

S. S. JAIN SUBODH P.G. (Autonomous) COLLEGE, JAIPUR

(Affiliated to University of Rajasthan)



SYLLABUS

Three Undergraduate Honours programme in Science

I & II Semester Examination 2023-24

III & IV Semester Examination

2024-25 V & VI Semester Examination

2025-26

Bachelor of Science (Honours)

DEPARTMENT OF BOTANY

(Syllabus as per NEP 2020 and Choice based Credit system)

Medium of programme: Hindi/English

w.e.f Academic Session 2023-24

Content

1. Eligibility
2. Scheme of Examination
3. Scheme for CBCS
4. Semester Structure
5. Contact Hours
6. Course Outcomes
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1. ELIGIBILITY:

10+2 with 50% from Rajasthan Board / CBSE from Rajasthan state and 60% for CBSE or any other equivalent recognized Board from other state in Science Stream with Physics, Chemistry and Biology.

2. SCHEME OF EXAMINATION

Sr. No.	Papers	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

B.Sc. Hons

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration. Each Practical /Lab work 4 hours duration

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper

concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

Note: Maximum marks for a theory paper is 75 marks which include 54 marks for ESE and 21 marks for internal assessment.

Examination Question Paper Pattern for all semester

Exams Attempt all questions

I. 7 Questions (very short answer questions) 7 * 2 Mark - 14

II. 4 Questions (1 question from each unit with internal choice) 4 * 10 Marks -

40 Total of End Sem. Exam - 54

Internal Assessment -

21 Maximum Marks - 75

Minimum Marks - 30

3. Scheme for CBCS

B. Sc. (Honours) Botany

Scheme for CBCS Curriculum

Semester	Subject 1 / Discipline 1 (DSC / DSE) (credits)	Subject 2 / Discipline 2 (DSC/ DSE) (credits)	Subject 2 / Discipline 2 (DSC/ DSE) (credits)	Generic Elective (GE) (credits)	Ability Enhancement Course (AEC) (credits)	Skill enhancement course (SEC) (credits)	Internship/ Apprenticeship/ Project/ Community	Value addition course (VAC) (credits)	Total Credits
I	DSC -1 (3)	DSC - 13 (2)			English (2)			Choose one from a pool of courses(0)	23 credits
	DSC -2 (3)	DSC - 14 (2)							
	DSC -3 (3)								
	DSC P(6)	DSCP(2)							
II	DSC -4 (3)	DSC - 15 (2)			Hindi (2)			Choose one from a pool of courses(0)	23 credits
	DSC -5 (3)	DSC - 16 (2)							
	DSC -6 (3)								
	DSC P(6)	DSCP(2)							
	Students on exit shall be awarded Undergraduate Certificate in Science (Subject Honours) after securing the requisite 46 credits in Semesters I and II								
III	DSC -7 (3)	DSC -17 (2)		Choose one from pool of courses, GE - 1 (2)**		Computer Science(2)		Choose one from a pool of courses(0)	23 credits
	DSC -8 (3)	DSC -18 (2)							
	DSC -9 (3)								
	DSC P(6)	DSCP(2)							

	DSC -10 (3)	DSC -19 (2)		Choose one	3	Env. Sc.		Choose from a	23 credits
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IV	DSC -11 (3)	DSC -20 (2)		from pool of courses, G E -2 (2)**		And Sustain. Dev. (2)		pool of courses (0)	
	DSC -12 (3)								
	DSC P(6)	DSCP(2)							
	Students on exit shall be awarded Undergraduate Diploma in Science (SubjectHonours) after securing the requisite 96 credits on completion of Semester IV								96 + 4
V	Choose two from pool of courses, DSE - 1 (3)	Choose two from pool of courses, DSE - 1 (2)				Mental Ability & reasoning (2)		Choose one from a pool of courses (0)	23 credits
	DSE -2 (3)	DSE - 2 (2)							
	DSE -3 (3)								
	DSE P(6)	DSEP (2)							
VI	Choose two from pool of courses, DSE -4 (3)	Choose two from pool of courses, DSE - 3 (2)				Ananda - Joy of giving (2) or NC C/ NSS / Rovers and Rangers / Red Ribbon Club / Sports / Extra - curricular and co -		Choose one from a pool of courses (0)	23 credits
	DSE -5 (3)	DSE - 4 (2)							
	DSE -6 (3)								
	DSE P(6)	DSEP (2)							
Students on exit shall be awarded Bachelor of Science (3 years) after securing therequisite 124 credits on completion of Semester VI								142 + 4	

Course structure with Nomenclature

**B.Sc.
(Honours)
BOTANY**

Semesters	Code	Name of Paper	Credits	Total credits
Semester-I				
Paper I	DSC-1 BOT (H)-101	Microbiology	3	15
Paper II	DSC-2 BOT(H)-1 02	Algae and Lichen	3	
Paper III	DSC-3 BOT(H)-1 03	Bryophyta	3	
Practical	DSCP BOT(H)- PI	Practical: Based on theory papers	6	
Semester-II				
Paper I	DSC-4 BOT(H)-2 01	Mycology and Phytopathology	3	15
Paper II	DSC-5 BOT(H)-2 02	Cell Biology, Genetics and Plant Breeding	3	
Paper III	DSC-6 BOT(H)-2 03	Biodiversity and Conservation	3	
Practical	DSCP BOT(H)-P II	Practical: Based on theory papers	6	
Semester-III				
Paper I	DSC-7 BOT(H)-3 01	Molecular Biology	3	15
Paper II	DSC-8 BOT(H)-3 02	Biotechnology	3	
Paper III	DSC-9 BOT(H)-3 03	Industrial Microbiology	3	
Practical	DSCP BOT(H)-P III	Practical: Based on theory Papers	6	

Semester-IV				
Paper I	DSC-10 BOT(H)-4 01	Pteridophyta, Gymnosperms and Paleobotany	3	15
Paper II	DSC-11 BOT(H)-4 02	Plant Physiology and Biochemistry	3	
Paper III	DSC-12 BOT(H)-4 03	Economic Botany	3	

Practical	DSCP BOT (H)P- IV	Practical: Based on theory Papers	6	
Semester-V		Choose any two		
Elective I-	DSE-1 BOT (H)501	Plant Anatomy and Embryology	3	15
Elective II-A	DSE-2	Plant Systematics	3	
	BOT (H)502-A			
	BOT (H)502-B	Natural Resource Management		
Elective II-B	DSE-3	Research Methodology	3	
	BOT (H)503-A			
	BOT (H)503-B	Tissue culture		
Practical	DSEP BOT (H)P- V	Practical: Based on theory Papers	6	
Semester-VI		Choose any two		
Elective I-	DSE-4 BOT (H)601	Ecology	3	15
Elective II-A	DSE-5		3	
	BOT (H)602-A	Biostatistics		
	BOT (H)602-B	Bioinformatics		
Elective II-B	DSE-6		3	
	BOT (H) 603-A	Medicinal and Ethnobotany		
	BOT (H)603-B	Nanotechnology		
Practical	DSE P BOT (H)PVI	Practical: Based on theory Papers	6	

Course Category

DSC: Discipline Specific Core

DSCP: Discipline Specific Core

PracticalDSE: Discipline Specific
Elective

DSEP: Discipline Specific Elective

PracticalGE : General Elective

AEC: Ability Enhancement Course

AECC: Ability Enhancement Compulsory

CourseSEC: Skill Enhancement Course

SEM: Seminar

PRJ: Project Work

RP: Research Publication

5. Contact Hours

L:

Lecture T:

Tutorial

P: Practical or

Other S: Self Study

Semester-I

The medium of instruction and examination shall be Hindi/English.

The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic.

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.	BOT (H) -101	Microbiology	DSC	3	3	-	-	3	-
2.	BOT (H) -102	Algae, and Lichens	DSC	3	3	-	-	3	-
3.	BOT (H) -103	Bryophyta	DSC	3	3	-	-	3	
4.	BOT (H) P	Practical	DSCP	6	0	-	6	-	6

Semester - II

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration	
					L	T	P	Theory	P
1.	BOT (H) -201	Mycology and Plant Pathology	DSC	3	3	-	-	3	-
2.	BOT (H) -202	Cell Biology, Genetics and plant Breeding	DSC	3	3	-	-	3	-
3.	BOT (H) -203	Biodiversity and Conservation	DSC	3	3			3	
4.	BOT (H) P	Practical	DSCP	6	0	-	6	-	6

Semester – III

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration	
					L	T	P	Theory	P
1.	BOT (H) – 301	Molecular Biology	DSC	3	3	-	-	3	-
2.	BOT (H) - 302	Biotechnology	DSC	3	3	-	-	3	-
3.	BOT (H) - 303	Industrial Microbiology	DSC	3	3			3	
4.	BOT (H) P	Practical	DSC P	6	0	-	6	-	6

Semester -IV

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per			ESE Duration (Hrs.)	
					L	T	P	Theory	P
1.	BOT (H) -401	Pteridophyta, Gymnosperms and	DSC	3	3	-	-	3	-
2.	BOT (H) - 402	Plant Physiology and Biochemistry	DSC	3	3	-	-	3	-
3.	BOT (H) - 403	Economic Botany	DSC	3	3			3	
4.	BOT (H) P	Practical	DSCP	6	0	-	6	-	6

Semester V-In Fifth Semester and Sixth Semester, students can choose any two electives. Departments will offer two theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.

