



GOVERNMENT OF KARNATAKA

**NATIONAL EDUCATION POLICY-
2020
(NEP-2020)**

**Report on
Proposed Model Syllabus for
Four Years Graduate Programmes in
Universities of Karnataka State under NEP-
2020 in
BOTANY**

**Submitted to
Department of Higher Education
Government of Karnataka,
Bengaluru**

**Submission of Report on
Syllabus Framework for
04 Years Graduate
Programme in
Botany
(NEP-2020)**

Syllabus Framing Committee

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Preface

Greetings, from NEP 2020 Botany syllabus framing committee.

The committee members are thankful to the Government of Karnataka for initiating the process of implementation of NEP-2020 in our state. It is our privilege to be part of this process through a committee constituted to frame the syllabus for the UG 4 year (Honors) course in Botany.

The committee members conducted online meeting on 23.08.2021, 27.08.2021, 02.09.2021 04.09.2021 and 05.09.2021 for discussion and finalizing the course titles as per pattern given in Table II A. These deliberations also helped in preparing the syllabus for Semester I and Semester II and the programme and subject outcomes. The model draft curriculum structure and the syllabus for first 2 semesters was presented in the faculty committee on 9th September and the inputs are considered during further revision. The model draft document is ready for submitting to Karnataka State Higher Education Council for further action.

The committee will be working further to complete the remaining part of the syllabus for other papers and any academic inputs required to implement the syllabus in the spirit and philosophy of NEP 2020.

Prof. G R Naik
Vice Chancellor,
Garden City University and
Chairperson, Botany Syllabus Curriculum Committee NEP-2020

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Preamble

The objective of a B.Sc. (Honors) programme in Higher Education system is to prepare its students for the society. The current pattern is designed to provide a focused learning outcome-based syllabus at the Honors level providing structured teaching-learning experiences catering to the needs of the students. The honors courses will prepare the students both academically and in terms of employability. The programme also inculcates various attributes at the Honors level. These attributes encompass values related to emotional stability, social justice, creative and critical thinking, well-being and various skills required for employability, thus preparing students for continuous learning and sustainability. The new curriculum based on learning outcomes of BSc (Honours) Botany offers knowledge of areas including Plant Systematics, Plant Biotechnology, Resource Botany, Genetics, Ecology, Conservation biology, Physiology and Bioinformatics, Medicinal plants, Plant diseases management etc. The courses define clearly the objectives and the learning outcomes, enabling students to choose the elective subjects broadening their skills in the field of Botany. The course also offers skills to pursue research and teaching in the field of Botany and thus would produce best minds to meet the demands of society. This curriculum framework for the bachelor-level program in Botany is developed keeping in view of the student-centric learning pedagogy, which is entirely outcome-oriented and curiosity-driven. To avoid a rote-learning approach and foster imagination, the curriculum is more leaned towards self-discovery of concepts. The curriculum framework focuses on the pragmatist approach whereby practical application of theoretical concepts is taught with substantial coverage of practical and field works.

Aims of Bachelor's degree programme in Botany

The broad aims of the bachelor's degree programme in Botany are:

1. To provide an environment that ensures the cognitive development of students in a holistic manner. A dialogue about plants and their significance is fostered in this framework, rather than didactic monologues on mere theoretical aspects
2. To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A botany graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
3. To mould a responsible citizen who is aware of the most basic domain-independent knowledge, including critical thinking and communication.
4. To enable the graduate to prepare for national as well as international competitive examinations, especially UGC-CSIR NET, and UPSC Civil Services Examination.

Program Learning Outcomes

The students graduating with the Degree B.Sc. Three years and B. Sc. (Honors) Botany should be able to acquire.

Core competency: Students will acquire core competency in the subject Botany, and allied subject areas.

1. The student will be able to identify major groups of plants and compare the characteristics of lower (e.g. algae and fungi) and higher (angiosperms and gymnosperms) plants.
2. Students will be able to use the evidence-based comparative botany approach to explain the evolution of organisms and understand the genetic diversity on the earth. The students will be able to explain various plant processes and functions, metabolism, concepts of

gene, genome, and how organism's function is influenced at the cell, tissue, and organ level.

3. Students will be able to understand the adaptation, development, and behavior of different forms of life.
4. The understanding of networked life on earth and tracing the energy pyramids through nutrient flow is expected from the students.
5. Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Botany.

Analytical ability:

The students will be able to demonstrate the knowledge in understanding research and addressing practical problems.

1. Application of various scientific methods to address different questions by formulating the hypothesis, data collection, and critically analyze the data to decipher the degree to which their scientific work supports their hypothesis.

Critical Thinking and problem-solving ability:

An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinkers and acquire problem-solving capabilities.

Digitally equipped:

Students will acquire digital skills and integrate the fundamental concepts with modern tools.

Ethical and Psychological strengthening: Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.

Team Player: Students will learn team workmanship in order to serve efficiently institutions, industry, and society.

Independent Learner: Apart from the subject-specific skills, generic skills, especially in botany, the program outcome would lead to gain knowledge and skills for further higher studies, competitive examinations, and employment. Learning outcomes-based curriculum would ensure equal academic standards across the country and a broader picture of their competencies. The Bachelor's program in Botany and Botany honors may be mono-disciplinary or multidisciplinary with following broad objectives.

