PROGRAM OUTCOMES, PROGRAM SPECIFIC OUTCOMES & COURSE OUTCOMES
DEPARTMENT OF BOTANY

Government General Degree College, Singur, Hooghly
DEPARTMENT OF BOTANY

Affiliated under THE UNIVERSITY OF BURDWAN
Under
Choice Based Credit System (CBCS)
(*w.e.f.* Academic Year 2017-2018)

Structure of B.Sc. Honours Botany under CBCS:
Core Courses:

1. Microbiology and Phycology
2. Archegoniatae
3. Mycology and Phytopathology
4. Morphology and Anatomy of Angiosperms
5. Plant Ecology and Phytogeography
6. Plant Systematics
7. Economic Botany
8. Palaeobotany and Palynology
9. Biomolecules and Cell Biology
10. Molecular Biology
11. Plant Physiology
12. Plant Metabolism
13. Genetics and Plant Breeding
14. Plant Biotechnology

Skill Enhancement Courses: Elective (Two)	
Semester- III SEC-I	**SEC-I (Any one)** 1. **ETHNOBOTANY*** 2. Intellectual Property Rights 3. Medicinal Botany 4. Mushroom Culture Technology 5. Agricultural Botany
Semester-IV SEC-II	**SEC-II (Any one)** 1. **BIOFERTILIZERS*** 2. Herbal Technology 3. Nursery & Gardening 4. Floriculture 5. Plant Diversity & Human Welfare
***Subject selected in our college**	

#Generic Electives (Four) Offered to the students of other Departments	
Semester –I (GE I)	**GE-I** (*Same as core course-1 of B.Sc. Botany general*) 1. Biodiversity (Microbes, Algae, Fungi and Archegoniatae)
Semester –II (GE II)	**GE-II** (*Same as core course-II of B.Sc. Botany general*) 2. Plant Ecology and Taxonomy
Semester –III (GE III)	**GE-III** (*Same as core course-III of B.Sc. Botany general*) 3. Plant Anatomy and Embryology
Semester –IV (GE IV)	**GE-IV** (*Same as core course-IV of B.Sc. Botany general*) 4. Plant Physiology and Plant Metabolism
#For Botany Honours students Generic Electives will be any subjects other than Botany	

Discipline Specific Electives (Four)

SEMESTER – V

DSE- 1 (Any One)

1. Techniques in Plant Sciences

2. REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (REP. BIOL. OF ANGIO.)*

3. Sylviculture & Forest Management (Sylvi. Cult. & Forest Mangt.)

DSE- II (Any One)

1. Biostatistics
2. Bioinformatics
3. **NATURAL RESOURCE MANAGEMENT (**NAT. RES. MGMT)*

DSE- III (Any One)

1. Phytoremediation & Immunology (Phyt. Rem & Immn)
2. **PLANT EVOLUTION & BIODIVERSITY (** PLNT. EVL. & BIODV)*
3. Marine Biology & Phycotechnology (Mar. Biol. & PyTec)

DSE- IV (Any One)

1. Horticulture Practices & Post-Harvest Technology (Hort. Prct. & PHT)
2. **INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (**IND & ENV. MICROB.)*

***Subject selected in our college**

Ability Enhancement Compulsory Course

1. **AECC- 1** Environmental Studies (ENVS)
2. **AECC- 2** English Communication / MIL

Semester wise Distribution of Courses

Semester	Core Course (14)	Ability Enhancement Compulsory Course (AEC)(2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective: (DSE) (4)	Generic Elective: (GE) (4)
I	Microbiology and Phycology Archegoniatae	ENVS			GE – I (For other than Botany Hons student)
II	Mycology and Phytopathology Morphology & Anatomy	English Communication / MIL			GE – II (For other than Botany Hons student)
III	Plant Ecology & Phytogeography Plant Systematics Economic Botany		SEC-I (Any one) 1. **Ethnobotany** 2. Intellectual PropertyRights 3. Medicinal Botany 4. Mushroom CultureTechnology 5. Agricultural Botany		GE – III (For other than Botany Hons student)
IV	Palaeobotany& Palynology Biomolecules & Cell Biology Molecular Biology		SEC-II (Any one) 1. **Biofertilizers** 2. Herbal Technology 3. Nursery & Gardening 4. Floriculture 5. Plant Diversity &Human Welfare		GE – IV (For other than Botany Hons student)
V	Plant Physiology Plant Metabolism			DSE-I (Any One) 1.Techniques in PlantSciences **2. Rep. Biol. of Angio.** 3. Sylvi. Cult. & Forest Mangt. DSE-II (Any One) 1.Biostatistics 2. Bioinformatics **3.Nat. Res. Mgmt**	
VI	Genetics & Plant Breeding Plant Biotechnology			DSE-III (Any One) 1.Phyt. Rem & Immn **2. Plnt. Evl. & BioDv** 3. Mar. Biol. & PyTec DSE-IV (Any One) 1. Hort. Prct. & PHT **2. Ind & Env. Microb.**	