S. No.	SubjectCode	Course Title	Course Category	Credit	Contact Hours Per			ESE Duration	
					L	T	P	Theory	P
1.	BOT (H) -501	P l a n t Anatomy and Embryology	DSE - 1	3	3	-	-	3	-
2.	BOT (H) -502 (A)	Plant Systematics	DSE – 2 (A)	3	3	-	-	3	-
3.	BOT (H) – 502 (B)	Natural resource Managemen	DSE -2 (B)	3	3	-	-	3	-
4.	BOT (H) – 503 (A)	Research Methodolog y	DSE – 3 (A)	3	3			3	
5.	BOT (H) – 503 (B)	Tissu e culture	DSE – 3 (B)	3	3			3	
6.	BOT (H) - P	Practical	DSEP	6	0	-	6	-	6

Semester – VI

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESE Duration (Hrs.)	
					L	T	P	T h eory	P
1.	BOT (H) -601	Ecology	DSE - 4	3	3	-	-	3	-
2.	BOT (H) -602 (A)	Biostatistics	DSE – 5(A)	3	3	-	-	3	-
3.	BOT (H) -602 (B)	Bioinformati cs	DSE – 5(B)	3	3	-	-	3	-
4.	BOT (H) -603 (A)	Medicinal Ethnobotany	DSE – 6(A)	3	3			3	
5.	BOT (H) -603 (B)	Nanotechnolo gy	DSE – 6 (B)	3	3			3	
6.	BOT (H) P	Practical	DSEP	6	0	-	6	-	6

In Fifth Semester and Sixth Semester, students can choose any two electives. Departments will offer two theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.

PROGRAMME LEARNING OUTCOME :

Botany is the broad discipline encompassing various subjects complex with the study of plants.

The B.Sc. Botany (H) Programme imparts knowledge on various fields of plant biology through teaching, interactions, and practical classes. Students would gain wide knowledge as follows:

1. Diversity of plants and microbes their habitat, morphology, and reproduction.
2. Genetics and molecular biology of plants
3. Fungi and disease-causing microbes and fungi
4. Economic value of plants and their use in Biotechnology Biodiversity generally refers to the variety and variability of life on earth. Introduction to Biodiversity ranging from Microbes (Viruses and Bacteria), to Fungi and to various plant groups (Algae and Archegoniates-Bryophytes, Pteridophytes and Gymnosperms) and information on the Ecological and Economic Importance of Microbes, Fungi and various plant groups to enable students understand and understand relevance of Microbes and Plants to environment and human well-being. Insight into the line of Plant Evolution on Earth and the consequent

Biodiversity is instrumental in creating Awareness on the threats to biodiversity and sensitize young minds towards the Biodiversity Conservation for sustainable development.

Objectives of B.SC.(HONS.) BOTANY:

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

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

3. Develop an understanding of Evolution of Plant forms and the consequent Biodiversity. These are

instrumental in creating awareness on the threats to biodiversity and sensitize students towards the Conservation of Biodiversity for sustainable development.

4. To study the organization of cell, cell organelles and biomolecules (i.e protein, carbohydrate, lipid and nucleic acid) to gain knowledge on the activities in which the diverse macro molecules and microscopic structures inhabiting the cellular world of life are engaged. This will facilitate the

students to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

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

COURSE DETAIL

B. Sc. Semester – I
DSC course code BOT (H) - 101
Paper –I: MICROBIOLOGY

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 2

1. Understand the concept, principle, and types of sterilization methods.
2. Know the concept and characteristics of antiseptic, and disinfectant and their mode of action.
3. Know the cultivation methods of bacteria, yeast, fungi, and viruses.
4. Principle, working, and applications of instruments viz, pH meters, spectrophotometer, centrifuge, and laminar airflow.
5. Understand the Microbial Genetics and Recombination in Bacteria.

45 Hrs

3 Credits
11Hrs.

UNIT I:

History and development of Microbiology; contribution of eminent scientists (Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff, Paul Ehrlich, Alexander Flemming, Selman A. Waksman, Edward Jenner), spontaneous generation, biogenesis, germ theory of disease, vaccination and discovery of antibiotics, concept of quorum sensing and biofilms.

UNIT II:

12Hrs.

General characteristics, occurrence, classification, ultra structure of Bacterial cell: morphology (Structure and shapes), flagella, capsule, nutritional types, chromatin material. Reproduction- Vegetative, asexual and sexual (transformation, conjugation and transduction), Comparison of Archaeobacteria and Eubacteria, Gram positive and Gram negative Bacteria

UNIT III:

11Hrs.

Discovery, classification and structural component of Viruses, replication, lytic and lysogenic cycle, Bacteriophages, Structure and reproductive cycle of TMV and Pox virus, Transmission of viruses. Economic importance of viruses.

UNIT IV:

11 Hrs.

Mycoplasma: Occurrence, morphology, reproduction and importance.

Economic and biological importance of bacteria with special reference to their role in agriculture, industry, medicine and sanitation.

Suggested readings:

1. Aneja, K. R. 2003. Experiment in Microbiology, Plant Pathology, and Biotechnology. New age international (P) Ltd. Publishers, New Delhi.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
3. Biswas, S. B. and Biswas, A. 2000. An introduction of Viruses. Vikas publications, New Delhi.
4. Dubey, R. C., and Maheshwari, D. K., 2002. A Text-Book of Microbiology. S. Chand and Co., New Delhi.

5. Kumar, H. D. and Kumar, S. 1998. Modern Concepts of Microbiology. Vikas publishing house Pvt. Ltd., New Delhi.
6. Madahar, C. L. 2001. Introduction of Bacteria. Mc Graw Hill Edu. Pvt. Ltd., London.
7. Mckane, L. and Judy, K. 1996. Microbiology: Essentials and Applications. McGraw Hill, New York.
8. Pandey, S. N., and Trivedi, P. C. 2005. A textbook of Fungi, Bacteria, and Virus. Vikas Publishing House, New Delhi.
9. Pelczar, M.J. Microbiology. 5th edition, Tata Mc Graw-Hill Co., New Delhi.
10. Presscott, L., Harley, J. and Klein, D. 2005. Microbiology. 6th edition, Tata Mc Graw-Hill Co., New Delhi.
11. Purohit, S. S. 2002. Microbiology. Agro. Bot. Publication, Jodhpur.
12. Sharma, P. D. 2003. Microbiology and Pathology. Rastogi Publication, Meerut.
13. Singh, V. and Srivastava, V. 1998. Introduction of Bacteria. Vikas Publication, New Delhi.

B.Sc. SEMESTER- I
DSC-Course Code: (BOT) H-102
PAPER-II: ALGAE AND LICHENS

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO- 3

1. Understand the diversity among Algae.
2. Know the systematic, morphology and structure of Algae.
- 3 Understand the life cycle pattern of Algae.
4. Understand the useful and harmful activities

45 Hrs
3 Credits
11 hrs

UNIT I:

Algae: General characters, distribution, classification of algae, range of thallus organization, flagella, photosynthetic pigments, and reserve food material. Reproduction: vegetative, asexual, and sexual, Alternation of generation and types of life cycles.

UNIT II:

Cyanophyceae: General characteristics, thallus organization, cell structure, reproduction and life cycle of *Nostoc*. Chlorophyceae: General characteristics, thallus organization, cell structure, reproduction and life cycle of *Volvox*, *Chara*.

Xanthophyceae - General characteristics, thallus organization, cell structure, reproduction and lifecycle of *Vaucheria*

UNIT III:

Phaeophyceae: General characteristics, thallus organization, cell structure, reproduction, and life cycle of *Ectocarpus*.

Rhodophyceae: General characteristics, thallus organization, cell structure, reproduction, and life cycle of *Polysiphonia*

UNIT IV:

Economic importance and role of algae in the environment, agriculture, biotechnology and industry, toxic algae.

Lichens: General characters, types, structure, reproduction economic importance, and its importance as colonizers and indicators of the environment. Applied aspects of Algae.

Suggested Readings:

1. Bold, H. C. and Wayne, M. J. 1996. Introduction to Algae. 2nd Edition. Prentice Hall, Inc. Englewood Cliffs, New Jersey.
2. Ghemawat, M. S., Kapoor, J. N. and Narayan, H. S. 1976. A Textbook of Algae. Ramesh Book Depot., Jaipur.
3. Gilbert, M. S. 1985. Cryptogamic Botany. Vol. I and II second edition. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Kumar, H. D. 1998. Introductory Phycology. Affiliated East-West Press Ltd., New York.
5. Sambamurthy, A.V.S.S. 2006. A Textbook of Algae. I. K. International Pvt. Ltd., New.
6. Singh, V., Pandey, P. C. and Jain, D. K. 2001. A Textbook of Botany. Rastogi Publication, Meerut.

7. Thakur, A. and Bassi, S., 2007. Diversity of microbes and Cryptogams. S. Chand and Co., New Delhi.
8. Van den Hoek, C., Mann, D.J. and Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press., England.
9. Vashitha, B. R. 2002. Botany for degree students (Algae and Bryophytes). S. Chand and Co. Ltd., New Delhi.
10. O. P. Sharma. 2011. Diversity of microbes and cryptogams. ALGAE. McGraw Hill Education (India) Private Limited. New Delhi.

B. Sc. Semester – I
Course Code: (BOT) H-103
PAPER-III: BRYOPHYTA

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO -5

1. Understand the morphological diversity of Bryophytes
2. Know the taxonomic position, occurrence, thallus structure, and reproduction of Bryophytes.
3. Understand the economic importance of the Bryophytes.
4. Become aware of the applications of different plants in various industries.
5. To highlight the potential of these studies to become an entrepreneur.
6. To equip the students with skills related to the laboratory as well as industries-based studies

45 Hrs
3 Credits
11 Hrs.

UNIT I:

Bryophytes: General characteristic, origin, classification, habitat range, thallus structure, reproduction, alternation of generation and Economic importance.

UNIT II:

Habitat, structure, reproduction, and life cycle of the following: Hepaticopsida; *Riccia*, and *Marchantia*.

11 Hrs.

UNIT III:

Habitat, structure, reproduction, and life cycle of the following: Anthocerosida; *Anthoceros*.

11 Hrs.

Phylogenetic relationship with Hepaticopsida and Bryopsida.