1. Critically evaluation of ideas and arguments by collecting relevant information about the plants, to recognize the position of the plant in the broad classification and phylogenetic level.
2. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise in the field of Plant Identification.
3. Accurately interpretation of collected information and use taxonomical information to evaluate and formulate a position of the plant in taxonomy.
4. Students will be able to apply the scientific method to questions in botany by formulating testable hypotheses, collecting data that address these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their hypotheses.
5. Students will be able to present scientific hypotheses and data both orally and in writing in the formats that are used by practicing scientists.
6. Students will be able to access the primary literature, identify relevant works for a particular topic, and evaluate the scientific content of these works.
7. Students will be able to apply fundamental mathematical tools (statistics, calculus) and physical principles (physics, chemistry) to the analysis of relevant biological situations.
8. Students will be able to identify the major groups of organisms with an emphasis on plants and be able to classify them within a phylogenetic framework. Students will be

able to compare and contrast the characteristics of plants, algae, and fungi that differentiate them from each other and other forms of life.

9. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped plant morphology, physiology, and life history.
10. Students will be able to explain the ecological interconnectedness of life on earth by tracing energy and nutrient flow through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities, and ecosystems
11. Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology.

B. Sc. Botany Course outcomes as per NEP 2020

The framework of curriculum for the Bachelor's program in Botany aims to transform the course content and pedagogy to provide a multidisciplinary, student-centric, and outcome-based, holistic education to the next generation of students.

Aside from structuring the curriculum to be more in-depth, focused, and comprehensive with significant skill-set for all exit levels; keeping in mind the job prospects; the emphasis has been to maintain academic coherence and continuum throughout the program of study and help build a strong footing in the subject, thereby ensuring a seamless transition into their careers.

Special attention is given to eliminate redundancy, discourage rote learning, and espouse a problem-solving, critical thinking, and inquisitive mindset among learners.

The curriculum embraces the philosophy that science is best learned through experiential learning, not limited to the confines of a classroom but rather through hands-on training, projects, field studies, industrial visits, and internships.

This updated syllabus, with modern technology, helps students stay informed on the leading-edge developments in plant sciences and promotes curiosity, innovation, and a passion for research, that will serve them well in their journey into scientific adventure and discovery beyond graduation.

The goal is to equip students with holistic knowledge, competencies, professional skills, and a strong positive mindset that they can leverage while navigating the current stiff challenges of the job market.

B. Sc. Botany Programme outcomes as per NEP 2020

Name of the Degree Program: B.Sc.

Discipline Core: Botany

Total Credits for the Program: 176

Starting year of implementation: 2021-22

Program Outcomes:

By the end of the program the students will be able to:

(Refer to literature on outcome based education (OBE) for details on Program Outcomes)

PO1: Skill development for the proper description using botanical terms, identification, naming and classification of life forms especially plants and microbes.

PO2: Acquisition of knowledge on structure, life cycle and life processes that exist among plant and microbial diversity through certain model organism studies.

PO3: Understanding of various interactions that exist among plants and microbes; to develop the curiosity on the dynamicity of nature.

PO4: Understanding of the major elements of variation that exist in the living world through comparative morphological and anatomical study.

PO5: Ability to explain the diversity and evolution based on the empirical evidences in morphology, anatomy, embryology, physiology, biochemistry, molecular biology and life history.

PO6: Skill development for the collection, preservation and recording of information after observation and analysis- from simple illustration to molecular database development.

PO7: Making aware of the scientific and technological advancements- Information and Communication, Biotechnology and Molecular Biology for further learning and research in all branches of Botany..

PO8: Internalization of the concept of conservation and evolution through the channel of spirit of inquiry.

PO 9: To enable the graduates to prepare for national as well as international level competitive examinations like UGC-CSIR, UPSC, KPSC etc.

PO10: To enable the students for practicing the best teaching pedagogy as a biology teacher including the latest digital modules.

PO 11: The graduates should be knowledgeable and competent enough to appropriately deliver on aspects of global importance like climate change, SDGs, green technologies etc at the right opportunity.

PO 12: The graduate should be able to demonstrate sufficient proficiency in the hands-on experimental techniques for their area of specialization within biology during research and in the professional career.

Assessment: (Teaching, Learning and Evaluation)

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	30	70
Practical	60	40
Projects	60	40
Experiential Learning (Internships etc.)	80	20

SUGGESTED METHODOLOGY FOR TEACHING, LEARNING AND EVALUATION

TEACHING-LEARNING

The whole programme is an Outcome Based Education. Different methods are to be used for teaching learning evaluation; in order to attain the fixed outcomes.

Theory:

Student: Review of Literature, Assignment, Presentation, e-learning, Discussion and Debate with peer group, teachers and experts.

Teacher: Lecture, Demonstration, Presentation, Discussion and Debate.

Practical:

Student: Identification, Comparison, Differentiation and Categorization of different plants and their parts by observing Permanent Slides, Hand sectioning etc., Demonstration, Experimentation, Field visit, Report Writing and Keeping records

Teacher: Demonstration, Experimentation, Field visit, Certification

Project: The finalization of the topic should be done at the beginning of the fourth semester and the list should be kept with the HOD for the perusal of the University Examination authorities. There should be at least three projects from a department. The selection of the topic and group should be student centered as far as possible. A project log book/register is to be maintained by each student and submitted along with the project report during the final submission.

Student: Suggestion of Topic, Discussion with the Project guide and Peer group, Review of Literature, Project planning and Designing, Experimentation, Data Analysis and Project Report Preparation and Presentation.

Teacher: Confirmation of Topic, Demonstration, Planning of Experimentation, Guidance and Correction and Certification.

Experiential Learning (Internships etc.):

Student should choose one of the topics for self-study from the beginning of the seventh semester. A report should be submitted by the end of Eighth Semester.

