesis, gynogenesis, embryo and endosperm culture, secondary metabolite production, germplasm conservation.</p>		
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Keywords

Rhizobium, *Azotobacter*, inoculum, cyanobacteria, nitrogen fixation, Azolla, VAM, mycorrhizae

Biofertilizers
(LSSE1)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective (2-3)

To gain the knowledge on the following aspects

1. Eco-friendly fertilizers like Rhizobium, Azospirillum Azotobacter, cyanobacteria and mycorrhizae, their identification, growth multiplication
2. Organic farming and recycling of the organic waste

Course Learning Outcomes

The student would have a deep understanding of ecofriendly fertilizers. They will be able to understand the growth and multiplication conditions of useful microbes such as Rhizobium, cyanobacteria, mycorrhizae, Azotobacter etc, their role in mineral cycling and nutrition to plants. The can also think of the methods of decomposition of biodegradable waste and convert into the compost

Unit 1

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. (4 lectures)

Unit 2

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication. (8 lectures)

Unit 3

Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. (4 lectures)

Unit 4

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. (8 lectures)

Unit 5

Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (6 lectures)

Practical

1. Isolation of *Anabaena* from *Azolla* leaf
 2. Study of Rhizobium from root nodules of leguminous plants by Gram staining method
 3. Test for pH, NO₂, SO₄, Cl and organic matter of different composts
 4. Observation of mycorrhizae from roots
 5. Isolation of arbuscular mycorrhizal spores from rhizospheric soil
 6. Spots, Specimen /photographs of earthworm, *Azolla*, arbuscules . vesicles
 7. Biocontrol photographs -pheromons trap, Trichoderma,, Pseudomonas, , Neem etc, , Identification and application
 8. Photographs of biocompost methods,
 9. Projects on any topic mentioned in the syllabus, with Rhizobium technology, , AMF technology, Organicfarming, vermicomposting,, biocompost , *Azolla* culture
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References

1. Kumaresan, V. (2005). *Biotechnology*. New Delhi, Delhi: Saras Publication. Chapter 39 for Unit 1, Chapter 38 for Unit 3, Chapter 57 for Unit 5)
2. Sathe, T.V. (2004). *Vermiculture and Organic Farming*. New Delhi, Delhi: Daya publishers. (Chapter 1 and 2 for Units 1, 2,3 and 5)
3. Subha Rao, N.S. (2000). *Soil Microbiology*. New Delhi, Delhi: Oxford & IBH Publishers. (Chapter 5 for Unit 2; Chapter 6 for Unit 3; Chapter 8 for Unit 1; Chapter 9 for Unit 4);

Additional Resources:

1. Vayas,S.C, Vayas, S., Modi, H.A. (1998). *Bio-fertilizers and organic Farming*. Nadiad, Gujarat: Akta Prakashan. (Chapters 2,3,4 for Unit 1; Chapter 18 for Unit 2; Chapter 19 for Unit 3; Chapter 20 for Unit 4; Chapter 4,5,6,12,13 for Unit 5)
 2. Anonymous (2016) *Proceedings of Workshop on Biofertilizers*. New Delhi. Delhi: Zakir Husain Delhi College (Chapter1 to 9 for Unit 1 to 5)
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Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded.

When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during

class hours. The students are asked to submit their record notebooks to the teacher/s for checking.

Week 2: Unit I

Week 3: Unit II

Week 4: Unit II

Week 5: Unit III

Week 6: Unit III

Week 7: Field visit

Week 8: Unit IV

Week 9: Unit IV

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit IV

Week 13: Unit V

Week 14: Unit V

Week 15: Unit V

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. The question paper is suitably modified for such students.

Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improves their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher.

The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Practicals: For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained is scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance.

The Internal Assessment for practicals comprises 50 % of the total marks.

Assessment Task

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	<i>Azospirillum</i> : isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. <i>Azotobacter</i> : classification, characteristics – crop response to <i>Azotobacter</i> inoculum, maintenance and mass multiplication.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Unit III:	Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Rhizobium, Azotobacter, inoculum, cyanobacteria, nitrogen fixation, Azolla, VAM, mycorrhizae

Ethnobotany
(LSSE3)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective (2-3)

To have the knowledge of the plants used by the local communities, tribals, ethnic groups, their nutritive and medicinal value.

Course Learning Outcomes

Students would have an understanding of the treasure, value and usefulness of the natural products and their efficient use by the local communities as food and medicine and their conservation practices.

Unit 1

Ethnobotany (6Lectures)

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants, b) intoxicants and beverages and c) Resins and oils and miscellaneous uses.