UNIT IV:

Bryopsida: Habitat, structure, reproduction, and life cycle of *Funaria* and *Sphagnum*.
Sterilization of sporogenous tissues in Bryophytes

12 Hrs.

Suggested Readings:

1. Chopra, R.N. and Kumar, P.K. 1988. Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
2. Pandey, S.N., Mishra, S.P. and Trivedi, P.S. 1981. A textbook of Botany vol. II, Vikas Publishing House Pvt. Ltd, New Delhi.
3. Parihar, N.S. 1965. An Introduction to Bryophyta. Central Book Depot, Allahabad.
4. Puri, P. 1985. Bryophytes. Atmaram and Sons, Delhi.
5. Smith, G.M. 1938. Cryptogramic Botany Vol. II. Bryophytes and Pteridophytes. Mc Graw Hill Book Company, London.
6. Sporne, K.R. 1967. The Morphology of Bryophytes. Hutchinson University Library, London.
7. Tyagi, A. and Saxena, M. 2014. Algae, Lichens and Bryophyta, CBH, Jaipur
8. Vashishta, B. R., Sinha, A. K. and Kumar, A. 2011. Botany for degree students, Bryophyta. S. Chand and Co. New Delhi.
9. Watson E.V. 1971. The structure and life of Bryophytes. Hutchinson University Library, London.

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks
		Credit-6

Practical Exercises

1. Study of Bacteria with permanent slides (*Bacillus*, *Coccus*, *Streptococcus*, *Spirillum*)
2. Comparative study of cell structure in *Allium*, *Hydrilla*, and *Spirogyra* cells.
3. Study of cyclosis in *Tradescantia* staminal hairs and *Hydrilla* leaf.
4. Bacterial staining (Gram's staining).
5. Study of Bacteria with permanent slides (*Bacillus*, *Coccus*, *Streptococcus*, *Spirillum*)
6. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas*, *Volvox*, *Chara*, *Vaucheria*, *Oedogonium*, *Ectocarpus*, *Polysiphonia*, and study of different types of lichens.
7. Laboratory culture of algae.
8. Study of external morphology, the internal structure of vegetative and reproductive parts of the following genera through the specimen and temporary slide preparation: *Riccia*, *Marchantia*, *Anthoceros*, *Funaria*, *Sphagnum*

B.Sc. SEMESTER- II
DSC-Course Code: (BOT) H-201
Paper –I: Mycology and Plant Pathology

Max. Marks: 54

Duration -3

Hrs.Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO- 4

1. Understand the Biodiversity of Fungi
2. Know the Economic Importance of Fungi
3. Know the terminologies in plant pathology.
4. Understand the scope and importance of Plant Pathology.
5. Know the prevention and control measures of plant diseases and their effect on the economy of crops.

45 Hrs
3 Credits

UNIT I:

12 Hrs.

General characteristics, classification (Alexopoulos and Ainsworth's), thallus, cell structure, nutrition, asexual, sexual reproduction, homothallism, heterothallism and heterokaryosis.

Plant diseases: Biotic and abiotic diseases, important symptoms caused by fungi, bacteria, virus and MLOs (Blight, mildew, Downy mildew and green ear, rust, smut, canker, mosaic, little leaf, gall) etc.

UNIT II:

11 Hrs.

General characteristics, structure and life cycles /disease cycles of members of *oomycetes* and *zygomycetes* with special reference to the genera: *Albugo* (white rust disease), *Sclerospora* (Downey mildew/Green ear disease) and *Mucor*.

UNIT III:

11 Hrs.

General characteristics, structure, reproduction, various types of fruiting bodies, life history /disease cycle of class Ascomycetes, Basidiomycetes with special reference to the genera: *Aspergillus*, *Peziza*, *Puccinia* (rust disease) and *Agaricus*.

UNIT IV:

11 Hrs.

General characteristics and structure and life cycle of class Deuteromycetes with special reference to *Alternaria* (early blight of potato disease). Parasexual cycle, Sex degeneration in fungi and economic importance of fungi.

Suggested Readings:

1. Alexopoulos, C.J. and Mims, C.V. 1988. Introductory Mycology. John Wiley and Sons, New York.
2. Dubey, H.C. 1989. Fungi. Rastogi publication, Meerut.
3. Pandey, S. N. and Trivedi, P. S. 1994. A text book of Fungi, Bacteria and Virus. Vikas Publishing House, New Delhi.
4. Sarabhai, R.C. and Saxena, R.C. 1990. A textbook Botany, Rastogi publication, Meerut
5. Vashishta, B. R. 2001. Botany for degree student's Fungi. S. Chand and company, New Delhi.

B. Sc. SEMESTER-II
DSC-Course Code: (BOT) H-202
CELL BIOLOGY, GENETICS, AND PLANT BREEDING

Max. Marks: 54
Duration - 3

Hrs. Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO - 1 :

1. Gain knowledge about "Cell Science".
2. Understand Cell wall Plasma membrane, Cell organelles and cell division
3. The eukaryotic cell cycle and mitotic and meiotic cell division
4. Structure and organization of cell membrane
5. Process of membrane transport and membrane models
6. Mendelian and Neo-mendelian genetics
7. To study the phenomenon of dominance, laws of segregation, independent assortment of genes.
8. To understand the different types of genetic interaction, incomplete dominance, codominance, inter allelic genetic interactions, multiple alleles and quantitative inheritance etc.
9. Understand the biochemical nature of nucleic acids, their role in living systems, experimental evidences to prove DNA as a genetic material. 6. Understand the process of synthesis of proteins and role of genetic code in polypeptide formation.
10. Understand the science of plant breeding.
11. To introduce the student with branch of plant breeding for the survival of human being from starvation.
12. To study the techniques of production of new superior crop varieties.
13. Understand the modern strategies applied in Genetics and Plant Breeding to sequence and analyze genomes
14. Get detail knowledge about modern strategies applied in Plant Breeding for crop improvement i.e. Mass selection, Pure line Selection, and Clonal selection.
15. Know about the exploitation of Heterosis, hybrid

45 Hrs
3 Credits

UNIT -I:

12 Hrs.

The Cell: History of cell and cell theory, elementary idea on micrometry and cell fractionation, cell size and cell structure of Prokaryotic and Eukaryotic cells. Cell wall and Plasma Membrane: Ultrastructure and functions of the cell wall; models of cell membrane organization; fluid mosaic model; chemical composition and functions of plasma membranes Cytoskeleton: Role and structure of microtubules, microfilaments, and intermediary filament.

UNIT-II:

11 Hrs.

Structure, and function of Mitochondria and chloroplast, Golgi complex and Endoplasmic reticulum, Ribosome, Vacuoles, Peroxisomes, and Glyoxysomes. Nuclear Organization: Ultra-structure; nuclear envelope and nuclear pore complex; nuclear lamina, nuclear matrix, and nucleoplasm; molecular organization of chromatin: DNA and histones; nucleosome and higher levels of the organization. Cell Division: Mitosis and Meiosis and their importance

UNIT-III

11 Hrs.

Mendelian Genetics: Mendel's Laws of Inheritance, Back cross and test cross, Allelic and Non-allelic Interaction: Codominance and incomplete dominance, and epistasis, Multiple allelism, Linkage, Crossing Over, and Chromosome Mapping: Coupling and repulsion phases; recombination frequency, linkage map. Preliminary study of maternal Influence: Kappa particles in Paramecium, Mutation: Types transitions, transversions, and frame-shift mutations. Mutagens - Physical and Chemical mutagens, Chromosomal Alterations: duplications, deletions, inversions, and translocations. Brief account on numerical changes in chromosomes.

Plant Breeding: Introduction, objectives of plant breeding. Types of plant reproduction: vegetative, sexual, green revolution. Methods of Plant improvement: Pure line, mass and clonal selection; hybridization in self- and cross-pollinated crops; introduction and acclimatization; hybrid vigor and inbreeding depression, National and International agriculture research institute, Famous plant breeders and their contribution (Indian and International).

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics. John Wiley & sons, India. 8th edition. "
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
3. " Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. " Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
5. " Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
6. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition. 52
7. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing "
8. Alberts, B., Johnson, A., Lewis, J., Roff, M., Roberts, K. and Walter, P., 2008. Molecular Biology of the Cell. Garland Publishers, New York.
9. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
10. Gupta, P.K. 2009. Cytology, Genetics, Evolution and Plant breeding, Rastogi publication, Meerut.
11. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc. New Jersey, USA.
12. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M., Scott, P.M., Zipursky, L. and Darnell, J. 2008. Molecular Cell Biology. W. H. Freeman and company, Macmillan publishers, London.
13. Roy, S.C. and De, K.K. 1999. Cell biology. New central Book Agency (P) Ltd., Calcutta. " Verma, P.S. and Agrawal, V.K. 2012. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand and Co. Ltd., New Delhi.
14. Brooker, R. J. 1999. Genetics: Analysis and Principles. Addison-Wesley, Boston.
15. Choudhary, H. K. 1989. Elementary Principle of Plant Breeding. Oxford and IBM Publishing Co., New Delhi.
16. De Robertis, E. D. P. and De Robertis, E. M. F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
17. Dnyansagar, V. R. 1986. Cytology and Genetics, Tata Mc Graw - Hill Pub Co. Ltd., New Delhi.
18. Gardner, E. J., Simmons, M. J. and Snustad, D. P. 2008. Principles of Genetics. 8th Edition, Wiley India.
19. Gupta, P. K. 2009. Cytology, Genetics, Evolution and Plant Breeding, Rastogi Publication, Meerut.
20. Miglani, G. S. 2000. Advanced genetics. Narosa Publishing House, New Delhi.
21. Shukla, R. S. and Chandel, P. S. 2000. Cytogenetics, Evolution and Plant Breeding, S. Chand and Co. Ltd., New Delhi.
22. Singh, R. B. 1999. Text Book of Plant Breeding. Kalyani publishers, Ludhiana.
23. Snustad, D. P., Simmons, M. J. 2011. Principles of Genetics. V Edition. John Wiley and Sons Inc. New Jersey USA.

E-Books

1. Advanced molecular biology, R.M. Twyman, Garland Science
2. Molecular biology of the cell, B. Alberts, Garland Science
3. Molecular biology, Clark and Pazdernik, Elsevier and academic press
4. Molecular biology of the gene- 7 th ed, James Watson
5. Pearson education, Molecular cell biology, Lodish Darnell -5 th ed, W H freeman

B.Sc. SEMESTER-II
DSC-Course Code: (BOT) H-203
Paper-III BIODIVERSITY AND CONSERVATION

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 15

1. Understanding the basics of the science of biodiversity in an ecological context
2. Learning tools and techniques relevant to monitoring of biological diversity
3. Ability to design a field-based project with rationale and appropriate methodology.