Suggested topics include: Studies on mangroves / Sacred groves / Campus flora; Cultivation of RET / Fruit / Vegetable / Medicinal plants / Mushroom; Topics related to Social responsibility- River restoration, PBR (People Biodiversity Register) preparation, Herbarium arrangement, VFC (Village Forest Committee), VNRC (Village Natural Resource Committee) formation, Landscaping and Green Auditing.

Field Study / Study Tour:

The plant diversity studies should be carried out with the support of Field Study / Study Tour. During each year there should be a field study of 1-5 days duration, with a minimum of 5 days for the completion of the programme.

EVALUATION**External Evaluation:**

External assessment by the University level examinations on specified times announced by the University for all the courses, theory, practical and Project/Viva Voce. Each student should go through the evaluation process according to the University Regulations 2021-2022

End Semester Evaluation-Theory:

The components of external evaluation and their unit wise and each theory and practical course and the time of examination will be in accordance with the calendar prepared by the University for each academic year. At the end of each semester, there will be an examination for theory courses. The duration of examinations for all theory and practical courses in Botany will be three hours, except for the Generic Elective Course papers.

External –Practical:

Practical Courses have external examination for all semester. There will be an external practical examiner and an internal examiner / skilled assistant for every practical examination of three hour duration. The external evaluation should be carried out by the team of examiners.

Sl. No.	COMPONENTS	WEIGHTAGE
1	Attendance	10
2	RECORD:	
	Scientific Accuracy	30
	Completeness	20
	Neatness and Legibility	10
3	Field Study Report/ Slide / Herbarium submitting	30

EXTERNAL – PROJECT / FIELD STUDY / VIVA VOCE

The Project/Field Study/General Viva Voce will be conducted in I/II/III/IV/V/VI/VII/ VIII Semester Practical Examination.

Viva should be based on:

Project work

Experiential Learning (Internships etc)

Field Study

General Learning Activity of four years:

For the external evaluation the components and weightage of Project/Field Study/ Viva Voce can be discussed and determined finally by the Board of Examiners; the suggested components and their weightage is given below. The project viva should be based on the Project and importance should be given to the Scientific method undertaken in that project. The general viva should be on based the changes in the outlook of the student after the learning activity of the 4 year programme, field study and Experiential Learning (Internships etc.). Time taken for each practical batch should be 3 hrs, by giving nearly 10-15 minutes for each student. The project/field study/viva voce evaluation should be conducted by external examiners and internal examiner.

Sl. No.	COMPONENTS	WEIGHTAGE
1	Attendance	10
2	PROJECT REPORT:	
	Report With All General Parts – Relevance, Objective, Methodology, Data Analysis, Discussion, Conclusion And Reference etc.	10
	Presentation Skill	30
	Viva	30
3	Field Study Report	10
4	Viva	10

ELIGIBILITY TO APPEAR FOR PRACTICAL EXAMINATION

1. 80% Attendance (All Sem.)
2. Certified Bona-fide Record (All Sem.)
3. Herbarium and Field Book (Respective Sem.)
4. Field Study Reports (Respective Sem.)
5. Certified Bona-fide Project Report (Eighth Sem.)
6. Report on Experiential Learning (Internships etc.) (Eighth Sem.)

CONTINUOUS INTERNAL EVALUATION

Internal evaluation is a continuous evaluation in all types of courses- theory/ practical / Project / Field study. The teacher has flexibility in deciding the components and their weightage in accordance with the University Regulations, 2021-22. Internal evaluation should be very

transparent to the students and the components and relative weightage should be announced at the beginning of each learning activity by the concerned teacher. Internal evaluation should be published in the notice board, one week before the closure of each semester.

INTERNAL –THEORY

The percentile system can be adopted for calculating the internal component, test paper.

Sl. No.	COMPONENTS	WEIGHTAGE
1	Attendance	10
	Test Papers	40
2	Assignment	20
	Seminar	20
	Viva	10

INTERNAL – PRACTICAL

The internal evaluation may be regular internal assessment on hourly basis or unit wise, whichever is communicated with the student.

Sl. No.	COMPONENTS	WEIGHTAGE
1	Regularity	25
2	Practical Skill- (Sectioning, Drawing, Labeling, Record Keeping Etc)	50
3	Regular Viva/Model Examination	25

INTERNAL - PROJECT/FIELD STUDY/VIVA VOCE

Internal evaluation of the project should start with the beginning of the project and can be finalized by the project viva.

Sl. No.	COMPONENTS	WEIGHTAGE
1	Participation	50
2	Viva	25
3	Field Study and other Assignment Reports	25

Curriculum Structure for the Undergraduate Degree Program

B.Sc. BOTANY

Total Credits for the Program: 176

Starting year of implementation: 2021-22

Name of the Degree Program: B.Sc.

Discipline/Subject: BOTANY

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately.