Unit 2

Methodology of Ethnobotanical studies (6 lectures)

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3

Role of ethnobotany in modern Medicine (10 lectures) Medicoethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadirachta indica* b) *Ocimum sanctum* c) *Vitex negundo* d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Unit 4

Role of ethnobotany in modern medicine with special example of *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5

Ethnobotany and legal aspects (8 lectures)

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India; Biopiracy.

Unit 6

Intellectual Property Rights and Traditional Knowledge.

Practical

1. Collection, identification and preparation of herbarium of three ethnobotanically important plants with appropriate references
 2. Preparation of crude extract of ethnobotanically important plants with appropriate references (any method to be used)
 3. Project work-documentation, literature survey, and collection of information on ethnobotanically useful plants from traditional healers)
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References

1. Gupta , R., Rajpal , T., (2012) Concise R. (2011). *Plant Taxonomy past Present and Future* . New Delhi, Delhi: TERI Press (Chapter 7 for Unit 8)
 3. Gupta , R., Rajpal, T. (2012) *Concise notes on Biotechnology*. New Delhi, Delhi: McGraw Hill Publication (chapter 14 for Unit 8)
 3. Jain, S.K. (1995). *Manual of Ethnobotany*. Rajasthan: Scientific Publishers. (Chapter 1,2,3 for Unit 1; Chapter 4 for Unit 2; Chapter 9 for Unit 3; Chapter 14 for Unit 4 ; Chapter 16 for Unit 5)
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Teaching Learning Process

To engage students and transform them into active learners the students are updated with latest books and review articles. The experiments included in the paper are performed individually or in group and are followed by group discussions and interjections

Weekly lesson Plan

Week 1: Unit I

Week 2: Unit I

Week 3: Unit II

Week 4: Unit II

Week 5: Local Field Visits

Week 6: Unit II

Week 7: Unit III

Week 8: Unit IV

Week 9: Unit IV

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit V

Week 13: Local Institute Visit

Week 14: Unit VI

Week 15: Unit VI

Assessment Methods

The students are assessed on the basis of oral presentations and regular class tests. Students are continuously assessed during practical class. Submission of class records is mandatory. This exercise develops scientific skill as well as methods of recording and presenting scientific data.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses	Activity :Class room lectures and Practical demonstration, experiments	Assessment: Hands on exercises, PPT, assignments, tests
Unit II:	Methodology of Ethnobotanical studies- Field work, Herbarium, Ancient Literature, Archaeological findings, temples and sacred places	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Medicoethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) <i>Azadiractha indica</i> b) <i>Ocimum sanctum</i> c) <i>Vitex negundo</i> d) <i>Gloriosa superba</i> e) <i>Tribulus terrestris</i> f) <i>Pongamia pinnata</i> g) <i>Cassia auriculata</i> h) <i>Indigofera tinctoria</i> .	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Role of ethnobotany in modern medicine with special example of <i>Rauwolfia serpentina</i> , <i>Trichopus zeylanicus</i> , <i>Artemisia</i> , <i>Withania</i> . Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Ethnobotany and legal aspects (8 lectures). Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Intellectual Property Rights and Traditional Knowledge.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Tribals, minor forest products, beverages, Resins, sacred groves, ethnobotanical practices, *Azadiractha indica*, *Ocimum sanctum*, *Vitex negundo*, *Gloriosa superba*, *Indigofera tinctoria*. ethnomedicines, conservation, Traditional Knowledge.

**Intellectual Property Right
(LSSE6)
Skill-Enhancement Elective Course - (SEC) Credit:4**

Course Objective (2-3)

To have knowledge of roles regulations, laws and processes of patents, copyright trademarks and concepts of traditional knowledge and protection of plant varieties.

Course Learning Outcomes

Students would have deep understanding of patents copyrights, their importance. They can think about the importance of traditional knowledge, bio-prospecting, biopiracy. They would gain the knowledge of farmers rights and the importance on indigenous plant varieties, concept of novelty and biotechnological inventions

Unit 1

Introduction to intellectual property right (IPR) (2 lectures)
Concept and kinds.Economic importance. IPR in India and world: Genesis and scope, some important examples.IPR and WTO (TRIPS, WIPO).

Unit 2

Patents (3 Lectures)
Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents.Infringement.