23

45 Hrs
3 Credits
11Hrs.

UNIT- I:

Plant Diversity and its Scope: Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa, Values and uses of biodiversity: Ethical and aesthetic values, Methodologies for valuation, Loss of biodiversity.

UNIT -II: **11Hrs.**
Management of Plant Biodiversity: *In situ* and *ex-situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. Organizations: IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication, concept of Bioeconomy.

UNIT-III: **12Hrs.**
Contemporary Practices in Resource Management: Environmental Impact Assessment (EIA), Geographical Information System (GIS), Participatory resource appraisal, Ecological footprint with emphasis on carbon footprint, Resource accounting; Solid and liquid waste management.

UNIT- IV: **11Hrs.**
Role of Plants in Relation to Human Welfare: Importance of forestry, their utilization and commercial aspects Avenue trees, ornamental plants of India. Fruits and nuts; Important fruit crops their commercial importance. Wood, fiber and their uses.

Suggested Readings:

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P. P, Jalal, K. F. and Boyd, J. A. 2008. An introduction to sustainable development, Prentice Hall of India Private Ltd, New Delhi.

BOTANY PRACTICAL II

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks
Credit-6		

1. Preparation of slides and study of the following genera through temporary mounts and permanent slides:
Albugo (white rust disease), *Sclerospora* (Downy mildew/Green ear disease), *MucorClaviceps* (ergot disease), *Puccinia* (rust disease), *Alternaria* (early blight of potato disease)
2. Preparation of Potato Dextrose Agar medium
3. Measurement of cell size by the technique of micrometry.
4. Study of different stages of mitosis in onion root tip and meiosis in onion flower bud using acetocarmine method.
5. Study various stages of meiosis in flower buds of onion.
6. Counting the cells per unit volume with the help of a hemocytometer. (Yeast/pollen grains).
7. Study of cells and its organelles with the help of electron micrographs.
8. Comparative study of cell structure in *Allium*, *Hydrilla* and *Spirogyra* cells.
9. Study of plastids in *Cassia*, *Lycopersicon*, *Capsicum* and *Solanum* (potato).
10. Study of cyclosis in *Tradescantia* staminal hairs and *Hydrilla* leaf.
11. Study of sex chromosomes
12. Study of Barr body through Giemsa staining. 24
13. Preparation of chromosome maps – gene mapping with a three-point cross
14. Solve exercises related to: · Mendelian law (Monohybrid and Dihybrid ratios) · Incomplete dominance · Gene interactions (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) · ABO blood groups & Rh factor
15. Exercise on emasculation, bagging, and tagging.

16. Practical exercises related to biodiversity conservation.

B.Sc. SEMESTER- III
DSC-Course Code: (BOT) H-301
PAPER –I: MOLECULAR BIOLOGY

Max. Marks: 54

Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempted. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

45 Hrs
3 Credits

UNIT I: 11
Hrs

Salient features and structure of DNA and RNA, chemistry of DNA synthesis (Korenberg's discovery). DNA Replication (prokaryotes and eukaryotes) Synthesis of leading and lagging strands, Okazaki fragments, DNA Polymerases, DNA damage and molecular mechanism of repair.

UNIT –II 11 Hrs

Transcription in prokaryotes and eukaryotes (Initiation, Elongation, and Termination), Promoter, RNA Polymerases, Transcriptional factors and Inhibitors, attenuation and antitermination, RNA Splicing and processing (concept of introns and exons, removal of Introns).

UNIT-III 11 Hrs

Translation (Initiation, Elongation, and Termination) in Prokaryotes and Eukaryotes. Genetic code, Translational factors and inhibitors, Operon concept, regulation of gene expression in prokaryotes and eukaryotes. Extranuclear genome: mitochondria and chloroplast.

UNIT-IV 12 Hrs

Southern, Northern and Western blotting, DNA fingerprinting, polymerase chain reaction, DNA sequencing methods (Sanger's & Maxam Gilbert Methods), DNA microarrays, Electrophoresis.

Suggested Readings:

1. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. 2009. The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Brown, T. A. 2010. Gene cloning and DNA analysis: An Introduction. Blackwell Publication, USA.
3. Buchanan, B., Gruissem, W. and Jones, R. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists., USA.
4. Chrispeel, M.J. and Sadava, D.E. 1994. Plants, Genes and Agriculture. Jones and Barlett Publishers, USA.
5. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5 ASM Press and Sunderland, Washington, D.C. Sinauer Associates, MA. th edition. 18
6. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology 8th edition. Lippincott Williams and Wilkins, Philadelphia.
7. Glick, B.R. and Pasternak, J.J. 2003. Molecular Biotechnology: Principles and Applications of recombinant DNA. ASM Press, Washington. Karp, G. 2010. Cell and Molecular Biology: Concepts

- and Experiments. 6 th edition. John Wiley and Sons. Inc. New jersey, USA.
8. Mascarenhas, A.F. 1988. Hand book of Plant tissue culture. Publication and information. Div., ICAR, New Delhi.
 9. Purohit, S.S. and Mathur, S.K. 1996. Biotechnology Fundamental and Application. Agro Botanical Publisher, Bikaner.
 10. Razdan, M.K., 1993. An introduction to Plant tissue culture. Publication and Information Div., ICAR, New Delhi.
 11. Rana, S.V.S. 2012. Biotechnology theory and practice. (Third Ed.) Rastogi Publication, Meerut.
Rastogi, V.B. 2008. Fundamentals of Molecular Biology. Ane Books, Meerut, India.
 12. Smith, R. H. 2000. Plant Tissue Culture: Techniques and Experiments. 2 nd Academic Press, USA. edition,
 13. Upadhyaya, A. and Upadhyaya, K. 2005. Basic Molecular Biology. Himalaya Publishers. New Delhi.

Max. Marks: 54

Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

UNIT I: 11Hrs.

Biotechnology: Functional definition. Basic aspects of Plant tissue culture, Basal medium, Media preparation, and aseptic culture technique. Concept of cellular totipotency, Differentiation and morphogenesis. Micropropagation and synthetic seeds.

UNIT II: 11Hrs.

Protoplast isolation, culture and Somatic cell hybridization, Androgenesis and its importance, Gynogenesis, Somaclonal variation, Somatic embryogenesis, Clonal propagation, Applications of Plant tissue culture,

UNIT III: 11 Hrs.

Recombinant DNA technology: Techniques used in rDNA technology. Restriction enzymes. Vectors for gene transfer. Plasmids and Cosmids. Genomic and c-DNA library, RFLP, RAPD, AFLP, Transgenic plants, Application of transgenic plants: Bt cotton, Golden rice, Selectable markers and reporter genes, method of gene delivery, *Agrobacterium-mediated* gene transfer,

UNIT IV: 12 Hrs.

Medical Biotechnology: Disease diagnosis - Infectious diseases and genetic diseases; Therapeutics-Antisense oligonucleotides, RNAi as therapeutics; Endogenous therapeutics - insulin, somatostatin, interferons, vaccines, gene therapy, stem cells and their relevance, Industrial Biotechnology: Large scale production of alcohol and antibiotics.

Suggested Readings:

1. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. 2009. The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco. Brown, T. A. 2010. Gene cloning and DNA analysis: An Introduction. Blackwell Publication, USA.
2. Buchanan, B., Gruissem, W. and Jones, R. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists., USA.
3. Chrispeel, M.J. and Sadava, D.E. 1994. Plants, Genes and Agriculture. Jones and Barlett Publishers, USA.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5 ASM Press and Sunderland, Washington, D.C. Sinauer Associates, MA. th edition.
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology 8th edition. Lippincott Williams and Wilkins, Philadelphia.
6. Glick, B.R. and Pasternak, J.J. 2003. Molecular Biotechnology: Principles and Applications of recombinant DNA. ASM Press, Washington.
7. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6 th edition. John Wiley and Sons. Inc. New jersey, USA.
8. Mascarenhas, A.F. 1988. Hand book of Plant tissue culture. Publication and information. Div., ICAR, New Delhi.
9. Purohit, S.S. and Mathur, S.K. 1996. Biotechnology Fundamental and Application. Agro Botanical Publisher, Bikaner.
10. Razdan, M.K., 1993. An introduction to Plant tissue culture. Publication and Information Div., ICAR, New Delhi.
11. Rana, S.V.S. 2012. Biotechnology theory and practice. (Third Ed.) Rastogi Publication, Meerut. Rastogi,
12. V.B. 2008. Fundamentals of Molecular Biology. A27 Books, Meerut, India.
13. Smith, R. H. 2000. Plant Tissue Culture: Techniques and Experiments. 2 nd edition, Academic Press, USA.
14. Upadhyaya, A. and Upadhyaya, K. 2005. Basic Molecular Biology. Himalaya Publishers. New Delhi.

B. Sc. Semester – III
DSC - Course Code (BOT) H – 303
Paper – III
INDUSTRIAL MICROBIOLOGY

Max. Marks: 54
Duration - 3

Hrs. Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO- 20

1. Learn about the different types of fermentation processes, the equipment used, and the microbiological processes involved.
2. Gain knowledge of the significance and activities of microorganisms in food.
3. Gain knowledge about the microbiology of milk and fermented products.
4. To know the microbial quality control and quality schemes used in food industries.

45 Hrs
3 Credits

Unit I.

12 Hrs.

The exploitation of microorganisms and their products, screening, strain development strategies, immobilization methods, fermentation media, raw material used in media production, anti-foaming agents, buffers, and downstream processing.

Centrifugation, cold percolation extraction, and hot extraction, using Soxhlet apparatus

Unit II.

11 Hrs.

Fermentation equipment and its uses, fermenter design, Types of fermenters and fermentations- single, batch, continuous, multiple, surface, submerged, and solid state.

Unit III

11 Hrs.

Industrial products from microorganisms- antibiotics: production of penicillin, streptomycin. Interferons, vaccines, hormones.

Unit IV

11 Hrs.

Enzymes from microbes: amylase, protease. Organic acids: acetic acid, amino acids: glutamic acid. Production of alcoholic beverages: beer and wine, biofuels: ethanol.