CREDIT DISTRIBUTION

SEMESTER	COURSE OPTED	COURSE: NAME	Credits
SEM – I Total Credit**22**	Ability Enhancement Compulsory Course-I	ENVS	4
	Core Course-I	Microbiology and Phycology	4
	Core Course-I **Practical**	Microbiology and Phycology- Practical	2
	Core Course-II	Archegoniate	4
	Core Course-II **Practical**	Archegoniate - Practical	2
	Generic Elective-I	GE-I	4
	Generic Elective-I **Practical/Tutorial**	GE-I- Practical	2
SEM – II Total Credit**20**	Ability Enhancement Compulsory Course-II	English Communication/MIL	2
	Core Course-III	Mycology and Phytopathology	4
	Core Course-III **Practical**	Mycology and Phytopathology- Practical	2
	Core Course-IV	Morphology & Anatomy	4
	Core Course-IV **Practical**	Morphology & Anatomy - Practical	2
	Generic Elective-II	GE-II	4
	Generic Elective-II **Practical**	GE-II – Practical	2
SEM – III Total Credit**26**	Core Course-V	Plant Ecology & Phytogeography	4
	Core Course-V **Practical**	Plant Ecology & Phytogeography - Practical	2
	Core Course-VI	Plant Systematics	4
	Core Course-VI **Practical**	Plant Systematics –Practical	2
	Core Course-VII	Economic Botany	4
	Core Course-VII **Practical**	Economic Botany - Practical	2
	Skill EnhancementCourse-I	SEC-I (Any one)	2
	Generic Elective-III	GE-III (Any one)	4
	Generic Elective-III **Practical**	GE-III - Practical	2
SEM - IV Total Credit **26**	Core Course-VIII	Palaeobotany & Palynology	4
	Core Course-VIII **Practical**	Palaeobotany & Palynology – Practical	2
	Core Course-IX	Biomolecule & Cell Biology	4
	Core Course-IX **Practical**	Biomolecule & Cell Biology – Practical	2
	Core Course-X	Molecular Biology	4
	Core Course-X **Practical**	Molecular Biology - Practical	2
	Skill Enhancement Course-II	SEC-II (Any one)	2
	Generic Elective-IV	GE-IV	4
	Generic Elective-IV **Practical**	GE-IV - Practical	2

SEM – V Total Credit **24**	Core Course-XI	Plant Physiology	4
	Core Course-XI **Practical**	Plant Physiology - Practical	2
	Core Course-XII	Plant Metabolism	4
	Core Course-XII **Practical**	Plant Metabolism - Practical	2
	Discipline Specific Elective-I	DSE-I	4
	Discipline Specific		2
	Elective-I	DSE-I- Practical	
	Practical		
	Discipline Specific Elective-II	DSE-II	4
	Discipline Specific		
	Elective-II	DSE-II – Practical	2
	Practical		
SEM – VI Total Credit**24**	Core Course-XIII	Genetics	4
	Core Course-XIII	Genetics - Practical	2
	Practical		
	Core Course-XIV	Plant Biotechnology	4
	Core Course-XIV **Practical**	Plant Biotechnology- Practical	2
	Discipline Specific Elective-III	DSE-III	4
	Discipline Specific	DSE-III - Practical	2
	Elective-III **Practical**		
	DSE – IV	DSE – IV	4
	DSE – IV – Practical	DSE – IV – Practical	2
	TOTAL		**142**

College has a team for NSS related works which is headed by the Principal and a University recognized NSS- Coordinator.

STRUCTURE OF B.Sc. HONOURS BOTANY PROGRAMME UNDER CBCS

Part	Year	Semester (July to December)	Semester (January to June)
Part – I	First Year	Semester I	Semester II
Part – II	Second Year	Semester III	Semester IV
Part – III	Third Year	Semester V	Semester VI

EXAMINATIONS:

The evaluation of each course shall contain two parts:

(i) INTERNAL ASSESSMENT (IA)

(ii) END-SEMESTER EXAMINATION (ESE)

COMPUTATION OF GRADE AND GRADE POINTS

For all courses (theory & practical), grades are given on a 08-point scale based on the total percentage of marks **(IA + ESE)** as given below:

% of Marks for a course	**CGPA Letter Grades**	**Grade Point Norms**
90% and above up to 100%	O - Outstanding	10
80% and above but below 90%	A^+ - Excellent	9
70% and above but below 80%	A - Very Good	8
60% and above but below 70%	B^+ - Good	7
50% and above but below 60%	B - Satisfactory	6
40% and above but below 50%	C - Average	5
35% and above but below 40%	D - Pass	4
Below 35	Not Awarded	0
	Ab – Absent	0

Mark sheet will be given after each semester

After completion of the 6th Semester a consolidated Mark sheet containing marks of all the semester will be given to each student.

Serial No [redacted]

B.Sc. (Honours) Semester VI

THE UNIVERSITY OF BURDWAN
B.SC. 3-YEAR DEGREE HONOURS FINAL EXAMINATION 2022 UNDER CBCS
GRADE CARD

Name : [redacted]

Roll No. 190[redacted]

