Syllabus for

UG0805-Three/Four Year Bachelor of Science (Botany)

(From the Academic Year 2025-26 onwards)

(Syllabus as per NEP-2020 and Choice Based Credit System)

For Semester - I to VI

(For students - admitted in the year 2025 onwards)

University of Rajasthan,

Jaipur-302004

Vision:

To create potential and competent professionals in Botany through the courses with practical

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training and advanced technical skills; equipped with knowledge and aptitude for higher education and research.

Mission:

- Dissemination of global demand- basedknowledge through teaching with technical professionalism.
- Creation of individuals with social and environmental concern.
- Training the students to create economically and environmentally viable solutions in the field of plant science.

Programme Outcomes:

PO1. Developing the potential for vertical career growth in plant sciences, academic and service sectors and related fields.

PO2. Development of in-depth analytical and critical thinking, so that students would be able to identify and solve the problems with the help of botany.

PO3. Proficient knowledge in the major domains of plant sciences including plant identification, plant diseases, microbiology, Plant biotechnology etc.

PO4. Students can successfully learn tools and techniques related to plant research.

PO5. After completion of course, students would be able to execute their professional roles in society as botanist, plant taxonomist, plant pathologist, etc.

PO6. Students will be able to learn skills to work as a team with the people from multidisciplinary environment.

PO7. To design and develop sustainable solutions to major biological problems by applying appropriate tools.

PO8. To develop skills, attitude and values required for self-directed, lifelong learning and professional development.

PO9. Acquire knowledge and understanding of norms and ethics in the field of botany.

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Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**Science**
Name of Discipline	**Botany**
Type of Discipline	**Major**
List of Programmes where offered as Minor Discipline	**----------**
Offered to Non-Collegiate Students	**No**

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0805-Three/Four Year Bachelor of Science (Botany)								
				Botany	**Credits**			
#	**Level**	**Semester**	**Type**	**Title**	**L**	**T**	**P**	**Total**
1.	5	I	MJR	**UG0805 - BOT-51T-151 -Cell Biology and Diversity of Plant Kingdom-I**	4	0	0	4
2.	5	I	MJR	**UG0805 - BOT-51P-152 - Practical-I**	0	0	2	2
3.	5	I	MJR	**UG0805 -BOT-51T-153 -Microbiology**	4	0	0	4
4.	5	I	MJR	**UG0805 -BOT-51P-154 -Practical-II**	0	0	2	2
5.	5	II	MJR	**UG0805 - BOT-52T-155 - Genetics, Plant Breeding and Diversity of Plant Kingdom-II**	4	0	0	4
6.	5	II	MJR	**UG0805 - BOT-52P-156 - Practical-I**	0	0	2	2
7.	5	II	MJR	**UG0805 - BOT-52T-157 -Molecular Biology**	4	0	0	4
8.	5	II	MJR	**UG0805 - BOT-52P-158 - Practical-II**	0	0	2	2
9.	6	III	MJR	**UG0805 - BOT-63T-251 - Plant Biochemistry and Physiology**	4	0	0	4
10.	6	III	MJR	**UG0805 - BOT-63P-252 - Practical-I**	0	0	2	2
11.	6	III	MJR	**UG0805 -BOT-63T-253 -Ecology and Plant Resource Utilization**	4	0	0	4
12.	6	III	MJR	**UG0805 -BOT-63P-254- Practical-II**	0	0	2	2
13.	6	IV	MJR	**UG0805 -BOT-64T-255-Fundamentals of Plant Pathology**	4	0	0	4
14.	6	IV	MJR	**UG0805 - BOT-64P-256 - Practical-I**	0	0	2	2
15.	6	IV	MJR	**UG0805 - BOT-64T-257-Fundamentals of Analytical Techniques**	4	0	0	4