References:

1. Whitaker and Stanbury. Principles of Fermentation Technology.
2. Casida. Industrial Microbiology. Tata McGraw Hill.

B.Sc. Hons. Semester III
DSC-Course Code: (BOT) H-303
BOTANY PRACTICAL III

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Credit-
6

1. Preparation of media & sterilization methods
2. Preparation of Murashige and Skoog (MS) media.
3. Preparation of Anther Culture, meristem and shoot tip culture.
4. Preparation of artificial seeds.
5. Estimation of soluble protein from a selected plant and separation by SDS-PAGE.
6. Isolation of plasmid DNA from *E. coli*.
7. Demonstration of gel electrophoresis.
8. Bacteriological analysis of food products.
9. Determining the quality of milk by MBRT.
10. Agglutination reactions – blood group, Widal, VDRL.
11. Enzyme-Linked Immunosorbent Assay.
12. Antibiotic sensitivity test by well and disc methods.
13. DLC, TLC.
14. Preservation methods.
15. Isolation and identification of major bacterial pathogens such as *Staphylococcus*, *Streptococcus* etc.

B.Sc. SEMESTER- IV
DSC-Course Code: (BOT) H-401
Paper –I: Pteridophyta, Gymnosperms and Paleobotany

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 6

1. Understand the morphological diversity of Pteridophytes and Gymnosperms.
2. Understand the economic importance of the Pteridophytes and Gymnosperms.
3. Know the evolution of Pteridophytes and Gymnosperms.
4. Know the scope of Paleobotany, types of fossils, their role in global economy and geological time scale.
5. Understand the various fossil genera representing different fossil groups.

45 Hrs
3 Credits

UNIT- I

Pteridophytes - General characteristics, Distribution, classification, Types of stele, development of sporangia (eusporangiate and leptosporangiate), life cycle patterns, and Economic importance.

11 Hrs.

UNIT –II

Hrs.

Heterospory and seed habit, Apospory and Apogamy.

Morphology, anatomy, and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Marsilea*.

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UNIT-III

Gymnosperm: General characteristics, distribution, classification (K. R. Sporne) and economic importance. Affinities of Gymnosperms with Pteridophytes and Angiosperms.

11 Hrs.

Morphology, anatomy, reproduction and life cycle of *Cycas* and *Pinus*.

UNIT-IV

Morphology, anatomy, reproduction, and life cycle of *Ephedra*.

11 Hrs.

Paleobotany: Geological time scale, fossil types and theory of fossilization, techniques of study of fossils. Fossil pteridophyte - *Rhynia*, and *Lepidodendron*, Fossil gymnosperm- *Williamsonia*.

Suggested Readings:

1. Bierhorst, D.W. 1971. Morphology of Vascular Plants. MacMillan Co., N.Y. and CollierMacMillan Ltd., London.
2. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
3. Singh, V., Pandey, P. C. and Jain, D. K. 2013. A textbook of Botany. IV edition, Rastogi publication, Meerut.
4. Sharma, O. P. 1990. Textbook of Pteridophyta, MacMillan India Ltd., Delhi. Vashishta, P.C. 1997. Botany for Degree Students- Pteridophyta. S. Chand and Company, New Delhi.
5. Wilson, N. S. and Rothewall, G. W. 1993. Paleobotany and Evolution of Plants. (2nd Edition), Cambridge University Press, U. S.A
6. Bhatnagar, S. P. and Moitra, A. 1997. Gymnosperms. New Age International (P) Ltd., Publisher, New Delhi.
7. Clark, D. L. 1976. Fossils, Palaeobotany and Evolution. W.M.C. Brown Company, New York. Meyen, S. V. 1978. Fundamentals of Palaeobotany. Chapman and Hall, London. Sharma, O. P. 1997. Gymnosperms. Pragati Prakashan, Meerut, India.
8. Sporne, K. R. 2002. The Morphology of Gymnosperms. B. I. Pub. Pvt. Ltd. Mumbai, Kolkata, Delhi.
9. Thomas, B. A. and Spice, R. A. 1986. The Evolution and Paleobotany of land Plants. Publ. Crom. Helm London and Sydney.
10. Vashishta P.C. 1980. Gymnosperms. S. Chand and Co. Ltd., New Delhi

B.Sc. SEMESTER- IV
DSC-Course Code: (BOT) H-402
Paper- II : PLANT PHYSIOLOGY AND BIOCHEMISTRY

Max. Marks: 54
Duration-3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 9

1. Know the importance and scope of plant physiology.
2. Understand the plants and plant cells in relation to water.
3. Understand the process of photosynthesis in higher plants with particular emphasis on light and dark reactions, C3 and C4 pathways.
4. Understand the respiration in higher plants with particular emphasis on aerobic and anaerobic respiration.
5. Learn about the movement of sap and absorption of water in plant body
6. Understand the plant movements.
7. Learn and understand about mineral nutrition in plants.
8. Understand the growth and developmental processes in plants.
9. Know about Photosynthesis and Respiration in plants.
10. Understand the process of translocation of solutes in plants
11. Know the nitrogen metabolism and its importance.
12. Understand the Biochemical nature of cells.
13. Know the chemical nature of biomolecules.
14. Understand the different types of interaction in Biomolecules.
15. Structure and general features of enzymes.
16. Concept of enzyme activity and enzyme inhibition.
17. Understand the properties of Monosaccharides, Oligosaccharides and polysaccharides.
18. They will learn about the Significance of Carbohydrates.
19. Understand the Properties of saturated fatty acids, and unsaturated fatty acids.
20. Understand lipid metabolism in plants.
21. Understand the Beta Oxidation, Gluconeogenesis, and its role in the mobilization of fatty acids during germination.
22. They will learn about the Significance of lipids.
23. They will be able to understand a brief outline of the biosynthesis of amino

45 Hrs
3 Credits
11Hrs.

Unit-I

Water: Structure, physiochemical properties, importance to plant life, concept of water potential, Absorption and Transport of water, Ascent of sap, Transpiration, Stomatal movement, Factors affecting transpiration, Guttation.

Mineral nutrition: Essential micro and macro nutrients, their uptake, hydroponics and nutrient requirement deficiency and toxicity symptoms.

Transport of organic substances: Mechanism of Phloem transport, factors regulating the translocations of nutrients.

Unit-II

Photosynthesis: pigments, Photosynthetic apparatus, light reaction, Photo system I and II, Photophosphorylation, C₃ (Calvin Cycle), C₄ Cycle, CAM Pathway, Photorespiration, Factors affecting the photosynthesis.

Respiration: Aerobic and anaerobic respiration, RQ (Respiration Quotient), Glycolysis, Krebs cycle, Oxidative phosphorylation and factors affecting the respiration, Fermentation.

31

Unit-III

11 Hrs.

Biomolecules:

Enzymes: Structure, nomenclature and classification of enzyme, Characteristics of Enzymes, Mechanism of action.

Carbohydrate, proteins and lipids: Structure, Classification, and function

Unit-IV

12 Hrs.

Phases of growth and development: seed germination and mobilization of food reserves, seed dormancy Plant growth regulators: structure, discovery, biosynthesis, mode of action and physiological effects of Auxins, Gibberellins, Cytokinins, Ethylene and ABA, jasmonic acid and brassinosteroids. Plant movement, biological clock, Photoperiodism and Vernalization and Physiology of flowering.

Suggested readings:

1. Hopkins, W.G. and Huner, P. A. 2008. Introduction to Plant Physiology. John Wiley and Sons, USA.
2. Jain, V.K. 2013. Fundamental of Plant Physiology. S. Chand and Company Ltd., New Delhi.
3. Malik, C.P. and Srivastava A.K. 1982. Text book of Plant Physiology. Kalyani publication, New Delhi.
4. Mukherjee S., Ghosh A. K. 2006. Plant Physiology. New Central Book Agency, Calcutta.
5. Parashar, A.N. and Bhatia, K.N. 1985. Plant Physiology. True Man Book Company, New Delhi. Edition Tata McGraw, New Delhi.
6. Sinha, R. K. 2007. Modern Plant Physiology.
7. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th edition Sinauer Associates Inc. Publishers, Massachusetts, USA.
8. Verma, S.K. and Verma, M. 2000. A Text book of Plant Physiology.
9. Biochemistry and Biotechnology. S. Chand and co. Ltd., New Delhi.
10. Verma, V. 2007. Text Book of Plant Physiology. A N E Books, India.
11. Hopkins, W.G. and Huner, P. A. 2008. Introduction to Plant Physiology. John Wiley and Sons, USA.
12. Jain, V.K. 2013. Fundamental of Plant Physiology. S. Chand and Company Ltd., New Delhi.
13. Malik, C. P. and Srivastava A.K. 1982. Text book of Plant Physiology. Kalyani publication, New Delhi.
14. Mukherjee S., Ghosh A. K. 2006. Plant Physiology. New Central Book Agency, Calcutta.
15. Parashar, A. N. and Bhatia, K.N. 1985. Plant Physiology. True Man Book Company, New Delhi. Tata Mc Graw, New Delhi.
16. Sinha, R. K. 2007. Modern Plant Physiology. 2
17. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th edition Sinauer Associates Inc. Publishers, Massachusetts, USA.
18. Verma, S. K. and Verma, M. 2000. A Text book of Plant Physiology, Biochemistry and Biotechnology. S. Chand and co. Ltd., New Delhi.
19. Verma, V. 2007. Text Book of Plant Physiology. ANE Books, India.

B.Sc. SEMESTER- IV
DSC-Course Code: (BOT) H-403
Economic Botany

45 Hrs
3 Credits

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 7 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 7 marks.

CO -14

This help in understanding economic value of angiosperm in terms of cereal, pulse, spice and condiments, fodder, and medicinal use etc.

UNIT I: 8 Hrs
Centre of origin of cultivated plants (Vavilov), secondary centre of origin. History, origin, distribution, botany, cultivation and processing of cereals: Wheat, maize, rice and bajra. General account of pulses: Chana and moong.

UNIT II: 8 Hrs.
General account and identification of spices and condiments (any five) of Rajasthan. dyes (Indigo and Lawsonia), beverages (tea and coffee), fumigatories and masticatories. fat and oil-yielding plants (Brassica and Cocus).