Honours: BOTANY

Semester No.	Subject	Course Code	Course Title	Grade (G)	Credit Value (V)	Grade Point (G×V)	Credit Retained Year	SGPA on the basis of CCs & DSEs	SGPA on the basis of All Courses	Result Code
I	BOTANY	CC-1	Microbiology and Phycology	6	6	36	2019	5.50	5.45	Q
		CC-2	Archegoniatae	5	6	30	2019			
	CHEMISTRY	GE-1	Atomic Structure, Chemical Periodicity, Acids And Bases, Redox Reactions, General Organic Chemistry & Aliphatic Hydrocarbons	5	6	30	2019			
	ENVIRONMENTAL STUDIES	AECC-1	Fundamentals of Environmental Studies	6	4	24	2019			
II	BOTANY	CC-3	Mycology and Phytopathology	8	6	48	2020	7.50	7.40	Q
		CC-4	Morphology and Anatomy of Angiosperms	7	6	42	2020			
	ZOOLOGY	GE-2	Comparative Anatomy & Developmental Biology of Vertebrates	7	6	42	2020			
	Communicative English/MIL	AECC-2	Bengali	8	2	16	2020			
III	BOTANY	CC-5	Plant Ecology and Phytogeography	9	6	54	2020	8.33	8.00	Q
		CC-6	Plant Systematics	7	6	42	2020			
		CC-7	Economic Botany	9	6	54	2020			
	CHEMISTRY	GE-3	Chemical Energetic, Equilibria, Organic Chemistry	7	6	42	2020			
	BOTANY	SEC-1	Ethnobotany	8	2	16	2020			
IV	BOTANY	CC-8	Palaeobotany & Palynology	9	6	54	2021	8.67	8.69	Q
		CC-9	Biomolecules and Cell Biology	8	6	48	2021			
		CC-10	Molecular Biology	9	6	54	2021			
	ZOOLOGY	GE-4	Genetics and Evolutionary Biology	9	6	54	2021			
	BOTANY	SEC-2	Biofertilizers	8	2	16	2021			
V	BOTANY	CC-11	Plant Physiology	9	6	54	2021	8.75	8.75	Q
		CC-12	Plant Metabolism	9	6	54	2021			
	BOTANY	DSE-1	Reproductive Biology of Angiosperms	8	6	48	2021			
		DSE-2	Natural Resource Management	9	6	54	2021			
VI	BOTANY	CC-13	Genetics & Plant Breeding	10	6	60	2022	9.50	9.50	Q
		CC-14	Plant Biotechnology	10	6	60	2022			
	BOTANY	DSE-3	Plant Evolution & Biodiversity	9	6	54	2022			
		DSE-4	Industrial and Environmental Microbiology	9	6	54	2022			

CGPA (Cumulative Grade Point Average) on the basis of CCs & DSEs : **8.33**

CGPA (Cumulative Grade Point Average) on the basis of All Courses : **8.03**

Letter Grade in CGPA : A+

Result : Q

Date of Publication of Result : 29.07.2022

$$SGPA\ (S) = \frac{\sum_{i=1}^{n}(G_i \times V_i)}{\sum_{i=1}^{n} V_i} \qquad CGPA = \frac{\sum_{i=1}^{N}(V_i \times S_i)}{\sum_{i=1}^{N} V_i}$$

Anindya Jyoti Pal

Controller of Examinations

Course Type	CGPA Letter Grades				Result Codes
CC – Core Course	CGPA	Letter Grade	CGPA	Letter Grade	Q – Qualified
GE – Generic Elective	9 and above	O (Outstanding)	5 to below 6	B (Average)	SNC – Semester Not Cleared
DSE – Discipline Specific Elective	8 to below 9	A+ (Excellent)	4 to below 5	P (Pass)	PNC – Programme Not Cleared [CGPA on the basis of
SEC – Skill Enhancement Course	7 to below 8	A (Very Good)	Below 4	F (Fail)	CCs and DSEs.<5 or any one or more semester(s) is/a not cleared]
AECC – Ability Enhancement Compulsory Course	6 to below 7	B+ (Good)			NC denotes "NotComputed" due to absence in C1, C2 and C4 as applicable.

Grade Point Norms				Percentage Conversion Formula:
90% to 100%	10	80% and above but below 90%	9	= (SGPA or CGPA×10) - 5.0
70% and above but below 80%	8	60% and above but below 70%	7	*Letter Grade in CGPA is awarded on the bas
50% and above but below 60%	6	40% and above but below 50%	5	of CCs and DSEs
35% and above but below 40%	4	Below 35%	Not Awarded (NA)	

A Model Mark Sheet of a B.Sc. Botany Honours Student

PROGRAM OUTCOMES, PROGRAM SPECIFIC OUTCOMES & COURSE OUTCOMES
DEPARTMENT OF BOTANY

PREAMBLE:

Government General Degree College, Singur, Hooghly is not an Autonomous college, strictly follows the CBCS syllabus prescribed by the UGC. The ongoing curriculum and the syllabus of the UG CBCS Program of the subject Botany of this College had been approved in the Board of Studies meeting by its affiliating University, The University of Burdwan with effect from 2017- 2018 academic session. Though the curriculum of all the affiliated colleges under this University is same, the way of delivery and implementation of the program are different in different colleges and hence the Program Outcomes are different.

Educational program, which is an organized set of learning activities are so designed in our college, that enable a student to develop knowledge, understanding, skills and attitudes relevant to the student's individual needs as well as the societal needs and ultimately fulfill the need of Nation at large. The Under-Graduate Program imbibes a Learning Outcome-based Curriculum Framework (LOCF) which will prepare the students for both, academia and employability. The LOCF approach is envisioned to provide a focused, outcome-based syllabus with an agenda to structure the teaching-learning experiences in a more student-centric manner. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each program prepares students for sustainability and life-long learning.

The new Choice Based Credit System (CBCS) curriculum of B.Sc. Botany (Honours) offers 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.

Along with these formal modes, various informal modes are also used by teachers to make the teaching-learning process more attractive and student-centric. These include Quiz, Science Exhibitions, Excursion, participation in Social Service and Environmental awareness programmes. Another method used to enhance learning experiences is publication of departmental wall magazines and college annual magazine. To enhance their creativity and critical thinking and writing skills, they are also motivated to publish in the college annual magazine.

PROGRAMME OUTCOMES (PO):

PO1: KNOWLEDGE AND UNDERSTANDING: The UGC recommended CBCS curriculum of the subject Botany of Government General Degree College, Singur of the University of Burdwan will help to cater awareness about the living and non living world with special reference to plant sciences to the students and make them able to understand the interrelationships and interdependences between the animal and plant community including human in the Centre, upgrade their attitude towards sustainable environment, Bio-diversity conservation and ecosystem restoration.