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				Botany	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
16.	6	IV	MJR	**UG0805 -BOT-64P-258 - Practical-II**	0	0	2	2
17.	7	V	MJR	**UG0805 -BOT-75T-351-Plant Biotechnology-I**	4	0	0	4
18.	7	V	MJR	**UG0805 -BOT-75P-352 Practical-I**	0	0	2	2
19.	7	V	MJR	**UG0805 - BOT-75T-353- Systematics of Angiosperms**	4	0	0	4
20.	7	V	MJR	**UG0805 - BOT-75P-354 – Practical-II**	0	0	2	2
21.	7	VI	MJR	**UG0805 - BOT-76T-355 - Plant Biotechnology-II**	4	0	0	4
22.	7	VI	MJR	**UG0805 - BOT-76P-356- Practical-I**	0	0	2	2
23.	7	VI	MJR	**UG0805 - BOT-76T-357 Morphology and Anatomy of Angiosperms**	4	0	0	4
24.	7	VI	MJR	**UG0805 - BOT-76P-358- Practical-II**	0	0	2	2
25.	8	VII	MJR	**UG0805 - BOT-87T-451- Environmental Biology**	4	0	0	4
26.	8	VII	MJR	**UG0805 - BOT-87P-452- Practical-I**	0	0	2	2
27.	8	VII	MJR	**UG0805 - BOT-87T-453- Embryology of Angiosperms**	4	0	0	4
28.	8	VII	MJR	**UG0805 - BOT-87P-454 - Practical-II**	0	0	2	2
29.	8	VIII	MJR	**UG0805 - BOT-88T-455 - Biostatistics and Evolution**	4	0	0	4
30.	8	VIII	MJR	**UG0805 - BOT-88P-456- Practical-I**	0	0	2	2
31.	8	VIII	MJR	**UG0805 - BOT-88T-457- Applied Botany**	4	0	0	4
32.	8	VIII	MJR	**UG0805 - BOT-88P-458 - Practical-II**	0	0	2	2

Examination Scheme

1. 1 credit = 25 marks for examination/evaluation
2. For Regular Students there will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components-Continuous assessment (20% weightage) and (End of end-semester examination) EoSE (80% weightage).
3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.

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4. To appear in the EoSE examination of a course/subject a regular student must appear in the mid-semester examination and obtain at least a "C" grade in the course/subject.
5. Credit points in a Course/Subject will be assigned only if, the regular student obtains at least a "C" grade in the CA and EoSE examination of a Course/Subject.

Examination Scheme for Continuous Assessment (CA)

DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

S. No.	CATEGORY	Weightage (out of total internal marks)		THEORY					PRACTICAL		
				CORE (Only Theory)	CORE (Theory + Practical)	AEC	SEC	VAC	CORE (Theory +Practical)	SEC	VAC
	Max Internal Marks			30	20	20	10	10	10	10	10
1.	Mid-term Exam	*50%*		15	10	10	5	5	5	5	5
2.	Assignment	*25%*		7.5	5	5	2.5	2.5	2.5	2.5	2.5
3.	Attendance	*25%*		7.5	5	5	2.5	2.5	2.5	2.5	2.5
		Regular Class Attendance	= 75%	3	2	2	1	1	1	1	1
			75-80%	4	3	3	1.5	1.5	1.5	1.5	1.5
			80-85%	5	4	4	2	2	2	2	2
			> 85%	7.5	5	5	2.5	2.5	2.5	2.5	2.5

Note:

1. Continuous assessment will be the sole responsibility of the teacher concerned.
2. For continuous assessment no remuneration will be paid for paper setting, evaluation, invigilation etc.
3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.

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5. Colleges are advised to keep records of continuous assessment, attendance etc.

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Examination Scheme for EoSE for Semester-I

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	BOT-51T-151 -Cell Biology and Diversity of Plant Kingdom-I	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-51P-152 – Practical-I Cell Biology and Diversity of Plant Kingdom-I	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BOT-51T-153 -Microbiology	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-51P-154 - Practical-IIMicrobiology	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks

The theory question paper will consist of **two** parts **A&B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

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Syllabus
UG0805-Three/Four Year Bachelor of Science (Botany)