Semester	Title / Name Of the course	Program outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy##	Assessment\$
1	BOT A1 Microbial Diversity and Technology	PO1	---	Ex. MOOC Desk Work	Quiz
2	BOT A2 Diversity of Nonflowering Plants	PO2, PO3	BOT A1	Problem solving,	Debate
3	BOT A3 Plant Anatomy and	PO4, PO5	BOT A1 and A2		

	Developmental Biology			Book Chapter	Class work Class work Seminar Project writing Articles writing, Interpretation of results
4	BOT A4 Ecology and Conservation Biology	PO4, PO5	BOT A1 A2 A3	Seminar,	
5.	BOT A5 Plant Taxonomy and Resource Botany	PO6, PO7	BOT A1 A2 A3	Project based learning,	
	BOT A6 Cell Biology and Genetics	PO6, PO7	BOT A6 A1 A2 A3 A4 A5		
6.	BOT A7 Plant Physiology and Biochemistry	PO6, PO7, PO9	BOT A5	Term paper Assignment,	
	BOT A8 Plant Biotechnology	PO8. PO9	BOT A5	Group Discussion	
7.	BOT A9 Molecular Biology	PO8, PO9	BOT A6 A8	Research Project	
	BOT A10 Seed Biology and Seed Technology	PO9, PO10	BOT A5 A8 A9	Instrumentation	
	BOT A11 Plant Health Technology	PO9, PO10	BOT A5 A4 A8		

8.	BOT A12 Medicinal Plants and Phytochemistry	PO9, PO10	BOT A4 A5 A7 A8		
	BOT A13 Biochemistry and Computational Biology	PO9, PO10	BOT A5 A8 A9		
	BOT A14 Research Methodology	PO9, PO10	BOT A13		

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self-study like seminar, term paper or MOOC

\$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

Semester I and II

Course Title: B.Sc. BOTANY	
Total Contact Hours: 56	Course Credits:06
Formative Assessment Marks: 30	Duration of ESA/Exam: 3hrs
Model Syllabus Authors: Dr. G.R.NAIK AND TEAM	Summative Assessment Marks: 70

Course Pre-requisite(s): Mention only course titles from the curriculum that are needed to be taken by the students before registering for this course.

DISCIPLINE CORE PAPERS (DSC)

Sl. No.	Semester Details	Subject	Paper No
1	Semester I	Microbial Diversity and Technology	A-1
2	Semester II	Diversity and Conservation of Non Flowering Plants	A-2
3	Semester III	Plant Anatomy and Development Biology	A-3
4	Semester IV	Ecology and Conservation Biology	A-4
5	Semester V	Plant taxonomy and Resource Botany	A-5
		Genetics and Cell Biology	A-6
6	Semester VI	Plant Physiology and Biochemistry	A-7
		Plant Biotechnology	A-8
7	Semester VII	Molecular Biology	A-9
		Seed Biology and Seed Technology	A-10
		Plant Health Technology	A-11
8	Semester VIII	Medicinal Plants and Phytochemistry	A-12
		Bioinformatics and Computational Biology	A-13
		Research Methodology	A-14

CORESPECIFIC ELECTIVE PAPERS (DSE)

Sl No.	Semester Details	Subject: Botany	Credits	Paper No
1	Semester V	DSE 1: Algal and Fungal Biotechnology	03	E-1
2	Semester VI	DSE 2: Herbal Technology	03	E-2
3	Semester VII	DSE 3: Plant Propagation and Tissue Culture	03	E-3
4	Semester VIII	DSE 4: Landscaping, Gardening and Green House Technology	03	E-4

BOTANY COURSE OUTCOMES (COs):

At the end of the course the student should be able to:

(Write 3-7 course outcomes. Course outcomes are statements of observable student actions that serve as evidence of knowledge, skills and values acquired in this course)

Semester I (A-1): Microbial Diversity and Technology

1. Understand the fascinating diversity, evolution, and significance of microorganisms.
2. Comprehend the systematic position, structure, physiology and life cycles of microbes and their impact on humans and environment.
3. Gain laboratory skills such as microscopy, microbial cultures, staining, identification, preservation of microbes for their applications in research and industry.

Semester II (A-2): Diversity of Non- Flowering Plants

1. Understand the diversity and affinities among Algae, Bryophytes, Pteridophytes and Gymnosperms.
2. Understand the morphology, anatomy, reproduction and life cycle across Algae, Bryophytes, Pteridophytes and Gymnosperms, and their ecological and evolutionary significance.
3. Obtain laboratory skills/explore non-flowering plants for their commercial applications.

Semester III (A-3): Plant Anatomy and Developmental Biology

1. Observation of variations that exist in internal structure of various parts of a plant and as well as among different plant groups in support for the evolutionary concept.

2. Skill development for the proper description of internal structure using botanical terms, their identification and further classification.
3. Understanding the basic concepts in plant morphogenesis, embryology and organ development.

Semester IV (A-4): Ecology & Conservation Biology

1. Understanding the fundamental concepts in ecology, environmental science and phytogeography.
2. Concept development in conservation, global ecological crisis, Sustainable development and pros and cons of human intervention.
3. Enable the student to appreciate bio diversity and the importance of various conservation strategies, laws and regulatory authorities and global issues related to climate change and sustainable development.

Semester V (A-5): Plant Taxonomy & Resource Botany

1. Ability to identify, classify and describe the plants in scientific terms. Identification of plants using dichotomous keys.
2. Recognition, processing and utilization of economically important plants.
3. Skill development in processing of biomass and plant products as source of food, healthcare, energy and natural products.

Semester V (A-6): Cell Biology & Genetics

1. Identify the basic principles and current trends in classical genetics and Cell biology.
2. Recognize the historical process of the evolution of molecular genetics from classical genetics.

3. Develop theoretical background on molecular genetics to provide a strong support for the student for future research and employability.

Semester VI (A-7): Plant Physiology & Biochemistry

1. Preliminary understanding of the basic functions and intermediary metabolism in a plant body.
2. Awareness on the interdisciplinary nature of botany, chemistry and physics by studying the principles of plant life, growth and reproduction.
3. Recognizing the wonderful mechanism of transport and the Interrelationships existing between metabolic pathways thereby gaining an idea about the importance of plants in the dynamicity of nature.