The curriculum will make them competent in identifying different plant groups viz., algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms and knowledge about their economic importance. The plant kingdom with all its aspects like taxonomy, morphology, anatomy, embryology, physiology, biochemistry, genetics, cell biology, molecular biology, phyto-geography etc. will be addressed which enable them to understand the fundamental aspects of life and all life-forms have a common ancestral origin. Students will understand the physiology of different biotic and abiotic stresses of plants, the basic attributes of Bioinformatics and Biostatistics.

PO2: CRITICAL THINKING: After completion of this educational program it is expected that learners will be able to think critically about any problem and can organize tasks into a structured form.

PO3: INTELLECTUAL SKILLS: Able to assimilate knowledge and ideas based on wide reading and can construct and test hypothesis. Plan, conduct and write a report on an independent term project.

PO4: EFFECTIVE COMMUNICATION: Communicate effectively with the community and society. Able to comprehend and write effective reports and design documentation, make effective presentations and reciprocate clear instructions.

PO5: SOCIAL INTERACTION: Understand plant diversity, its importance for society, health, safety, legal and environmental issues and the consequent responsibilities relevant to the biodiversity conservation practice.

PO6: EFFECTIVE CITIZENSHIP: After completion of this educational program students will play important role in promoting human as well as societal wellbeing and in developing India as envisioned in its Constitution - a democratic, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. Learners are expected to be responsible citizen and be aware of moral and ethical duties.

PO7: ETHICS: Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and criminal under Indian constitution. Learners should know academic and research ethics, Benefit Sharing, Plagiarism, Scientific Misconduct etc.

PO8: ENVIRONMENT AND SUSTAINABILITY: Besides the theoretical knowledge, the student is acquainted with moral and ethical duties, an awareness towards the conservation of nature and natural resources, legal and environmental issues and the consequent responsibilities relevant to the biodiversity conservation practice and sustainability.

PO9: SELF-DIRECTED AND LIFE-LONG LEARNING: The program also has a strong interdisciplinary component. Emphasis is on experiential learning through hands-on laboratory exercises, field trips and assignments. Current thrust areas of teaching provide students with substantial exposure and skills in plant biology. Learners will have the ability to recognize the need, preparation and to engage in independent and life-long learning in the broadest context of technological change.

PO10: REFLECTIVE THINKING: The structure and content of the course enables students to reflect on the learning from different courses and integrate the same for a problem solving approach. They would be capable of correlating various concepts applicable to diverse situations and phenomenon.

PO11: MULTICULTURAL COMPETENCE: 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.

PO12: LEADERSHIP QUALITIES: The vast and deep knowledge of the subject, analytical and scientific reasoning, effective communication and problem solving task develop special qualities in a

person to attract and influence the audience, which would be gained after the completion of this course. Students are expected to be familiar with decision making process and basic managerial skills to become a better leader. Skills may include defining objective vision and mission, how to become responsible citizens and charismatic inspiring leader.

PROGRAMME SPECIFIC OUTCOMES (PSO):

PSO1: After completion of the Programme students acquire core knowledge about Plant Biodiversity ranging from Microbes (Viruses and Bacteria), to Fungi, Algae, including diverse plant groups of Archegoniates- Bryophytes, Pteridophytes and Gymnosperms and higher plant groups of Angiosperms.
PSO2: Practical classes will help students to learn use of microscope, mounting, section-cutting and staining techniques for the study of plant materials.
PSO3: Combination of Theoretical and Practical components will provide comprehensive information and insight into the Fascinating world of Microbes and higher Plant groups.
PSO4: To enable students to understand and appreciate the relevance of Microbes and Plants to environment with reference to ecological and economic importance and at large human well-being.
PSO5: Scope of Biodiversity includes Medicinal field, Industry, Agriculture, Research and Study, Job Opportunities and Environmental Conservation, which is both informative and interesting. Students will be able for higher academic pursuits, particularly in the field of Biological Sciences, Environment and Biodiversity Conservation and become a nature lover, which will ultimately create awareness on the threats to biodiversity and sensitize students towards the Conservation of Biodiversity for sustainable development.
PSO6: Develop an understanding of Evolution of Plant forms and the consequent Biodiversity to understand the fundamental aspects of life and all life-forms have a common ancestral origin.
PSO7: Understanding anatomy, morphology of plants and plant classification systematics, reproduction, genetics and molecular biology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, ecology and evolution of various plants groups.
PSO8: To know the scope and significance of palaeobotany, types of fossils, its role in global economy and basic idea of stratigraphic deductions based on plant fossils and correlation with geological time scale.
PSO9: 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.
PSO10: Understanding of Cell metabolism, chemical composition, physiochemical and functional organization of organelles; know about design of bioreactors, factors affecting growth and production; contemporary approaches in modern cell and molecular biology; and understand how plant sciences, molecular biology and microbiology are applied in manufacturing of industrial products.
PSO11: 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.

PSO12: Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as human livelihood support system and the use of transgenic technologies for basic and applied research in plants.

PSO13: Understanding recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data analyses.

PSO14: A botany graduate would be competent in the field to undertake further disciplinespecific studies, as well as to begin domain-related employment and also aware of most basic domain-independent knowledge, including critical thinking and communication.

PSO15: To enable the graduate to prepare for National and International competitive examinations for employment and inspire them to become responsible, dutiful and conscious citizen.