UNIT III: 8 Hrs.
History, cultivation, processing and economic use of sugar and rubber, fiber-yielding plants (cotton and jute). Fat and oil-yielding plants (Brassica and Cocus).

UNIT IV: 6 Hrs.
General account and identification of locally available fruits, vegetables and ornamental plants. Characteristics and uses of timber-yielding plants teak and sal. Identification and medicinal value of locally available medicinal plants (only five).

Suggested Readings

1. Gupta, S.K. and Kaushik, M.P. 1973. An Introduction to Economic Botany. K. Nath and Co., Meerut.
2. Hill, A.W. 1952. Economic Botany. McGraw Hill Book Co., New York." Jain, S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
3. Jain, S.K. 1987. A Manual on Ethnobotany. Scientific Publisher, Jodhpur.
4. Prakash, G., Sharma, S. K. 1975. Introductory Economic Botany. Jai Prakash Nath and Cossec, Meerut.
5. Sambamurthy, A.V.V.S. and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd., New Delhi.
6. Sen, S. 1992. Economic Botany. New Central Book Agency, Calcutta.
7. Singh, V., Pandey, P.C. and Jain, D.K. 1998-99. Economic Botany. Rastogi Publications, Meerut.
8. Verma, V. 1974. A Text Book of Economic Botany. Emkay Publications, New Delhi.

B.Sc. SEMESTER- IV
DSC-Course Code: (BOT) H-403

BOTANY PRACTICAL IV

Maximum practical	=	150
Marks	=	marks
Internal marks	=	60
External marks	=	Marks
		90
		Marks

Credit-6

1. Double staining technique and technique for preparation of permanent slides.
2. Study of following with the temporary slide preparation and specimens ((Vegetative and reproductive)
Pteridophytes: *Psilotum*, *Selaginella*, *Equisetum*, *Pteridium*, *Marsilea*.
Gymnosperms: *Cycas* (coralloid root, T.S. of coralloid root, T.S. of leaflet, petiole, male cone and L.S. of male cone, microsporophyll, megasporophyll, T.S. of microsporophyll, ovule, L.S. of ovule and seed).
Pinus (T.S. of stem and needle, male cone and female cone, L.S. of male cone and female cone, seed).
Ephedra (Stem T.S., leaf T.S., male and female cones, L.S. of ovule, seed)
3. Study of fossil specimens *Rhynia*, Fossil pteridophyte - *Lepidodendron*, Fossil gymnosperm-*Williamsonia*.
4. Study of the mechanism of stomatal opening a closing.
5. Rate of photosynthesis under varying HCO_3 concentration in an aquatic plant using bicarbonate (Wilmott and Bubbler).
6. Demonstration of O_2 evolution during photosynthesis by inverted funnel method.
7. To study that light is necessary for photosynthesis by using ganong screen.
8. To demonstrate of anaerobic and aerobic respiration.
9. To study that CO_2 , light and chlorophyll is essential for photosynthesis (Moll's half experiment).
10. Study C_3 and C_4 plant with the kranz anatomy.
11. To study the R.Q. of different substrates by Ganong's respirometer.
12. Demonstration of O_2 evolution during aerobic respiration.
13. To study growth by auxanometer and movement by clinostat.
14. Demonstration of phenomenon of osmosis using potato osmoscope.
15. Demonstration of phenomenon of plasmolysis.
16. To determine the osmotic potential of vacuolar sap by plasmolytic method.
17. To study the permeability of plasma membrane using different concentration of organicsolvents.
18. To study the effect of temperature on permeability of plasma membrane.
19. To demonstrate root pressure.

20. Study of effect of temperature on rate of transpiration.
21. Study of transpiration rate in dorsiventral and isobilateral leaves by use of potometer.
22. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through stomata in a mesophyte and a xerophyte.
23. Study of vegetative and floral characters of species of the families studied in theory.
24. Identification of selected taxa up to genus using taxonomic keys.
25. Herbarium technique.
26. Familiarity with local flora and preparation of herbarium sheet.
27. Preparation and applications of Phosphate buffers in biological studies.
28. Principle, working and use of colorimeter and spectrophotometer.
29. Principle, types and application of centrifuges
30. Principle and types of Chromatography.
31. Separation of amino acids by paper chromatography and thin layer chromatography.
32. Microchemical tests for carbohydrates (Fehling's test, Benedict's test) and proteins
33. Separation of chlorophyll and carotenoid pigments by solvent method
34. Separation of chlorophyll and carotenoid pigments by paper chromatography.
35. Preparation of standard curve of protein for estimation of soluble proteins in plant materials by Lawry's method.
36. To study the activity of peroxidase, catalase, and amylase enzyme.
37. Estimate chlorophyll and carotenoid content in C₃ and C₄ plant.
38. To test the presence of ascorbic acid in different plant juices.
39. Study the following specimens with special reference to:

Botany of the economically important part.

Processing if any involved. Specimens of cereals, pulses, fibers, spices, beverage (tea, coffee), sugar, oil yielding plants and medicinal plants (mentioned in theory).

Microchemical test for starch, sugar, oils, proteins, fat, carbohydrate, lignin using wheat, maize, soyabean. Chana, sweet potato, clove, ground nut, mustard and match sticks.

1. Study of starch grains in potato and pea.
2. Field trip to economically important place.

B.Sc. SEMESTER- V
DSE - 1 Course Code: (BOT) H-501
PAPER - I: Plant Anatomy and Embryology

Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks. CO- 8

1. Understand the habits of the angiosperm plant body.
2. Know the vegetative characteristics of the plant.
3. Learn about the reproductive characteristics of the plant.
4. Understand the plant morphology and basic taxonomy.
5. Know the evolutionary trends and affinities of living gymnosperms with respect to external and internal features. Know the methods of pollination and fertilization.
6. Know fertilization, endosperm, and embryogeny.
7. Understand the scope & importance of Anatomy.
8. Know various tissue systems.
9. Understand the normal and anomalous secondary growth in plants and their causes.
10. Perform the techniques in anatomy.

35

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two

marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

Unit I:

12 Hrs.

Meristematic and permanent tissues Root and shoot apical meristems; Simple and complex tissues Organs-primary structure of dicot and monocot root stem and leaf.

Unit II:

11Hrs.

Secondary Growth: cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood). Primary and secondary abnormalities with suitable examples. Adaptive and protective systems. Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit III

11Hrs.

Structural organization of flower: Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. Pollination and fertilization

Unit IV:

11Hrs.

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms. Embryo and endosperm, Endosperm types, structure, and functions; Dicot and monocot embryo; Embryo-endosperm Relationship.

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication

B.Sc. Semester V
DSE -2 Course Code: (BOT) H-502-A
Paper-II PLANT SYSTEMATICS

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 7

1. Know the conceptual development of „taxonomy“ and „systematics“
2. Understand the Phylogeny of Angiosperms -A general account of the origin of Angiosperms.
3. Understand the general range of variations in the group of angiosperms.
4. Trace the history of the development of systems of classification emphasizing angiospermic taxa.
5. To learn the wide activities in angiosperm and trends in classification.
6. Learn about the characters of biologically important families of angiosperms.
7. Know the floral variations in angiospermic families, their phylogeny and evolution.
8. Understand various rules, principles and recommendations of plant nomenclature produces in plant identification.
9. Understand major evolutionary trends in various parts of angiospermic plants
10. With respect to recent knowledge students should know about the different tools in the taxonomy so as to relocate the phylogenetic position of plant or taxa

45 Hrs
3 Credits
12 Hrs.

UNIT I:

Scope and importance of taxonomy, history, and classification of angiosperm (Linnaeus, Bentham and Hooker and Engler and Prantl), brief reference of angiosperm phylogeny group (APGIII) classification, concept of species, genus and family. Taxonomic tools: Herbarium, E- Flora, botanical garden, monograph, journals, key and icons.

UNIT II:

Principle and rules of botanical nomenclature: Ranks, names, type method, author citation, valid publication, principle of priority and its limitations. Taxonomic studies of the following families (Bentham and Hooker), Dicots: *Ranunculaceae, Brassicaceae, Malvaceae, Myrtaceae*

UNIT III:

Taxonomic evidences from morphology, anatomy, palynology, cytology, phytochemistry, embryology, genome analysis and nucleic acid hybridization and taxometrics. Taxonomic studies of the following families (Bentham and Hooker) Dicots: *Fabaceae, Asteraceae, Apocyanaceae* and *Asclepiadaceae*.

UNIT IV:

Taxonomic studies of the following families (Bentham and Hooker): *Solanaceae, Convolvulaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Arecaceae, Liliaceae* and *Poaceae*.

11 Hrs.

Suggested readings:

1. Naik, V.N. 2011. Taxonomy of Angiosperms. TATA McGraw Hill, New Delhi.
2. Pandey, S.N. and Misra, S.P. 2008. Taxonomy of Angiosperms. Ane Books India, New Delhi.
3. Saxena, N.B. and Saxena, S. 2011. Plant Taxonomy. Pragati Prakashan, New Delhi.
4. Sharma, B.D. 1984. Flora of India vol. I. Botanical Survey of India, Calcutta.
5. Sharma, O.P. 1996. Plant Taxonomy. TATA McGraw Hill, New Delhi
6. Simpson, M.C. 2006. Plant Systematics. Elsevier, Amsterdam.

6. Singh, G. 2001. Plant systematics. Oxford and IBH, New Delhi.
7. Sivarajan, V.V. 1991. Introduction to Principles of Plant Taxonomy. Oxford and IBH, New Delhi.
8. Taxonomy of Angiosperm, V.N. Nair (1995) IMH Publishing Company
9. A.K. Mondol, Advanced Taxonomy, NCBA Publication
10. N.S. Subramaniam, Modern Plant Taxonomy, Vikas Publication House

B.Sc. Semester V
DSE- 2 Course Code: (BOT) H-502-B
Paper-II Natural Resource Management

Max. Marks: 54

Duration -3

Hrs.Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO- 14

1. Understand the role of plants in human welfare.
2. Gain knowledge about various plants of economic use.
3. Know the importance of plants & plant products.
4. Understand the chemical contents of the plant products.
5. Know about the utility of plant resources.