Semester VI (A-8): Plant Biotechnology

1. Learning of knowledge & skill in plant tissue culture, plant molecular biology and transgenic.
2. Application of plant biotechnology in plant genomics, phylogenetic studies and metabolic engineering.
3. Understanding of new molecular techniques in cell and metabolic manipulations.

Semester VII (A-9): Molecular Biology

1. Understanding the mechanism and concepts of life process at molecular level through central dogma concept.
2. Skill acquiring in the basic molecular biology techniques & characterization of micro-molecules.
3. Acquiring the emerging technology skills in plant genetic engineering & proteomics.

Semester VII (A-10): Seed Biology & Seed Technology

1. Understanding the seed structure and related functions, seed health and productivity.
2. Technology for assessing the seed pathology, purity, and preservation.
3. Learning the field and laboratory protocols of seed production, certification and quality.

Semester VII (A-11): Plant Health Technology

1. Understanding & learning common diseases & control measures of plant diseases.
2. Acquiring skills in plant disease diagnosis, control & management through IPM.
3. Learning of new skills in health clinic through biological methods.

Semester VIII (A-13): Medicinal Plants & Phytochemistry

1. Knowledge of Indian system of medicine with regard to medicinal plants.
2. Acquiring skills in identification, cultivation and preservation of medicinal plants.
3. Isolation, identification, characteristics of active principles in medicinal plants & drug formulations.

Semester VIII (A-14): Bioinformatics & Computational Biology

1. Learning of basic principles of application, ICT Technology in biological studies & research.
2. Acquiring skill to utilize the computational apps, active data basis and tools in analysis in genetics & proteomics.
3. Learning skills and software used for biological research & process understanding.

Semester VIII (A-15): Research Methodology

1. Understanding the working of science for further application in free, independent, individual needs and in designing scientific experimentation.
2. Acquire knowledge on the principles, components and applications of various scientific equipment in biology.
3. Foundation knowledge in the basic concepts, components and functions of informatics and the importance of statistical principles in biological research.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

SEMENAR	Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1.	A-1	X	X	X			X			X			X
2.	A-2	X	X	X			X		X	X			X
3.	A-3		X	X	X	X		X		X			X
4.	A-4			X		X	X	X	X	X	X	X	X
5.	A-5, A-6	X	X	X	X	X		X	X	X	X	X	X
6.	A-7, A-8					X		X		X		X	X
7.	A-9, A-10, A-11					X	X	X		X	X	X	X
8.	A-12A-13, A-14,					X	X	X	X	X	X	X	X

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

B.Sc. BOTANY: Semester - 1

Title of the Course: Microbial Diversity and Technology

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours / semester
4	56	2	56
Content of Theory Course 1			56 Hrs
Unit –1			15
<p>Chapter No. 1: Microbial diversity-Introduction to microbial diversity; Methods of estimation; Hierarchical organization and positions of microbes in the living world. Whittaker’s five-kingdom system and Carl Richard Woese’s three-domain system. Distribution of microbes in soil, air, food and water. Significance of microbial diversity in nature.</p>			5
<p>Chapter No. 2 History and developments of microbiology-Microbiologists and their contributions (Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Dmitri Iwanowski, Sergius Winogradsky and M W Beijerinck and Paul Ehrlich).</p>			5
<p>Chapter No. 3 Microscopy-Working principle and applications of light, dark field, phase contrast and electron microscopes (SEM and TEM). Microbiological stains (acidic, basic and special) and Principles of staining. Simple, Gram’s and differential staining.</p>			5

Unit – 2	15
Chapter No. 4. Culture media for Microbes- Natural and synthetic media, Routine media -basal media, enriched media, selective media, indicator media, transport media, and storage media.	5
Chapter No. 5. Sterilization methods -Principle of disinfection, antiseptic, tyndallisation and Pasteurization, Sterilization -Sterilization by dry heat, moist heat, UV light, ionization radiation, filtration. Chemical methods of sterilization-phenolic compounds, anionic and cationic detergents.	5
Chapter No. 6. Microbial Growth -Microbial growth and measurement. Nutritional types of Microbes- autotrophs and heterotrophs, phototrophs and chemotrophs; lithotrophs and organotrophs.	5
Unit – 3	11
Chapter No. 7 Microbial cultures and preservation -Microbial cultures. Pure culture and axenic cultures, subculturing, Preservation methods-overlaying cultures with mineral oils, lyophilisation. Microbial culture collections and their importance. A brief account on ITCC, MTCC and ATCC.	5
Chapter No. 8. Viruses- General structure and classification of Viruses; ICTV system of classification. Structure and multiplication of TMV, SARS-COV-2, and Bacteriophage (T2). Cultivation of viruses. Vaccines and types.	4
Chapter No. 9. Viroids- general characteristics and structure of Potato Spindle	2

Tuber Viroid (PSTVd); Prions - general characters and Prion diseases. Economic importance of viruses.	
Unit – 4	15
Chapter No. 10. Bacteria- General characteristics and classification. Archaeobacteria and Eubacteria. Ultrastructure of Bacteria; Bacterial growth and nutrition. Reproduction in bacteria- asexual and sexual methods. Study of <i>Rhizobium</i> and its applications. A brief account of Actinomycetes and Cyanobacteria. Mycoplasmas and Phytoplasmas- General characteristics and diseases. Economic importance of Bacteria.	5
Chapter No. 11. Fungi- General characteristics and classification. Thallus organization and nutrition in fungi. Reproduction in fungi (asexual and sexual). Heterothallism and parasexuality. Type study of <i>Phytophthora, Rhizopus, Neurospora, Puccinia, Penicillium and Trichoderma</i> .	5
Chapter No. 12. Lichens – Structure and reproduction. VAM Fungi and their significance. Fungal diseases -Late Blight of Potato, Black stem rust of wheat; Downy Mildew of Bajra, Grain smut of Sorghum, Sandal Spike, Citrus Canker, Root Knot Disease of Mulberry. Economic importance of Fungi.	5

Text Books

1. Ananthnarayan R and Panikar JCK. 1986. Text book of Microbiology. Orient Longman ltd. New Delhi.
2. Arora DR. 2004. Textbook of Microbiology, CBS, New Delhi.