TEACHING LEARNING PROCESS TO ACHIEVE THE COURSE OUTCOMES:

1. Chalk -board method, Visual media, power point presentations, discussion and seminars are some of the methods for teaching and learning which make the subject interesting.
2. Visual media would be used for teaching to feel the subject and create the subject interesting.
3. More emphasis would be given on physical specimens.
4. The acquired knowledge in the classroom will be integrated with practical classes to impart a sound understanding of the subject.
5. Field visits would be organized to enhance the understanding of the subject concerned.
6. Visits to various research institutes/industries would be organized to understand the application of microbes for commercial applications.
7. Students will be motivated to become self-directed learners.
8. Field visit will be organized to familiarize the students with local plant species, their identification and to understand the community pattern.
9. Practical: 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.
10. The students are asked to submit their record notebooks to the teacher/s for checking.
11. 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.

COURSE OUTCOMES (COS) OF B.Sc. HONOURS BOTANY:

Sl. No.	Semester	Name of the Course	Course Code	Course Outcome On completion of this course, the students will be able to:
1	I	Microbiology and Phycology	CC I Theory	**1.** An introduction to Microbial Biodiversity ranging from Viruses, Bacteria including Algae. **2.** Understand and appreciate the relevance of Microbes and Plants to environment (ecological significance) and human well-being (economic importance). **3.** Understand the reproductive behaviour in Algae and microbes **4.** Introduce students to application of microbes in Industrial production and Environmental remediation strategies. **5.** Know discovery, physiochemical as well as biological characteristics and classification of viruses and bacteria. **6.** Study economic and pathogenic importance of bacteria and viruses **7.** Develop understanding on the concept of microbial nutrition. Classify viruses based on their characteristics and structures. **8.** Examine the general characteristics of bacteria and their cell reproduction/ recombination. **9.** Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance. **10.** Get the idea of the range of thallus structure in algal group
		Microbiology and Phycology	CC I Practical	**1.** Understand the concept, principle and types of sterilization methods. **2.** Know the concept and characteristics of antiseptic, disinfectant and their mode of action. **3.** Know the cultivation methods of microbes. **4.** Principles, working and applications of instruments viz, pH meters, spectrophotometer, Hot air oven, autoclave, laminar air flow etc. **5.** Learn the Camera Lucida drawings and magnifications.
2	**I**	Archegoniate	CC II Theory	**1.** Develop an understanding including economic importance and ecological significance of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms.

				2. Develop critical understanding on morphology, anatomy classification, characteristics and reproduction of Bryophytes, Pteridophytes and Gymnosperms. **3.** Understanding of plant evolution and their transition to land habitat.
		Archegoniate	CC II Practical	**1.** Practical knowledge on morphology and reproductive structures and proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes and Gymnosperms.
3	**II**	Mycology and Phytopathology	CC III Theory	**1.** Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies. **2.** Understand the general characteristics, life cycle pattern, biodiversity and economic Importance of fungi and general idea about phytopathology. **3.** Identify true fungi and demonstrate the principles and application of plant pathology in the control of plant diseases. **4.** Understand the ecological and economic significance of fungi. **5.** Understand the application of mycology in various fields of economic and ecological significance.
		Mycology and Phytopathology	CC III Practical	**1.** Demonstrate skills in laboratory, field and glasshouse work related to mycology and plant pathology. **2.** Able to identify *Rhizopus, Talaromyces, Alterneria, Ascobolus, Agaricus and Polyporus* sp. **3.** Develop laboratory skills working with fungal and pathological specimens
4	**II**	Morphology & Anatomy of angiosperms	CC IV Theory	**1.** Understand various cells, tissues, meristem, epidermal and vascular tissue system in plants in a detailed manner. **2.** Understand various aspects of growth, development of the tissues and differentiation of various plant organs. **3.** Know basic structure and organization of plant parts in angiosperms. **4.** Correlate structure with morphology and functions. **5.** Understand the evolutionary concept of organization of shoot and root apex anatomy.

				6. Analyze the composition of different parts of plants and their relationships. **7.** Evaluate the adaptive and protective systems of plants.
		Morphology & Anatomy of angiosperms	CC IV Practical	**1.** Know and carry out the plant anatomical specimen preparations, staining and permanent slide preparations. **2.** Know the floral variations in angiosperm families, their phylogeny and evolution. **3.** Understand different inflorescence and fruit types in plant kingdom with laboratory skills.
5	**III**	Plant Ecology and Phytogeography	**CCV Theory**	**1.** Understand core concepts of ecology and ecosystem and the interdependences of biotic and abiotic communities. **2.** Understand complex community patterns and processes, and ecosystem functioning. **3.** Know functional aspects of ecosystem like principles and models of energy flow and different biogeochemical cycles etc. **4.** Analyze the phytogeography and phytogeographical regions of India. **5.** Think critically in evolving strategies for sustainable natural resource management and biodiversity conservation.
		Plant Ecology and Phytogeography	**CCV Practical**	**1.** Measure microclimatic variables. **2.** Conduct experiments using laboratory skills to assess the ecological parameters of different sites.
6	**III**	Plant Systematics	**CCVI Theory**	**1.** Know the aims, objective and significance of plant taxonomy and systematics. **2.** Understand various rules, principles and recommendations of botanical nomenclature as discussed in ICN. **3.** Know Taxonomic hierarchy, Biometrics, numerical taxonomy and cladistics. **4.** Understand the various classification systems and its scope in plant systematics. **5.** Understand the morphological and molecular features of angiosperms in a systematic way. **6.** Learn plant identification and classification by the evidences from palynology, cytology, phytochemistry and molecular data. **7.** Understand the characters of biologically important families of angiosperms.