45 Hrs
3 Credits

Unit I

Classification of Natural Resources: Renewable and non-renewable resources, Classes of earth resources, resource regions. Definition and criteria: Resource degradation, Depletion of Natural resources

11 Hrs.

Unit II

Non-mineral resources: Land, Land use classification, Planning, land degradation. Soil: Soil formation and Profile. Water: Classification and characteristics of water resources. Bioresources: Plants, animals, and microorganisms. Forest resources: Timber and non-timber resources, Agricultural resources.

12 Hrs.

Unit III

Mineral resources: Ores, reserves, and formation and classification of mineral deposits. Fuel resources: Fossil fuel. Coal, petroleum and natural gas. Marine resources.

11 Hrs.

Unit IV

Natural resource Management: Preservation, conservation, and restoration. Sustainable management of resources, mine reclamation practices, Water conservation methods.

11 Hrs.

Suggested Readings:

1. Energy and Environment, V K Ahluwalia The Energy and Resources Institute (TERI)
2. Energy, the Environment, and Sustainability, Efstathios E. Michaelides, CRC Press
3. Sustainable Energy and Environment: An Earth System Approach, Sandeep Narayan Kundu, Muhammad Nawaz, CRC Press
4. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 1996.
5. Raven, P. H, Hassenzahl, D. M. Hager, M.C, Gift, N. Y. and Berg, L.R. (2015). Environment, 9 th Edition. Wiley Publishing, USA.
6. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
7. Kaushik, Anubha and Kaushik, C.P. (2018). Perspectives in Environmental Studies
8. Bharucha, Erach Textbook of Environmental Studies for Undergraduate Courses. 2018
9. Sharma, P.D. Fundamentals of Ecology. Rastogi Publications.

B.Sc. Semester V
DSE -3 Course Code: (BOT) H-503-A
PAPER – III: Research Methodology

Max marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions

are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 17

Demonstrate the ability to choose methods appropriate to research aims and objectives

Understand the limitations of particular research methods

Develop skills in qualitative and quantitative data analysis and presentation

Develop advanced critical thinking skills

Demonstrate enhanced writing skills

UNIT I: 12Hrs.
Principles of Microscopy: Light microscopy, Fluorescence microscopy, Confocal microscopy, Use of fluorochromes, Flow cytometry, FLUORESCENCE-ACTIVATED CELL SORTING Transmission and Scanning electron microscopy – Principle and Instrumentation.

UNIT II: 11Hrs.
Centrifugation: Differential and density gradient centrifugation.
Electrophoresis: PAGE, SDS-PAGE; PCR: Principle, Procedure, and application.

UNIT-III 11Hrs.
Chromatography: Principle, Paper chromatography, Column chromatography, TLC
Spectrophotometry: Principle and its application in biological research.

UNIT IV: 11Hrs.
Fixation of Biological Materials: Chemistry of Fixation, Fixative solutions, Freeze-drying, cryopreservation. Histological Methods: Fixation, dehydration, clearing, embedding, Microtomy, Staining: Classification of stains, Mechanism, and chemistry of staining.

Suggested Readings:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

B.Sc. Semester V
DSE- 3 Course Code: (BOT) H-503-
BPAPER – III: TISSUE CULTURE

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 16

1. Define the basic concepts of Plant Tissue Culture as a Biotechnology tool.
2. Recognize the importance of the Plant Tissue Culture technique.
3. Practice the different techniques used in Plant Tissue Culture.
4. Acquire all skills used in Plant Tissue Culture techniques.
5. List of chemicals, media, and equipment required for Plant Tissue Culture Lab.
6. Explain and analyze the role of plant growth regulators in PTC technique.
7. Describe how to regenerate plants using the different techniques of PTC –
8. Recognize the possible reasons for failure of a specific plant tissue or organ culture.
9. Analyse and interpret the in vitro data and draw sensible conclusions from such data

45 Hrs
3 Credits

Unit I:

12 Hrs.

History of plant tissue culture research - basic principles of plant tissue callus culture meristem culture, organ culture, Totipotency of cells, differentiation and dedifferentiation.
Methodology - sterilization (physical and chemical methods), culture media, Murashige and Skoog's (MS medium), phytohormones, medium for micro-propagation/clonal propagation of Ornamental and horticulturally important plants.
Isolation and maintenance of Callus and suspension culture, single cell culture, growth measurements.

UNIT-II:

11Hrs.

Micro propagation, Shoot-tip culture, Clonal propagation, Virus free plants, Anther, Pollen and ovary culture. Protoplast isolation, culture and fusion: Technique, culture. Somatic hybridization, selection of hybrid cells, cybrid.

UNIT-III:

11Hrs.

Organogenesis and Somatic Embryogenesis, Synthetic seed production
Endosperm culture – Embryo culture -culture requirements – applications, embryo rescue technique. Production of secondary metabolites.
Cryopreservation; Germplasm conservation, Somaclonal variation.

UNIT-IV:

11Hrs.

Applications in Agriculture, Horticulture and Forestry: Achievements and current trends in improvement of cereals, vegetable crops, oil yielding plants, ornamental plants and forest trees.

BOTANY PRACTICAL V

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Credit-6

Practical

1. Study of meristems through permanent slides and photographs.
Calculation of the percentage of germinated pollen in a given medium.
2. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
Leaf: Dicot and Monocot leaf (only Permanent slides). Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
3. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs). Ultrastructure of mature egg apparatus cells through electron micrographs. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens). Dissection of embryo/ endosperm from developing seeds.
4. Introduction to basic laboratory instruments and equipment- Autoclave, Centrifuge, pH meter, Micropipettes, Digital balance, Homogenizer, Electrophoresis.
5. Preparation of media & sterilization methods
6. Preparation of Murashige and Skoog (MS) media.
7. Preparation of Anther Culture, meristem and shoot tip culture.
8. Preparation of artificial seeds.
9. Estimation of soluble protein from a selected plant and separation by SDS-PAGE.
10. Isolation of plasmid DNA from *E. coli*.
11. Demonstration of gel electrophoresis.
12. Practical Exercise related to natural resource management and conservation policies.
13. Survey and Biodiversity index preparation based on biodiversity conservation

B.Sc. SEMESTER-VI
DSE- 4 Course Code: (BOT)
H-601Paper-I: ECOLOGY

Max. Marks: 54

Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO-10

1. Know the scope and importance of the discipline.
2. Understand plant communities and ecological adaptations in plants.
3. Know the concept of methodology in taxonomy.
4. Learn about the conservation of biodiversity, Non-conventional Energy, and Pollution.
5. Discover botanical regions of India and vegetation types of Rajasthan.
6. Understand Bioremediation, Global warming and climate change.

45 Hrs

3 Credits

12 hrs

UNIT – I

Environment and plant: ecological factors, atmosphere (Four distinct zone), light (Photosynthetically active radiation, zonation in water bodies, photoperiodism, heliophytes and sciophytes), temperature (Raunkier's classification of plants: megatherms, mesotherms, microtherms, Heikistotherms, thermoperiodicity and vernalization), soil (Development, soil profile, properties)

UNIT– II.

11 hrs

Population Ecology: characteristics, growth curve, ecotypes, ecads. Population interaction among organisms. Community characteristics, frequency, density, biological spectrum, ecological succession (Hydrosere, psammosere and xerosere), concept of climax.

UNIT – III

11 hrs

Ecosystem: Ecosystem: structure and components, Food chain, Food web, energy flow, trophic levels and Ecological pyramids. Primary, and Secondary Productivity. Biogeochemical cycles- Carbon, Nitrogen and Phosphorous.

UNIT – IV

11 hrs

Pollution: air, water and soil. WWF, Chipko movement, greenhouse effect, ozone depletion, loss of biodiversity and extinction of species, Red data book. Efforts of environment management by Vienna convention, Montreal protocol, Earth summit, Kyoto protocol, World summit on sustainable development.

Suggested Readings:

1. Koromondy, E.J. 1996. Concepts of Ecology. New Delhi. 4th Edition Prentice-Hall of India Pvt.Ltd.
2. Misra, K.C. 1988. Manuals of Plant Ecology. (3rd Edition) Oxford and IBH Publishing Co., New Delhi.
3. Banerjee, P.K. 2006. Introduction to Biostatistics. S. Chand and Co., New Delhi.
4. Odum, E.P. 1983. Basic Ecology. 5th Edition Thomson Business International Waldis Pvt. Ltd., Baricahd.
5. Odum, E.P. 2008. Ecology. Oxford and IBH Publisher.
6. Sharma, P.D. 2010. Ecology and Environment, (8th Edition) Rastogi Publications, Meerut.
7. Singh, J.S., Singh, S.P. and Gupta, S. 2006. Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi.

B.Sc. SEMESTER-VI
DSE- 5 Course Code: (BOT) H-602-A
Paper-II: Biostatistics

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO -18

1. Define the principal concepts of biostatistics.
2. Recognize the definition of statistics, its subject, and its relation with the other sciences.
3. Restate the principal concepts of biostatistics.
4. Identify data relating to variable/variables.
5. Identify a convenient sample by using sampling theory.
6. Identify the distribution form relating to the variable/variables.
7. Recognize normal distribution.
8. Define the principal concepts of probability.
9. Recognize the binomial distribution.

45 Hrs
3 Credits

Unit - I

Introduction to Biostatistics, Definition, Statistical terms - Population, sample, primary and secondary data, qualitative and quantitative data, variables, discrete and continuous variables and statistical error. Sampling Techniques, Introduction, Methods of Sampling - Serial Random Sampling and Stratified Sampling.

12 Hrs.

Unit - II

Diagrammatic and Graphic Representation of Data, Introduction, Diagrammatic representation of data - Bar diagram and Pie diagram, Measures of Central Tendency, Introduction, Calculation of arithmetic mean, median, and mode in an ungrouped data

11 Hrs.

Unit - III

Measures of Dispersion, Introduction, Methods of measuring dispersion A. Range - Characteristic of Range and coefficient of range B. Variance and Standard Deviation - Calculation of Standard Deviation and coefficient of Variation.