3. William CG. 1989. Understanding microbes. A laboratory text book for Microbiology. W.H. Freeman and Company. New York.
4. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, NewDelhi.
5. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology, S.C.Chand and Company, Ltd. Ramnagar, New Delhi.
6. Sharma R. 2006. Text book of Microbiology. Mittal Publications. New Delhi. 305pp.
7. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
8. Vasanthkumari R. 2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.

References

1. Alexopoulos CJ and Mims CW. 1989. Introductory Mycology, Wiley Eastern Ltd., NewDelhi.
2. Allas RM. 1988. Microbiology: Fundamentals and Applications, Macmillan publishing co. New York.
3. Brook TD, Smith DW and Madigan MT. 1984. Biology of Microorganisms, 4th ed. Eaglewood Cliffts. N.J.Prentice- Hall. New Delhi.
4. Burnell JH and Trinci APJ. 1979. Fungal walls and hyphal growth, Cambridge UniversityPress. Cambridge.
5. Jayaraman J. 1985. Laboratory Manual of Biochemistry, Wiley Eastern Limited. New Delhi.
6. Ketchum PA. 1988. Microbiology, concepts and applications. John Wiley and Sons. New York.
7. Michel J, Pelczar Jr.EC and Krieg CR. 2005. Microbiology, Mc.Graw-Hill, New

Delhi.

8. Powar CB and Daginawala. 1991. General Microbiology, Vol – I and Vol – II Himalaya publishing house, Bombay.
9. Reddy S and Ram. 2007. Microbial Physiology. Scientific Publishers, Jodhpur, 385pp.
10. Sullia SB and Shantharam S. 1998. General Microbiology. Oxford and IBH publishing Co.Pvt.Ltd. New Delhi.
11. Schlegel HG. 1986. General Microbiology. Cambridge. University Press. London, 587pp.
12. Roger S, Ingrahan Y, Wheelis JL, Mark L and Page PR. 1990. Microbial World 5th edition. Prentice-Hall India, Pvt. Ltd. New Delhi.
13. Sullia SB. and Shantharam S. 2005. General Microbiology, Oxford and IBH, NewDelhi.

Pedagogy:

Lectures, Practicals, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc

Formative Assessment	
Assessment Occasion/ type	Weightage in Marks
I TEST	10
II TEST	10
ASSIGNMENT	10
Total	30

Date

Course Co-ordinator

Subject Committee Chairperson

Content of Practical Course 1: List of Experiments to be conducted

Practical 1: Safety measures in microbiology laboratory and study of equipment/appliances used for microbiological studies (Microscopes, Hot air oven, Autoclave/Pressure Cooker, Inoculation needles/loop, Petri plates, Incubator, Laminar flow hood, Colony counter, Haemocytometer, Micrometer etc.).

Practical 2: Enumeration of soil/food /seed microorganisms by serial dilution technique.

Practical 3: Preparation of culture media (NA/PDA) sterilization, inoculation, incubation of *E coli* / *B. subtilis*/ Fungi and study of cultural characteristics.

Practical 4: Determination of cell count by using Haemocytometer and determination of microbial cell dimension by using Micrometer.

Practical 6: Simple staining of bacteria (Crystal violet /Nigrosine blue) / Gram's staining of bacteria.

Practical 7: Isolation and study of morphology of *Rhizobium* from root nodules of legumes

Practical 8: Preparation of spawn and cultivation of paddy straw (Oyster) mushroom.

Practical 9: Study of vegetative structures and reproductive structures - *Albugo*, *Phytophthora*/*Pythium*, *Rhizopus*/*Mucor*, *Saccharomyces*, *Neurospora*/*Sordaria*, *Puccinia*, *Agaricus*, *Lycoperdon*, *Aspergillus*/*Penicillium*, *Trichoderma*.(Depending on local availability)

Practical 10: Preparation of agar slants, inoculation, incubation, pure culturing and preservation of microbes by oil overlaying.

Practical 11: Study of late blight of Potato, Downy mildew of Bajra, Citrus canker, Tobacco mosaic disease, Sandal spike disease.

Practical 12: Study of well-known microbiologists and their contributions through charts and photographs.

Practical-13: Visit to water purification units/Composting/ microbiology labs/dairy and farms to understand role of microbes in day today life.