				8. Gain knowledge about origin and evolution of angiosperms as well as methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).
		Plant Systematics	**CCVI Practical**	1. Able to describe a plant specimen systematically **2.** Acquaint with the basic technique in the preparation of herbarium, virtual herbarium, E-flora etc. 3. Know about field exploration and plant specimen handling in botanical studies.
7	**III**	Economic Botany	**CCVII Theory**	**1.** Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems. **2.** Understand the evolution and origin of Cultivated Plants and importance of germplasm diversity. **3.** Understand and familiar with economic importance of diverse plants that offer resources to human life. **4.** Understand the role of plants in human welfare used as- food for man, fodder for cattle, feed for poultry, plants having medicinal value and also plant source of huge economic value etc. **5.** Increase the awareness and appreciation of plants and plant products encountered in everyday life. **6.** Appreciate the diversity of plants and the plant products and learn to explore the regional diversity in food crops and other plants in human use and their ethno-botanical importance as well.
		Economic Botany	**CCVII Practical**	**1.** Able to perform micro chemical tests of starch grains, proteins and fat from different cereals, pulses or oil yielding food crops and also test for lignin **2.** Identify the drug yielding plants and can measure the drug adulteration through organoleptic study
	III	Ethnobotany (Selected for our Students)	**Skill Enhancement Courses I SEC-1**	➢ Know the plants used by the local communities, tribals, ethenic groups, and their nutritive and medicinal value. ➢ Understand the treasure, value and usefulness

				of the natural products as medicine and food and their conservation practices.
8	**IV**	Palaeobotany & Palynology	**CC VIII Theory**	**1.** Understand the diversity and distributions of prehistoric flora. **2.** Know the scope and significance of palaeobotany, types of fossils, its role in global economy and geological time scale. **3.** Understand the various fossil genera representing different fossil groups. **4.** Learn the basic idea of correlation and stratigraphy and stratigraphic deductions based on plant fossils. **5.** Understand the microsporogenesis, megasporogenesis and different types of pollination. **6.** Familiarize with the spore/pollen morphology with reference to polarity, size, shape, symmetry, aperture and sculpture.
		Palaeobotany & Palynology	**CC VIII Practical**	1. Able to study (including mode of preservation) the plant fossils of following specimens: *Lepidodendron*, (stem in T. S.), *Calamites* (stem in T. S.), *Bucklandia* (stem, specimen), *Glossopteris* (leaf, specimen), *Lyginopteris* (stem in T. S.), *Vertebraria* (root, specimen) 2. Pollen morphological studies of *Impatiens* and *Hibiscus* pollens form prepared slides
9	**IV**	Biomolecules and Cell Biology	CC IX Theory	**1.** Understand the relationship between the properties of macromolecules, their cellular activities and biological responses. **2.** Develop understanding on chemical bonding among molecules. **3.** Describe the relationship between the structure and functions of biomolecules. **4.** Know about Bioenergetics, Biomolecules (Protein, Carbohydrate, Lipid and Nucleic acids), Enzymes (Classification, structure & functions), Cell Biology (cell organelles) and Signal transduction in cells. **5.** Compare the structure and functions of cells and explain the development of cells. **6.** Identify the concept that explains chemical composition and structure of cell wall and membrane.

				7. Understand various metabolic processes such as respiration, photosynthesis etc. which are important for life through the study of biomolecules (i.e. protein, carbohydrate, lipid and nucleic acid) and cell organelles. **8.** Know contemporary approaches in modern cell and molecular biology.
	IV	Biomolecules and Cell Biology	CC IX Practical	1. Able to perform qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins 2. Demonstrate the phenomenon of protoplasmic streaming 3. Measure cell size by the technique of micrometry 4. Stain DNA and cell wall 5. Demonstrate the phenomenon of plasmolysis and deplasmolysis 6. Demonstrate the effect of organic solvent and temperature on membrane permeability 7. Demonstrate different stages of mitosis and meiosis cell division of *Allium cepa*
10	**IV**	Molecular Biology	CC X Theory	**1.** Understand the structure and functions of Genes i.e. DNA and RNA **2.** Understand central dogma and genetic code **3.** Understand the molecular mechanism of DNA replication, transcription, translation, and post transcriptional and translational modifications **4.** Understand about the gene regulations
	V	Molecular Biology	CC X Practical	**1.** Able to prepare LB medium and develop the pure culture of *E. coli* **2.** Able to understand the theoretical knowledge of central dogma- replication, transcription and translation more clearly through the practical work by the photographical study
	V	Biofertilizers (Selected for our Students)	Skill Enhancement Courses - II SEC-2	➢ Know eco-friendly fertilizers like *Rhizobium*, *Azospirilium*, *Azotobactor*, Cyanobacteria and Mycorrhizae, their identification, growth and multiplication conditions of useful microbes. ➢ Know about organic farming and recycling of the organic waste and can think of the

				methods of decomposition of biodegradable waste and convert into the compost.
11	**V**	Plant Physiology	CC XI Theory	**1.** Understand how plants absorb water and mineral nutrients reach to different parts and understand Water relations of plants with respect to various physiological processes. **2.** Understand how plants manufacture food (photosynthesis) and generate energy (respiration) and explain the significance of Photosynthesis and respiration and translocate the product to different parts (translocation). **3.** Realize how light, pigments and hormones help in plant growth and development. **4.** Explain chemical properties and deficiency symptoms in plants. **5.** Assess dormancy and germination in plants. **6.** Utilize the commercial applications of plant physiology.
	V	Plant Physiology	CC XI Practical	1. Determine the osmotic potential of plant cell sap by plasmolytic method 2. Determine the water potential of given tissue (potato tuber) by weight method 3. Study the effect of Humidity and light on the rate of transpiration in excised twig/leaf 4. Calculate the stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte 5. To study the phenomenon of seed dormancy (TTZ) 6. Demonstrate the effect of different concentrations of IAA on Plant (Locally available) coleoptile elongation (IAA Bioassay) 7. To study the induction of amylase activity in germinating grains
12	**V**	Plant Metabolism	**CC XII Theory**	1. Understand the concept of cellular metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes) and differentiate anabolic and catabolic pathways of metabolism. 2. Understand the concept of Carbon