Semester-I
BOT-51T-151 - Cell Biology and Diversity of Plant Kingdom-I

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	BOT-51T-151	Cell Biology and Diversity of Plant Kingdom-I				5	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Introductory	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		------					
Prerequisites		Biology Courses of Senior Secondary level					
Objectives of the Course		➢ To understand the structural organization and functions of organelles in thecell. ➢ To differentiate between prokaryotic and eukaryotic cells and plant andanimal cells. ➢ To gain understanding on Nucleic acids and chromosome organization. ➢ To understand cell cycle and analyze different stages of mitosis and meiosis. ➢ To understand microscopic to macroscopic view of the Algae and Fungi. ➢ To be able to differentiate algal and fungal members. ➢ To understand difference between Hepaticopsida, Anthocerotopsida and Bryopsida. ➢ To be able to identify and know about Lichens.					

Detailed Syllabus

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BOT-51T-151-Cell Biology and Diversity of Plant Kingdom-I

Unit – I

Ultrastructure of Cell and Cell Organelles: Eukaryotic and Prokaryotic cell structure; Ultrastructure and functions of different cell organelles (Cell wall, Plasma membrane, Nucleus, Mitochondria, Chloroplast, Ribosome, Peroxisomes, Lysosome, Golgi bodies and Endoplasmic Reticulum); Basic idea of Mitochondrial and Chloroplast genome.

Chromosome organization: Chromosome Number, Morphology, nucleosome model of chromosome organization, Special types of chromosomes: Lamp brush and Polytene chromosomes. **15 Lectures**

Unit – II

Nucleic Acids: DNA as genetic material (Griffith's transformation experiment and Hershey and Chase blender experiment); Structure of DNA (Watson and Crick Model); Structure and function of different types of RNA (rRNA, mRNA, tRNA, snRNA).

Cell Division: Basic idea of Cell cycle; Different stages of mitosis; Different stages of Meiosis I and Meiosis II, synaptonemal complex, chiasmata formation and crossing over.

Structural and numerical aberrations in human chromosomes and ploidy in plants: Deletion, Duplication, Translocation, Inversion, Aneuploidy and Polyploidy. **Mutations**: Types of Mutations, Spontaneous and induced Mutations, Physical and Chemical mutagens. **15 Lectures**

Unit -III

Introduction to Plant Kingdom: Basic idea of hierarchy in all groups of plants.

Algae: General characteristics, Classification (Fritsch) upto classes. Diverse Habitat. Range of thallus structure. Reproduction (Vegetative, Asexual, Sexual); Economic importance. Life history of:Cyanophyceae- *Nostoc;* Chlorophyceae- *Volvox;* Xanthophyceae- *Vaucheria;* Phaeophyceae-*Ectocarpus;* Rhodophyceae-*Polysiphonia.*

Lichens- General characters, habitat, morphology, reproduction and Ecological and economic importance.

15 Lectures

Unit -IV

Fungi: General characteristics; Thallus organization; types of hyphal forms, Heterokaryosis and Parasexuality; Nutrition and reproduction; economic importance. Classification **(**Alexopoulos**).**Life history of: Zygomycota-*Rhizopus*; Ascomycota-*Peziza*; Basidiomycota-*Puccinia*.

Bryophytes: General characteristics; affinities with Algae and Pteridophytes;Reproduction (Vegetative and Sexual); Alternation of generations and evolution of sporophytes.Classification (Proskauer, 1957); Structures of gametophyte & sporophyte and life history (Development details not included) of: Hepaticopsida-*Marchantia*, Anthocerotopsida-*Anthoceros* and Bryopsida-*Funaria.*

15 Lectures

Suggested Books and References:

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- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6thEd.). New York: Garland Science.
- Cooper, G. M., and Hausman, R. E. (2013). **The Cell: A Molecular Approach** (6th Ed.). Washington: ASM; Sunderland.
- Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York.
- Veer Bala Rastogi. **Genetics.** Medtech.
- Veer Bala Rastogi. **A Textbook of Cell Biology and Genetics.** Kedarnath Ramnath
- Alexopoulos, C.J. and Mims, C.W.: **Introductory Mycology**, John Wiley and Sons, New York, 2000.
- Singh, Pande and Jain**. A Textbook of Botany,** Rastogi publications.
- Dube, H.C.: Fungi, Rastogi Publications, Meerut, 1989.
- Vashishtha, B.R. **Botany for Degree Students-Fungi**, S. Chand & Co., New Delhi, 2001.
- Gilbart, M. Smith: **Cryptogamic Botany,Vol. I & II (2nd Ed.)**Tata McGraw Hill. Publishing Co., Ltd., New Delhi, 1985.
- Puri. P.: **Bryophytes**, Atmaram& Sons. Delhi, Lucknow, 1985.
- Aneja, K.R.: **Experiments in Microbiology, Plant Pathology and Biotechnology**. New Age International (P) Ltd., Publishers, New Delhi 2003.
- Pandey B. P. (2022) **Algae, Bryophytes and Lichens**. S Chand Publication.
- Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

Suggested E-resources:

Online Lecture Notes and Course Materials:

1. **https://youtu.be/K2teJ6-DBLw**
2. nptel.ac.in

B.Sc. Botany Semester-I
BOT-51P-152Practical-I
Cell Biology and Diversity of Plant Kingdom-I

Suggested Laboratory Exercises:

Cell and Cell Organelles

- Study of electron microphotographs of prokaryotic and eukaryotic cell.
- Study of electron microphotographs of virus, bacteria and eukaryotic cells for comparative study of cellular organization.
- Study of cell structure in Onion, *Hydrilla* and *Spirogyra*.
- Study of plastid for pigment distribution in *Lycopersicon*, *Cassia* and *Capsicum*.

Nucleic Acids, Cell Division and Chromosomes

- Isolation of Genomic DNA from Onion/Banana/Pineapple/etc.
- Demonstration of Gel-electrophoresis

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- Study of permanent slides/photographs of different stages of mitosis and meiosis, sex chromosomes, polytene chromosome and salivary gland chromosomes.
- Study of different stages of mitosis and meiosis in root-tip cells and flower buds respectively of onion.
- Calculate the mitotic index of onion root tip cells.
- Study of induced aberrations in onion root tips employing chemicals and plant extracts.

Algae and Lichen

- **Algae:**Study of morphology and anatomy of *Nostoc*, *Volvox, Vaucheria, Ectocarpus*and*Polysiphonia*(vegetative and reproductive structures) by preparing temporary slides and studying permanent slides.
- **Lichens:** Study of growth forms of lichens (crustose, foliose and fruticose)

Fungi

- **Fungi:**Microscopic observation of vegetative and reproductive structures of *Rhizopus*, *Peziza* and *Puccinia* through preparation of temporary slides and permanent slides.

Bryophyta

- **Bryophytes**:Study of morphology, anatomy, vegetative and reproductive organs of *Marchantia*, *Anthoceros* and *Funaria* by preparing temporary slides and studying permanent slides.
- Study of renowned Indian scientists in the fields of phycology(M.O.P Iyengar), mycology (K. C. Mehta), bryology (S.R.Kashyap) and lichens (D.D.Awasthi).
- Make a list of national and international institutes of repute in the fields of cytology, phycology, mycology, bryology and lichens.

Any other exercise based on theory syllabus.

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	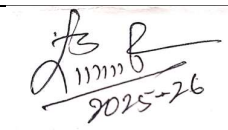	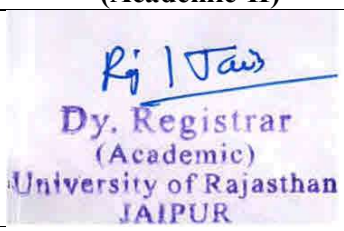

UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester-I
BOT-51P-152 Practical-I
Practical-I
Scheme of Practical Examination and Distribution of marks
BOT-51P-152 Max. Marks: 10*+40 Min. Marks: 4*+16

Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise based on Cell biology/ Nucleic Acids.	**4**	**6**
2. Make a suitable acetocarmine preparation of the given material. Draw a well-labelled diagram of any one stage of nuclear division.	**4**	**6**
3. Make a suitable stained preparation of the given material **A**. Draw a labelled diagram and identify giving reasons **(Algae).**	**4**	**6**
4. Make a suitable stained preparation of the given material **B**. Draw a labelled diagram and identify giving reasons (**Fungi).**	**4**	**6**
5. Make a suitable stained preparation of the given material **C** (vegetative/Reproductive part). Draw a labelled diagram and identify giving reasons (**Bryophyte).**	**4**	**6**
6. Comment upon the spots- identify giving reasons (1 to 5).	**10**	**15**
7.Viva-voce	**5**	**5**
8. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. Learn, understand and develop skill and hands on training in basics of cell biology.
2. Acquire basic knowledge of hereditary material and chromosomes.
3. Know all the kind of plant groups and understand relationships between them.
4. Understand diversity of lower plant presents on various habitats.
5. Identify microscopic to macroscopic view of the plants.
6. Apply the economic importance of lower plants in their endeavours.
7. Promote shared learning through practical classes, presentations and assignments.

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Syllabus
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Semester-I
BOT-51T- 153 - MICROBIOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	BOT-51T- 153	MICROBIOLOGY				5	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Biology Courses of Senior Secondary level					
Objectives of the Course		➢ The objective of the course is to make students aware of the diversity, distribution and characteristic features of various microorganisms. ➢ The course also aims to make students aware of the indispensable role of microorganisms in the environment, biotechnology, fermentation, medicine and other industries important to human welfare. ➢ In addition to this, the course shall also prepare students for higher education in microbiology-related disciplines.					

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Detailed Syllabus
BOT-51T- 153 - MICROBIOLOGY

UNIT-I

History of Microbiology: History of development of microbiology, Spontaneous generation versus biogenesis, major contributions of Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, and contribution of Indian microbiologists.

Virus: Characteristics and Classification of Viruses (Baltimore), Cryptograms, structure with special reference to TMV, Bacteriophage, Multiplication of Viruses (Lytic and Lysogenic). Viroids, Virusoids, Prions.

15 Lectures

UNIT-II

Bacteria: General Characteristics, Classification by Bergey's Manual, Cell structure, Cell-wall: Composition and detailed structure of Gram positive and Gram-negative cell walls, mechanism of Gram's staining, endospore formation, Asexual Reproduction and Sexual Recombination (Conjugation, Transformation and Transduction), Archaebacteria and Eubacteria.

Mycoplasma: General Characteristics, Morphology and Reproduction. **15 Lectures**

UNIT-III

Microbial Nutrition and Growth: Nutritional types of microorganisms, growth factors, culture media-synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics. Use of physical methods (heat, low temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

15 Lectures

UNIT-IV

Applications of Microbiology: Importance of microbes in agriculture and food industries. Basic design of fermenter,continuous and discontinuous culture. Preparation of fermented food products (yogurt, curd and cheese). Preparation of alcoholic beverages (wine and beer). Treatment of waste water (Municipal treatment plant) and Sewage, Bioremediation.

15 Lectures

Suggested Books and References:

- Pelczar, M.J. (2001) **Microbiology,** 5th edition. New Delhi, Delhi: Tata Mc-Graw- Hill Co.
- J. Willey, L. Sherwood & C. Woolverton. (2017). **Prescott's Microbiology**. McGraw Hill international.
- M. J Chan, ECS Krieg & NR Pelczar. (2004). **Microbiology,** McGraw Hill. International. J. G. Cappuccino, and N. Sherman. (2013). **Microbiology: A Laboratory manual**, Benajamin/Cummings.
- M. T. Madigan, J. M. Martinko & D. A. Stahl, Brock. (2010). **Biology of Microorganisms,** Pearson Education International.
- Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

Suggested E-resources:

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Online Lecture Notes and Course Materials:

1. Vidhya Mitra Integrated E-Content Portal
2. eGyanKosh-Introductions to Microbiology
3. e-Krishi Shiksha- Introduction Microbiology
4. NPTEL :: Biotechnology - Microbiology