(Note: Botanical study tour to a floristic rich area for 1-2 days and submission of study report is compulsory)

B.Sc. BOTANY: Semester – 2

Title of the Course: Diversity of Non- Flowering Plants

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	56
Content of Theory Course 2			56Hrs
Unit –1			15
<p>Chapter No. 1 Algae –Introduction and historical development in algology. General characteristics and classification of algae, Diversity- habitat, thallus organization, pigments, reserve food, flagella types, life-cycle and alternation of generation in Algae. Distribution of Algae.</p>			5
<p>Chapter No. 2 Morphology and reproduction and life-cycles of <i>Nostoc</i>, <i>Oedogonium</i>, <i>Chara</i>, <i>Sargassum</i> and <i>Batrachospermum</i>. Diatoms and their importance. Blue-green algae-A general account. Algal blooms and toxins.</p>			5
<p>Chapter No. 3 Algal cultivation- Cultivation of microalgae-<i>Spirulina</i> and <i>Dunaliella</i>; Algal cultivation methods in India. Algal products- Food and Nutraceuticals, Feed stocks, food colorants; fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres from algae and uses.</p>			5
Unit – 2			15

Chapter No. 4. Bryophytes – General characteristics and classification of Bryophytes, Diversity-habitat, thallus structure, Gametophytes and sporophytes.	5
Chapter No. 5 Distribution, morphology, anatomy, reproduction and life-cycles of <i>Riccia</i> , <i>Anthoceros</i> , and <i>Funaria</i> . Ecological and economic importance of Bryophytes. Fossil Bryophytes.	5
Chapter No. 6. . Pteridophytes- General characteristics and classification; Structure of sporophytes and life-cycles. Distribution, morphology, anatomy, reproduction and life-cycles in <i>Selaginella</i> , <i>Equisetum</i> , <i>Pteris</i> and <i>Salvinia</i> .	5
Unit – 3	15
Chapter No. 7 A brief account of heterospory and seed habit. Stelar evolution in Pteridophytes. Affinities and evolutionary significance of Pteridophytes. Ecological and economic importance.	5
Chapter No. 8. Gymnosperms- General characteristics. Distribution and classification of Gymnosperms. Study of the habitat, distribution, habit, anatomy, reproduction and life-cycles in <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> .	5
Chapter No. 9. Affinities and evolutionary significance of Gymnosperms. Economic importance of Gymnosperms - food, timber, industrial uses and medicines.	5
Unit – 4	11

Chapter No. 10. Origin and evolution of Plants: Origin and evolution of plants through Geological Time scale.	2
Chapter No. 11. Paleobotany- Paleobotanical records, plant fossils, Preservation of plant fossils - impressions, compressions, petrification's, moulds and casts, pith casts. Radiocarbon dating.	5
Chapter No. 12. Fossil taxa- <i>Rhynia</i> , <i>Lepidodendron</i> , <i>Lepidocarpon</i> , <i>Lyginopteris</i> and <i>Cycadeoidea</i> . Exploration of fossil fuels. Birbal Sahni Institute of Paleosciences.	4

Text Books

- 1) Chopra, G.L. A text book of Algae. Rastogi & Co., Meerut, Co., New Delhi, Depot. Allahabad.
- 2) Johri, Lata and Tyagi, 2012, A Text Book of, Vedam e Books, New Delhi.
- 3) Sharma, O.P. 1990. Text Book of Pteridophyta. McMillan India Ltd. New Delhi.
- 4) Sharma, O.P. 1992. Text Book of Thallophytes. McGraw Hill Publishing Co. New Delhi.
- 5) Sharma, O.P., 2017, Algae Singh-Pande-Jain 2004-05. A Text Book of Botany. Rastogi Publication, Meerut.

References

1. Sambamurty, A.V.S.S.. A Text Book of Algae. I.K. International Private Ltd., New Delhi.
2. Agashe, S.N. 1995. Paleobotany. Plants of the past, their evolution, paleoenvironment and Allied plants. Hutchinson & Co., Ltd., London.
3. Anderson R.A. 2005, Algal cultural Techniques, Elsevier, London.
4. Publication, Application in exploration of fossil fuels. Oxford & IBH., New Delhi.

5. Eams, A.J., (1974) Morphology of vascular plants - Lower groups. Tata Mc Grew-Hill Publishing Co. New Delhi, Freeman & Co., New York.
6. Fritze, R.E. 1977. Structure and reproduction of Algae. Cambridge University Press.
7. Goffinet B and Shaw A.J. 2009, Bryophyte Biology, 2nd ed. Cambridge University Press, Cambridge. Gymnosperms.
8. Srivastava, H N, 2003. Algae Pradeep Publication, Jalandhar, India.
9. Kakkar, R.K. and B.R.Kakkar (1995) The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad.
10. Kumar H. D., 1999, Introductory Phycology, Affiliated East-West Press, Delhi.
11. Lee, R.E., 2008, Phycology, Cambridge University Press, Cambridge. 4th edition. McGraw Hill Publishing Co., New Delhi.
12. Parihar, N.S. 1970. An Introduction to Embryophyta. Vol. I. Bryophyta. Central Book, Allahabad.
13. Parihar, N.S. (1976) An Introduction to Pteridophytes, Central Book Depot, Allahabad.
14. Parihar, N.S. 1977. The Morphology of Pteridophytes. Central Book Depot., Allahabad. Press, Cambridge.
15. Rashid, A. 1998. An Introduction to Pteridophyta. II ed., Vikas Publishing House, New Delhi.
16. Smith, G.M. 1971. Cryptogamic Botany. Vol. II. Bryophytes & Pteridophytes. Tata Tata McGraw Hill Publishing, New Delhi.
17. Smith, G.M. 1971. Cryptogamic Botny. Vol.I Algae & Fungi. Tata McGraw Hill Publishing. New Delhi.

18. Sporne, K.R. 1965. The Morphology of Gymnosperms. Hutchinson & Co., Ltd., London.
19. Stewart, W.M. 1983. Paleobotany and the Evolution of Plants, Cambridge University Cambridge.
20. Sundarajan, S. 1997. College Botany Vol. I. S Chand & Co. Ltd., New Delhi.
21. Vanderpoorten, A. and Goffinet, B. 2009, Introduction to Bryophytes, Cambridge University Press, Cambridge.
22. Vashista, B.R. 1978. Bryophytes. S Chand & Co. Ltd., New Delhi.