				reduction and Assimilation Metabolism, Oxidation and ATP-Synthesis. 3. Interpret the lipid metabolism and Biological nitrogen fixation. 4. Understand the mechanism of Signal Transduction.
	V	Plant Metabolism	**CC XII Practical**	1. Able to separate photosynthetic pigments chemically 2. To study the effect of light intensity on the rate of photosynthesis 3. To study the effect of carbon dioxide on the rate of photosynthesis 4. Able to compare the rate of respiration in different parts of a plant 5. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources 6. To study the activity of lipases in germinating oil-seeds and demonstrate mobilization of lipids during germination 7. Demonstrate the absorption spectrum of photosynthetic pigments
	V	Reproductive Biology of Angiosperms	**DSE 1 Theory**	• Know induction of flowering, molecular and genetic aspects of flower development. • Understand the structure of anther, ovule, embryo sac development, pollen development, dispersal of pollen, pollination and fertilization. • Know endosperm development and its importance • Understand alternative pathways of reproduction and their importance. • Apply this knowledge for conservation of plants, pollinators and fruit development.
	V	Reproductive Biology of Angiosperms	**DSE 1 Practical**	• Know the ontogeny of Anther Wall; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation • Able to study the morphology of Pollen grains through fresh and acetolysis method showing ornamentation and aperture

				• Able to test Pollen viability through Tetrazolium test (TTC) germination method and can calculate the percentage of germination in different media using hanging drop method • Know about different types of ovules and their special structures, female gametophyte, ultra structure of mature egg apparatus through permanent slides/ photographs • Know about embryogenesis of dicotyledon embryo, seed development at various stages- through photographs and electron micrographs
	V	Natural Resource Management	DSE 2 Theory	• Acquaint with various Natural Resources- their availability, causes of depletion, conservation, sustainable utilization and their management strategies. • Evolve management strategies of natural resources for sustainable development and know the national and international policies and initiatives adopted in natural resources management.
	V	Natural Resource Management	DSE 2 Practical	• Able to study solid wastes generated by a domestic system (biodegradable and non biodegradable) • Aware people about and its impact on land degradation and guide people to separate biodegradable and non biodegradable wastes in domestic system • Collect data from forest cover of specific area. • Measure dominance of woody species by DBH (diameter at breast height) method • Calculate and analyze ecological footprint • Know about ecological modeling
13	**VI**	Genetics & Plant Breeding	CC XIII Theory	**1.** Understand the structure and functions of Genes - classical versus molecular. **2.** Understand the laws of inheritance, genetic basis of loci, alleles and their linkage. **3.** Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders.

				4. Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels. **5.** Analyze the effect of mutations on gene functions. **6.** Learn the methods of crop improvement and modern strategies applied in Plant Breeding for crop improvement i.e., Mass selection, Pure line Selection and Clonal selection. **7.** Know about the advantages of Heterosis and hybrid vigour, disadvantages of inbreeding depression, hybrid variety development and their release through artificial hybridization.
	VI	Genetics & Plant Breeding	CC XIII Practical	1. Able to perform Meiosis through temporary squash preparation, *Allium cepa* 2. Able to test the result outcomes of dihybrid and monohybrid cross through seed ratios utilizing the chi-square probability test, i.e., Testing of goodness of fit with Mendelian mono and dihybrid ratios 3. Know Chromosome mapping using point test cross data 4. Analyze pedigree for dominant and recessive autosomal and sex linked traits 5. Use chi-square probability test to test the incomplete dominance and gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seed count method 6. Study Translocation Ring, Laggards and Inversion Bridge through Photographs or Permanent Slides
14	**VI**	Plant Biotechnology	CC XIV Theory	1. Understand the core concepts and fundamentals of plant biotechnology 2. Understand the Concept of Plant Tissue Culture, Recombinant DNA technology, Gene Cloning, analyze the enzymes and vectors for genetic manipulations and Methods of Gene Transfer 3. Understand the major concerns and Applications of Transgenic Technology and genetic engineering
	VI	Plant Biotechnology	CC XIV Practical	1. Able to prepare MS medium and inoculation of explants like leaf segment, shoot apex, nodal

				explants etc. of tobacco, Datura, Brassica, carrot etc. 2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs 3. Know the protocol of protoplast isolation 4. Understand the methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment 5. Know the steps of genetic engineering for production of Bt cotton, Golden rice, through photographs 6. Know the protocol of plasmid DNA isolation
	VI	Plant Evolution and Biodiversity	DSE 3 Theory	• Understand how life originated in this planet, what was the nature of earliest environment, how eukaryotes, prokaryotes and other higher plants evolved • Know the evolutionary path way of aquatic to terrestrial habit of plant life, non-vascular to vascular plants, gymnosperm to angiosperms, evolution of C4 and CAM photosynthetic pathway etc. • Know about the theories of evolution and understand which one is acceptable • Know about the plant biodiversity around the world with reference to hydrophytes, halophytes, sciophytes, epiphytes, climbers, plants of cold or hot arid habitats etc.
	VI	Plant Evolution and Biodiversity	DSE 3 Practical	• Able to study the vegetative and reproductive structure of aquatic plants (*Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Polysiphonia*) • Study of vegetative and reproductive structure of plants of moist shady habitats (*Marchantia*, *Funaria*, *Pteris*) • Know Leaf anatomy of *Suaeda*, *Avicennia* and *Hertiera* (Halophytes) - through Photographs • Know morphological and anatomical study of *Hydrilla*, *Vallisnaria* and *Arum* • Know morphological and anatomical study of plants of arid habitat (*Nerium* and *Pinus*)