Unit 3

Copyrights (3 Lectures)
Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement

Unit 4

Trademarks (3 Lectures)

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name

Unit 5

Geographical Indications (3 Lectures)

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position

Unit 6

Protection of Traditional Knowledge (4 Lectures)

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio- Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 7

Industrial Designs (2 Lectures) Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 8

Protection of Plant Varieties (2 Lectures)

Plant Varieties Protection- Objectives, Justification, International Position, Plant varieties protection in India. Rights of Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9

Information Technology Related Intellectual Property Rights (4 Lectures)

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Unit 10

Biotechnology and Intellectual Property Rights (4 Lectures): Patenting Biotech Inventions

Practical

1. Patent search
2. Trademark search
3. copyright infringement (Plagiarism check by Urkund and other available software,
4. Geographical Indicators

5. food- Malabar pepper, Basmati rice, Darjeeling Tea, and Requefort cheese,
 6. handlooms (Kota Doria, Banarasi Sari, Muga Silk, Kanchipuram),
 7. Industry (Mysore agarbatti, Feni Goa, Champagne France).
 8. Natural resources- Makrana marbles Two example of each category Biopiracy- neem, turmeric
 9. Industrial designs- Jewelry design, chair design, car design, Bottle design, Aircraft design,
 10. IPR e diary
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References

1. Gupta, R. (2011). *Plant Taxonomy past Present and Future*. New Delhi, Delhi: TERI Press (Chapter 7 for Unit 6)
 2. Gupta, R., Rajpal, T. (2012). *Concise Notes on Biotechnology*. New Delhi, Delhi: Mc Graw Hill Publication (chapter 14 for Unit 1)
 3. Acharya, N.K.(2001). *Text Book on Intellectual Property Rights: (Copyright, Trademark, Patent Design, Geographical Indications, Protection of New Plant Varieties & Farmers Rights and Protection of Biodiversity*. New Delhi S.P Gogia HUF) (chapters 1 to 8 for Units 1 to 9)
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Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours.

Weekly lesson plan

Week 1: Unit I

Week 2: Unit II

Week 3: Unit III

Week 4: Unit IV

Week 5: Unit V

Week 6: Unit VI

Week 7: Unit VI

Week 8: Unit VII

Week 9: Unit VIII

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit VIII

Week 13: Unit IX

Week 14: Unit IX

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students. Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improve their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher. An assignment can be given in place of the presentation.

The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Assessment method

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Copyrights (3 Lectures) Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Geographical Indications (3 Lectures) Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

	Bio-Piracy, Alternative ways, experiments Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.		
Unit VII:	Industrial Designs (2 Lectures) Objectives, Rights, Assignments, Infringements, Defences of Design Infringement	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VIII:	Plant Varieties Protection- Objectives, Justification, International Position, Plant varieties protection in India. Rights of Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IX:	Information Technology Related Intellectual Property Rights Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
	Biotechnology and Intellectual Property Rights. Patenting Biotech Inventions	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Patents, IPR, Copyrights, trademarks, geographical indicators, traditional knowledge, industrial design, plant varieties, novelty, biotechnology.

Medicinal Botany
(LSSE2)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective (2-3)

To introduce students to complementary and alternative medicine and provide them an opportunity

To explore uses of plants as medicine ranging from traditional indigenous approach for treating ailments to modern pharmaceuticals

To inculcate awareness about the rich diversity of medicinal plants in India.

Course Learning Outcomes

Knowledge Skills

- An appreciation of the contribution of medicinal plants to traditional and modern medicine and the importance of holistic mode of treatment of the Indian traditional systems of medicine.

- To develop an understanding of the constraints in promotion and marketing of medicinal plants.

Professional and Practical Skills

- Transforming the knowledge into skills for promotion of traditional medicines.

- Developing entrepreneurship skills to establish value addition products, botanical extracts and isolation of bioactive compounds.

Unit 1

Scope and importance of medicinal plants in the traditional systems of medicine and modern medicine. Importance of preventive and holistic healing in the Indian traditional systems of medicine. Ayurveda: History, origin, fundamental doctrine and concepts of Panchamahabhutas, Saptadhatu and Tridoshas in relation to health and disease.

Unit 2

Therapeutic and pharmaceutical uses of important plants used in the Ayurveda system of medicine. Concept of Rasayanadrugs. Siddha Origin, concepts, therapeutic and pharmaceutical uses of important plants used in Siddha system of medicine. Unani: History, concept of Umoor-e-Tabiya (Fundamentals of Physique), therapeutic and pharmaceutical uses of plants used in Unani system of medicine

Unit 3

Nutraceuticals and polyherbal formulations. Plants used for the treatment of hepatic disorders, cardiac diseases, infertility, diabetes, blood pressure, cancer and skin diseases. Role of AYUSH, NMPB and AIIA in the promotion of medicinal plants.