Pedagogy: Lectures, Practicals, Field and laboratory visits, participatory learning, seminars, assignments, MOOCs and specimen preparation and submission.

Formative Assessment	
Assessment Occasion / type	Weightage in Marks
I TEST	10
II TEST	10
ASSIGNMENT	10
Total	30

Date

Course Co-ordinator

Subject Committee Chairperson

Content of Practical Course 2: List of Experiments to be conducted

Practical-1: Study of morphology, classification, reproduction and lifecycle of *Nostoc/Oscillatoria*.

Practical-2: Study of morphology, classification, reproduction and life-cycle of *Oedogonium* & *Chara*, *Sargassum*, *Batrachospermum/ Polysiphonia*.

Practical-3: Study of morphology, classification, reproduction and life-cycle of *Riccia* & *Anthoceros*.

Practical-4: Study of morphology, classification, anatomy, reproduction and life-cycle of *Selaginella* and *Equisetum*.

Practical -5: Study of morphology, classification, anatomy, reproduction and life-cycle of *Pteris*, *Azolla*..

Practical -6: Study of morphology, classification, anatomy and reproduction in *Cycas*.

Practical -7: Study of morphology, classification & anatomy, reproduction in *Pinus*.

Practical -8: Study of morphology, classification & anatomy, reproduction in *Gnetum*.

Practical -9: Study of important blue green algae causing water blooms in the lakes.

Practical -10: Study of different methods of cultivation of ferns in a nursery.

Practical -11: Preparation of natural media and cultivation of *Azolla* in artificial ponds.

Practical -12: Media preparation and cultivation of *Spirulina*.

Practical -13: Study different algal products and fossils impressions and slides.

Practical-14: Visit to algal cultivation units/lakes with algal blooms/Fern house/ Nurseries/Geology museum/lab to study plant fossils.

(Note: Botanical study tour to a floristic rich area for 1-2 days and submission of study report is compulsory)

Job opportunities in Botany

Exit After ONE Year: Certificate Course

I Sem. - A1: Microbial Diversity and Technology

II Sem. – A2: Diversity and Conservation of Non- Flowering plants

Job opportunities in Botany

- Preparation of algal, fungal microbial, bryophyte, pteridophyte, and gymnosperm slides for educational institutions and other line departments (Entrepreneurship).
- Providing algal, fungal microbial, bryophyte, pteridophyte, and gymnosperm materials for educational institutions and other line departments (Entrepreneurship).
- Developing Nursery (Entrepreneurship).
- Nursery supervisor/manager
- Mushroom cultivation (Entrepreneurship).
- Cyanobacterial, algal and microbial culture (Entrepreneurship).
- Fermentation industries. Dairy farming industries. Dairy products industries. Spice Industries (Lichens)
- Quarantine dept., Quality control/analyst, packaging, Lab. assistant

Job opportunities in Botany

Exit After **TWO** Year: **Diploma Course**

III Semester- A3: Plant Anatomy and Developmental Biology

IV Semester- A4: Ecology and Conservation Biology

Job opportunities in Botany

In Addition to one year certificate

- Preparation of Anatomy embryology and Ecological slides for educational institutions and other line departments (Entrepreneurship).
- Providing Anatomy embryology and Ecological materials for educational institutions and other line departments (Entrepreneurship).
- Lab technician
- Garden / nursery supervisor
- Developing his/her own nursery (Entrepreneurship).
- Forest guard, Wild life watch guard.
- Forest nursery (Entrepreneurship).

Job opportunities in Botany

Exit After **THREE** Year: **Degree Course**

V Semester- **A5: Plant Taxonomy and Resource Botany**

V Semester- **A6: Genetics and Cell Biology**

VI Semester- **A7: Plant Physiology and Biochemistry**

VI Semester- **A8: Plant Biotechnology**

Job opportunities in Botany

In Addition to two year diploma

- Supplying the angiosperm plants and cytological slides to the educational institutions and other line departments (Entrepreneurship).
- Advisor for Health department
- Marketing NTFPs species (Entrepreneurship).
- RFO/ forest officers
- Biochemical Laboratory (Soil, Water, Air testing etc). (Entrepreneurship).
- Adviser to grow advanced crop (Biotech crop).
- Farmer friendly liaison officer.
- Advisor for crop improvement programme.
- Teacher in primary and High Schools

Job opportunities in Botany

Exit After FOUR Year: Degree Course (Honors)

VII Semester-	A9: Molecular Biology
VII Semester-	A10: Seed Biology and Seed Technology
VII Semester-	A11: Plant Health Technology
VIII Semester-	A12: Medicinal Plants and Phytochemistry
VIII Semester-	A13: Bioinformatics & Computational Biology
VIII Semester-	A14: Research Methodology

Jobs opportunities in Botany

In Addition to three year degree

- Assisting for Ayurvedic doctors.
- Medicinal plants Marketing (Entrepreneurship).
- R & D Botany, Biotechnology, Ayurvedic and Pharmaceutical Lab.
- Laboratory on checking food adulteration (Entrepreneurship).
- Soil and water assessment laboratory (Entrepreneurship).
- Biological material analysis Laboratory (Entrepreneurship).
- Teacher in primary and High Schools.
- Prepare for joining Research institution for Ph.D. programmes.
- Wild life photographer
- Separation and Analyzing phytochemical compounds.
- Seed technician.
- Plant health manager