11 Hrs.

Unit - IV

Test of Significance, Introduction, laying down of hypothesis - Null hypothesis, Alternative hypothesis and level of significance, Test based on normal distribution [Large sample test] Testing one population mean, Testing equality of two population mean, Student's t-test [Small sample test] Testing one population mean, Testing equality of two population mean, Paired t-test, Chi-Square test as a test of goodness of fit and its significance

11 Hrs.

References:

1. Bisen, P. S. and Shruti Mathur, Life Science in Tools and Techniques.
2. Marimuthu, R., Microscopy and Microtechnique.
3. Sharma, V.K., Techniques in Microscopy and Cell Biology.
4. Prasad and Prasad, Outlines of Microtechnique.
5. Srivastava, Sharad and Singhal. Vineeta, Laboratory Methods in Microbiology.
6. Annie and Arumugam, Biochemistry and Biophysics.
7. Sass, John E., Botanical Microtechnique.

8. Pranab Kumar Banerjee, Introduction to Biostatistics.
9. Khan and Khanum, Fundamentals of Biostatistics.
10. Mahajan, B. K., Methods in Biostatistics for medical students and research workers.
11. Parikh, M. N. and Nithya Gogtay, ABC of Research Methodology and Applied Biostatistics.
12. K. Viswesara Rao, Biostatistics in Brief.
13. Wayne W. Daniel, Biostatistics - Basic Concepts and Methodology for the Health Sciences.
- Agarwal, B. L., Basic Statistics.
14. B. Antonisamy, Solomon Christopher and P. Prasanna Samuel, Biostatistics - Principle and Practice
15. Sundar Rao, P.S.S. and Richards J, Introduction to Biostatistics and Research Methods. 17. Neil A. Weiss, Introductory Statistics

B.

Sc. SEMESTER-VI
DSE-5 Course Code: (BOT) H-602-B
PAPER –II Bioinformatics

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 13

1. Mastery of the core concepts of Bioinformatics, including computational biology, databasedesign and implementation, and probability and statistics.
2. To get the ability to apply skills in a professional environment via an industrial oracademic internship in Bioinformatics.

45 Hrs
3 Credits
11 Hrs.

Unit I

Introduction to bioinformatics and data generation. What is bioinformatics and its relation with molecular biology. Examples of related tools (BLAST), databases (GENBANK), and software (RASMOL).

Data generation; Generation of large-scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-ray diffraction, and microarray). Applications of Bioinformatics.

Unit II

11 Hrs.

Biological Database and its Types, Introduction to data types and sources. Population and sample, Classification, and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD). Structure databases (CATH)

Unit III

11 Hrs.

Introduction to Metadata and search; Indices, Boolean, Fuzzy, and Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages, and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON, and OMG/LIFESCIENCE.

Unit IV

12 Hrs.

Sequence Alignments and Visualization Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).

Methods for presenting large quantities of biological data: sequence viewers (Artemis), 3D structure viewers (Rasmol, SPDBv), Anatomical visualization. Gene Expression and Representation of patterns and Relationships, General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes).

B. Sc. SEMESTER - VI
DSE- 6 Course Code: (BOT) H-603-A
PAPER –III: MEDICINAL AND ETHNOBOTANY

Max. Marks: 54
Duration -3

Hrs. Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO – 19

1. Gain the knowledge of Morphological and anatomical Characters of medicinally important plants
2. Knowledge of plants used in Ayurvedic preparations
3. knowledge of national parks, Biosphere Reserves, and Botanical gardens of India
4. knowledge of famous personalities of Ayurveda and Siddha medicine.

45 Hrs
3 Credits

UNIT I:

12 Hrs.

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

UNIT II: 11 Hrs.

Role of Ethnobotany in Modern Medicine: Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) *Azadiractha indica*, *Ocimum sanctum*, *Vitex negundo*, *Gloriosa superba*, *Tribulus terrestris*, *Pongamia pinnata*, *Cassia spp.*, *Indigofera tinctoria*, *Aloe vera*, *Andrographis paniculata*, *Clotora spp.*

UNIT III:

11 Hrs.

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

11 Hrs.

UNIT IV:

Ethnobotany and Legal Aspects: Ethnobotany as a tool to protect interests of ethnic groups Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings:

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian Ethnobotany, Oxford and I B H, New Delhi – 19813 Lone et al. Palaeoethnobotany
3. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
4. S.K. Jain, 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
5. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons Chichester
6. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
7. Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA–SHREE Publishers, Jaipur-1996
8. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

B. Sc. SEMESTER-VI
DSE- 6 Course Code: (BOT) H-603-
BPaper - III:
NANOTECHNOLOGY

Max. Marks: 54
Duration -3 Hrs.

Scheme of Examination: There will be two parts in the end semester theory paper. Part A of the paper shall contain ten short answer questions, out of which 7 questions to be attempt. Each question will carry two marks for the correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

CO - 21

1. To understand the nature and properties of nanomaterials.
2. To Understand the scientific application of nanomaterials and nanotechnology in agriculture, health, and environmental conservation.
3. Familiarity with working principles, tools, and techniques in the field of nanomaterials.
4. Understanding of the strengths, limitations and potential uses of nanomaterials.

45 Hrs
3 Credits
12 Hrs.

Unit I:

Fundamentals of Nanoscience and Nanotechnology, Definitions, Relationship and Differences. Nano and Nature: Nanoscopic Colours (Butterfly Wings), Bioluminescence (Fireflies), Tribiology (Geckos sticky feet, lotus leaf effect). Introduction to hydrophilic and hydrophobic materials.

Unit II :

Introduction to Self-assembled Biological Nanomaterials in Nature, Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, and Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus).

11 Hrs.

Unit III:

Fundamentals of Atomic Structure and Bonding, Bohr's atomic structure, Bohr's atomic radii, the comparative size of nanomaterials and atomic size, electronic configuration, energy levels of shells, and related numerical problems on excitation of electrons from lower to higher energy level. Concept of quantization of energy. Arrangement of atoms in solids (two-dimension crystal structures and three dimension crystal structures). Bonding in solids (MOT), bonding, and antibonding states. Electronic structures of solids.

11 Hrs.

Unit IV:

Terminology and Techniques in Nanobiotechnology Definitions, Scopes and Applications of Biotechnology, Nanobiotechnology, Biomolecular Nanotechnology, Biomedical Nanotechnology, Green Nanotechnology. Fundamentals and introduction to techniques such as mechanical extraction, physical methods of homogenization, centrifugation, dialysis, electrophoresis and chromatography techniques for purification of biomolecules and microscopy.

11 Hrs.

References:

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno. Materials Science and Engineering –V. raghavan
3. Elements of Material Science and Engineering-H. Vanvlach (4th Edition)
4. Nanotechnology-S. K. Kulkarni (3rd Edition)
5. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.

6. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and FrancisGroup, Boca Raton, M. Kuno.
7. Nanotechnology-S. K. Kulkarni (3rd Edition)
8. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash (4th Edition), Tata McGraw-Hill Publishing Company Ltd., New Delhi.

BOTANY PRACTICAL VI

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Credit-6

1. Study of adaptive anatomical and morphological features of Hydrophytes, Epiphytes and Xerophytes using plant material.
2. Study of soil pH, soil moisture in relation to depth, bulk density, porosity and waterholding capacity of different soil samples.
3. Determination of requisite size and number of quadrat for the study of plant community.
4. Study of structure of plant community by determining frequency, density and abundance of quadrat method.
5. Find out the transparency of a water body by sacchi disc.
6. Determine the dissolved oxygen content in polluted and unpolluted water samples.
7. To study different statistical methods: mean, median and mode, standard error, standard deviation.
8. Regression analysis and application of statistical tests in environmental problems.
9. Collection of different soils, studying their texture
10. Observing polluted water bodies
11. Student study projects,
12. Debates on man's activity on ecosystem
13. Practical Exercise based on Bioinformatics concepts
14. Biodiversity conservation methods.
15. Visiting a nearest natural vegetation area.
16. Visit to NGO, working in the field of biodiversity and report writing
17. Measurement and Sampling
18. Frequency Distributions
19. Summary Statistics
20. Probability
21. Introduction to Estimation
22. Introduction to Hypothesis Testing
23. To study Honey Bees and plants yielding honey.
24. Reduction of Ag^+ by glucose (Tollen's Test for reducing sugars).
25. Reduction of Cu^{2+} by aldehydes (Fehling's Test).
26. Synthesis of Ag nanoparticles using sodium borohydride (Creighton's method).
27. Synthesis of Au nanoparticles using citric acid (Lee –Meisel method).
28. Determination of density of colloidal Ag/Au nanoparticles using specific gravity bottle (5 ml).
29. Measurements of conductivity of KCl solution at different concentrations.
30. Volumetric acid base titration using pH meter. (Strong acid vs Strong base , Weak acid vs Strong base.
31. Determination of viscosity of polymer by using a viscometer.
32. Diffraction grating by LASER.
33. Determination of surface tension of a liquid by drop weight method.
34. Error analysis.
I-V characteristics of solar cells.
35. Demonstration of nano TiO_2 dye-sensitized solar cell. – NVIS kit
36. Demonstration of nanotechnology. – NVIS kit
37. Use of a multimeter to measure resistance/Inductance/diode/transistor.

38. Validation of Lambert's-Beer's law using CuSO_4 solution.
39. Calculation of a total number of atom's and surface atom's present in a nanoparticle of a given size. (Theoretical).
40. Introduction to Nanobiotechnology lab equipments- Calorimeter, pH meter, Weighing balance, Hot Air Oven, Water Bath, Autoclave, Laminar Air Flow, -20°C deep freezer, Thermal cyclermachine (PCR machine), Gel Electrophoresis system, PAGE system, power supply/unit, Centrifuge, water distillation unit etc.
41. Preparation of stock solutions and Buffer Solution, Stock Solution, such as Acetate Buffer pH 4.8, phosphate buffer pH 9.6, Phosphate Buffer saline pH 7.2, Saline solution pH 7.0 22. Preparation of Plant Extract (Organic and aqueous), Crushing, grinding, maceration, homogenization, Filtration, Centrifugation, cold percolation extraction, and hot extraction, using Soxhlet apparatus.