	VI	Industrial and Environmental Microbiology	DSE 4 Theory	• Understand how microbiology is applied in manufacturing industrial products. • Know about the design of bioreactors and factors affecting growth and production. • Understand the rationale in medium formulation and design for microbial fermentation. • Comprehend the different types of fermentation processes. • Comprehend the techniques and the underlying principles in upstream and down- stream processing. • Know the occurrence, abundance and distribution of microorganism in the environment and learn their methods of detection and their role in the environment. • Understand the basic principles of environment microbiology and application of the same in solving environmental problems – waste-water treatment and bioremediation. • Comprehend the various methods to determine the quality of water.
	VI	Industrial and Environmental Microbiology	DSE 4 Practical	• Know principles and functioning of instruments in microbiology laboratory. • Know the different parts of fermenter and their functions by photograph. • Know the procedure of sterilization techniques and preparation of culture media. • Know the assessment protocol of microbiological quality of water.

COURSE OUTCOMES OF B.Sc. BOTANY GENERIC ELECTIVES:

Generic Electives (Four) Offered to the students of other Departments:				
SL. No. **1**	**Semester I (Other than the students of Botany Honours)**	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	GE I Theory **(Other than the students of Botany Honours)**	1. Understand what is biodiversity and the fascinating world of Microbes and Plants and the variety and variability of life on earth ranging from Microbes (Viruses and Bacteria), to Fungi, to various plant groups (Algae and Archegoniates-Bryophytes, Pteridophytes and Gymnosperms) through the combination of Theoretical and Practical components. 2. Understand and appreciate relevance of Microbes and Plants to environment and human well-being. 3. Understand the line of Plant Evolution on Earth and the consequent Biodiversity.
		Biodiversity (Microbes, Algae, Fungi and Archegoniate)	GE I Practical	1. Learn use of microscope, mounting, section-cutting and staining techniques for the study of plant materials 2. Make drawings in Practical Records will enhance understanding morphological and structural details and related functional aspects in diverse plant groups (Microbes, Algae, Fungi and Archegoniate)
2		Plant Ecology and Taxonomy	GE II Theory	1. Understand basic ecological concepts and inter-relationships between the living and non living world. 2. Understand complex community patterns and processes, and ecosystem functioning. 3. Know functional aspects of ecosystem like principles and models of energy flow and different biogeochemical cycles etc. 4. Analyze the phytogeography and phytogeographical regions of India. 5. Know the aims, objective and significance of plant taxonomy and systematics. 6. Understand various rules, principles and recommendations of botanical nomenclature as discussed in ICN. 7. Know Taxonomic hierarchy, Biometrics, numerical taxonomy and cladistics. 8. Understand the various classification systems and its scope in plant systematics.

				9. Understand the morphological and molecular features of angiosperms in a systematic way. 10. Understand the characters of biologically important families of angiosperms.
		Plant Ecology and Taxonomy	GE II Practical	1. Know about field exploration and plant specimen handling in botanical studies. 2. Acquaint with the basic technique in the preparation of herbarium.
3		Plant Anatomy and Embryology	GE III Theory	**1.** Understand various cells, tissues, meristem, epidermal and vascular tissue system in plants in a detailed manner. **2.** Evaluate the adaptive and protective systems of plants. 3. Know about pollination mechanisms, double fertilization, seed-structure, embryo-endosperm relationship.
		Plant Anatomy and Embryology	GE III Practical	1. Know the anatomical details of meristems, Tissues (parenchyma, collenchyma and sclerenchyma), Macerated xylary elements, Phloem, anatomy of monocot and dicot root, stem and leaf (*Zea mays* and *Helianthus*) from permanent slides and photographs. 2. Understand adaptive anatomy of Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem). 3. Know the structure of different types of ovules (anatropous, orthotropous, circinotropous, amphitropous/ campylotropous) and female gametophyte, *Polygonum* (monosporic) type of embryo sac development and also pollination types and seed dispersal mechanisms -Through Permanent Slides/Photographs.
4		Plant Physiology and Metabolism	GE IV Theory	1. Understand how plants absorb water and mineral nutrients and reach to different plant parts. 2. Understand Water relations of plants with respect to various physiological processes. 3. Understand the concept of cellular metabolism and differentiate anabolic and catabolic pathways of metabolism. 4. Understand the concept of Carbon reduction and Assimilation Metabolism, Oxidation and ATP-Synthesis.

				5. Interpret the lipid metabolism and Biological nitrogen fixation. 6. Understand how plants manufacture food (photosynthesis) and generate energy (respiration) and explain the significance of Photosynthesis and respiration and translocate the product to different parts (translocation). 7. Understand photomorphogenesis. 8. Understand the role and action of plant growth regulators and apply commercially.
			GE IV Practical	1. Determine osmotic potential of plant cell sap by plasmolytic method. 2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig. 3. Calculate stomatal index and stomatal frequency of a mesophyte and a xerophyte. 4. Demonstrate Hill reaction. 5. To study the effect of light intensity and bicarbonate concentration on evolution of Oxygen in photosynthesis. 6. Compare the rate of respiration in any two parts of a plant.