Unit 4

Adulteration of herbal drugs. Evaluation and Standardization of crude drugs. Fundamentals of Pharmacognosy. Organoleptic, microscopic and phytochemical evaluation of plant drugs.

Unit 5

Conservation of Endangered and Endemic Medicinal plants. Red Data List Criteria. In situ Conservation: Biosphere Reserves, National Parks, Sacred Groves. Ex-situ conservation: Botanic Gardens, National Gene Banks, Plant cell, tissue, and Organ culture, Cryopreservation. Role of NBPGRI, CIMAP, JNTBGRI and RRL

Unit 6

General aspects of cultivation and propagation of medicinal plants. WHO Guidelines of Good Agricultural and Cultivation Practices (GACP). Objectives of the Nursery, classification and important components of nursery. Greenhouse technology. Propagation through cuttings, layering, grafting and budding.

Practical

- ✓ 1. Identification and medicinal value of locally available medicinal plants in the field.
 2. Study of organoleptic, macroscopic and microscopic parameters of any two plant drugs. Sections and powder microscopic evaluation.
 - ✓ 3. Isolation of bioactive compounds in the lab and phytochemical analysis of the crude extract of various parts of medicinal plants.
 4. Study of ingredients and medicinal uses of common polyherbal formulations used in the traditional systems of medicine.
 5. Project Report based on visit to Pharmaceutical Industries and/or Institutes.
 - ✓ 6. E-presentations : Traditional Systems of Medicine, Contribution of medicinal plants to alternative and modern medicine, Conservation strategies of medicinal plants, Nutraceuticals, Rasayana drugs, Medicinal plants and non-communicable diseases, Cultivation, marketing and utilisation of medicinal plants.
 - ✓ 7. Laboratory Records
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References

1. Chaudhry, B. (2019). *A Handbook of Common Medicinal Plants Used in Ayurveda*. Kojo Press, New Delhi. (For Units 1-3).

2. Purohit, Vyas (2008). *Medicinal Plant Cultivation : A Scientific Approach*, 2nd edition. Jodhpur, Rajasthan: Agrobios. (Chapter 1 for Unit 1; Chapter-6 for Unit 6, Chapter 12 for Unit 5).
3. S.B. Gokhale, C.K. Kokate (2009). *Practical Pharmacognosy*. Pune, Maharashtra: Nirali Prakashan. (For Unit 4).
4. Trivedi, P.C. (2006). *Medicinal Plants Traditional Knowledge*. New Delhi, Delhi: I.K. International Publishing House Pvt. Ltd. (Chapter 1 for Unit 4; Chapter 2 and 11 for Unit 3)

Additional Resources:

1. Trivedi, P.C. (2009). *Medicinal Plants. Utilisation and Conservation*. Jaipur, Rajasthan: Aavishkar Publishers. (Chapter 1 and 19 for Unit 5; Chapter 20 for Unit 3).
2. Evans, W. (2009). *Trease and Evans's Pharmacognosy*, 16th edition. Edinburg, London, Philadelphia, Pennsylvania: Saunders Ltd. (Chapter 1, 42-44 for Unit 4).
3. Ayush.gov.in (Ministry of AYUSH) (for Unit 1 and 2).

Teaching Learning Process

To encourage innovation, to link theoretical knowledge with practical training and application of knowledge to find practical solutions to the challenges encountered in the field of traditional medicine. To hold regular and structured workshops, seminars, field trips, collaboration with Research institutions, Industry and other Government Organizations, in order to facilitate peer learning and skill enhancement. To complement classroom teaching with discussions, presentations, quizzes, interpretation of results, short projects, writing project reports and field exposure.

Weekly lesson Plan

Week 1: Unit I

Week 2: Unit I

Week 3: Unit II

Week 4: Unit II

Week 5: Unit III

Week 6: Unit III

Week 7: Field visit

Week 8: Unit IV

Week 9: Unit IV

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit V

Week 13: Unit V

Week 14: Unit VI

Week 15: Unit VI

Assessment Methods

Continuous Evaluation

(Project/ E-presentation:10 marks, Lab Records :

Attendance in Practicals

Practical Examination:

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Scope and importance of medicinal plants in the traditional systems of medicine and modern medicine. Importance of preventive and holistic healing in the Indian traditional systems of medicine. Ayurveda: History, origin, fundamental doctrine and concepts of Panchamahabhutas, Saptadhatu and Tridosha in relation to health and disease.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	Therapeutic and pharmaceutical uses of important plants used in the Ayurveda system of medicine. Concept of Rasayanadrugs. Siddha : Origin, concepts, therapeutic and pharmaceutical uses of important plants used in Siddha system of medicine. Unani : History, concept of Umoor-e-Tabiya (Fundamentals of Physique), therapeutic and pharmaceutical uses of plants used in Unani system of medicine	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Nutraceuticals and polyherbal formulations. Plants used for the treatment of hepatic disorders, cardiac diseases, infertility, diabetes, blood pressure, cancer and skin diseases. Role of AYUSH, NMPB and AIIA in the promotion of medicinal plants.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Adulteration of herbal drugs. Evaluation and Standardization of crude drugs. Fundamentals of Pharmacognosy. Organoleptic, microscopic and phytochemical evaluation of plant drugs.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Conservation of Endangered and Endemic Medicinal plants. Red Data List Criteria. In-situ Conservation: Biosphere Reserves, National Parks, Sacred Groves. Ex-situ conservation: Botanic Gardens, National Gene Banks, Plant cell, tissue, and Organ culture, Cryopreservation. Role of NBPGR, CIMAP, JNTBGRI and RRL.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	General aspects of cultivation and propagation of medicinal plants. WHO Guidelines of Good Agricultural and Cultivation Practices (GACP). Objectives of the Nursery, classification and important components of nursery. Greenhouse technology. Propagation through cuttings, layering, grafting and budding	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

ACKNOWLEDGEMENTS

This work would not have been possible without the help by the Undergraduate Curriculum Committee, who time to time provided the academic as well as technical guidance during the revision of the courses.

I am especially indebted to Professor K. S. Rao, Head, Department of Botany, University of Delhi, who worked actively to provide me with the academic time to pursue the goal of course revision.

I am grateful to all of those with whom I have had the pleasure to work. Each of the conveners and members of working groups and other teachers have provided me extensive personal and professional guidance in the improvement of the contents of the syllabi of Botany programmes. I would especially like to thank Dr. Anuradha Sharma, Hindu College, Dr Vijay Kumar, Shivaji College and Atika Chandra, Maitryie College, who have greatly contributed in the preparation of the course revision groups and preparation of the framework and writing substantial part of the course outcome. Besides that I especially thank the following members who have been more important to me in the pursuit of this project by working as conveners and working members for the revision of the courses of Botany programmes

1. Dr Sadhna Babbar, Swami Shraddhanand College
2. Dr Madhu Bajaj, Miranda House
3. Dr Suman Kumra, Hindu College
4. Dr Sujata Sinha, Deen Dayal Upadhyay College
5. Dr Renu Kathpalia Kiromal College
6. Dr Kuldeep K. Koul, Hindu College
7. Dr Janaki Subramanyan, Miranda House
8. Dr Roshni Rajamohan, Deshbandhu College
9. Dr Kalyani Krishnan, Sri Venkateshwara College
10. Dr Rajni Gupta, Kirorimal College
11. Dr Meenam Bhatia, Daulat Ram College
12. Dr Neeru Bhandari, Dyal Singh College
13. Dr Vijaya Rani Rajpal, Hansraj College
14. Dr Dharmendra Mallick, Deshbandhu College
15. Dr Surinder Kaur, SGTB Khalsa College
16. Dr Inderdeep Kaur, SGTB Khalsa College
17. Dr Bharti Chaudhry, Ramjas College
18. Dr Rashni Mathur, Sri Aurobindo College
19. Dr D. Monika Ram, Hindu College
20. Dr S N Tripathi, Deen Dayal Upadhyay College
21. Dr Anjana Sagar, SGTB Khalsa College

22. Dr Suman Sharma, Ramjas College
23. Dr Archana Singh, Hansraj College
24. Dr Kumar Shantanu, Deshbandhu College
25. Dr Anand Sonkar, Hansraj College
26. Dr Bhupender Giri, Swami Shraddhanand College
27. Dr Priyanka Pandey (nee) Kapoor, Gargi College
28. Dr Shukla Saluja, Sri Venkateshwara College
29. Aparna Nautiyal, Deshbandhu College, University of Delhi
30. Jasleen Kaur Kalia, Dyal Singh College
31. Dr Varnika Bhatia Deen Dayal Upaddhyay College
32. Dr Monika Koul, Hansraj College
33. Dr Sudesh Bhardwaj, Kalindi College
34. Dr Saloni Bahari, Miranda House
35. Dr Mohammad Wahid Anisari, Zakir Husain Delhi College
36. Dr Savindra Chatwal, Zakr Husain Delhi College
37. Dr Smita Tripathi, Shivaji College
38. Dr Somdatta Sinha, Miranda House
39. Dr Savita Singh, Hindu College

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