B.Sc. Botany Semester- I
BOT-51P- 154 Practical-II
MICROBIOLOGY

Suggested Laboratory Exercises:

1. Preparation of the liquid culture media for the growth of microorganisms.
2. Preparation of the solid culture media for the growth of microorganisms
3. Study of physical methods of sterilization.
4. Study of chemical methods of sterilization.
5. Study of bacterial cultures using streak plate culture method.
6. Study of bacterial cultures using pour plate culture method.
7. Study of bacterial cultures using serial dilution method.
8. Simple Staining of bacteria.
9. Perform Gram staining.
10. Demonstration of antibiotic resistance in bacteria.
11. Study of the growth curve of bacteria.
12. Study of the effect of pH and temperature on bacterial growth.
13. Measurement of microbial cell using micrometry.
14. Study of different shapes of TMV, Bacteriophage, Viroids, Bacteria, Mycoplasma using permanent slides/pictographs.
15. Any other exercise based on theory syllabus.

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UNIVERSITY OF RAJASTHAN

B.Sc. Botany Semester- I

BOT-51P- 154 Practical-II

MICROBIOLOGY

Scheme of Practical Examination and Distribution of marks

BOT-51P- 154 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C	**5**	**7**
4. Exercise D	**5**	**7**
5. Comment upon the spots- identify giving reasons. (1 to 5)	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. To understand about general characteristics and structural details of various microbes.
2. To understand about various microbiological techniques including sterilization, media preparation, maintenance of microbial culture and staining.
3. Students will learn about various parameters required for optimum growth of microbes.
4. To understand various commercial applications of microbiological techniques.
5. Economic importance of Microbes
6. Acquire skills in several laboratory methods
7. Study of gram staining, microscopy, and biochemical assays.

Signature of Dean	Signature of BoS Convenor	Signature Of DR (Academic-II)
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Examination Scheme for EoSE for Semester-II

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		MaximumMarks		Minimum Marks	
Theory	BOT-52T- 155 - Genetics, Plant Breeding and Diversity of Plant Kingdom-II	**CA**	**01 Hr**	**CA**	**20 Marks**	**CA**	**08 Marks**
		EoSE	**03 Hrs**	**EoSE**	**80 Marks**	**EoSE**	**32 Marks**
Practical	BOT-52P-156 - Practical-IGenetics, Plant Breeding and Diversity of Plant Kingdom-II	**CA**	**1 Hr**	**CA**	**10 Marks**	**CA**	**04 Marks**
		EoSE	**04 Hrs**	**EoSE**	**40 Marks**	**EoSE**	**16 Marks**
Theory	BOT-52T-157 - Molecular Biology	**CA**	**01 Hr**	**CA**	**20 Marks**	**CA**	**08 Marks**
		EoSE	**03 Hrs**	**EoSE**	**80 Marks**	**EoSE**	**32 Marks**
Practical	BOT-52P-158 - Practical-II Molecular Biology	**CA**	**1 Hr**	**CA**	**10 Marks**	**CA**	**04 Marks**
		EoSE	**04 Hrs**	**EoSE**	**40 Marks**	**EoSE**	**16 Marks**

The theory question paper will consist of **two** parts **A&B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

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Syllabus
UG0805-Three/Four Year Bachelor of Science (Botany)
Semester-II
BOT-52T- 155 - Genetics, Plant Breeding and Diversity of Plant Kingdom-II

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	BOT-52T- 155	Genetics, Plant Breeding and Diversity of Plant Kingdom-II				5	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Introductory	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Botany Course of Foundation or Introductory Level					
Objectives of the Course		➢ To understand Mendel's laws and its deviations. ➢ To impart knowledge on DNA replication, Mendel's laws of inheritance ➢ To understand functions of genes, linkage and crossing over and mutations. ➢ To be able to apply knowledge of Plant breeding methods in crop improvement. ➢ To learn about institutes and scientists in the field of crop improvement. ➢ To understand morphology and anatomy of Pteridophytes and Gymnosperms. ➢ To understand reproduction in Pteridophytes and Gymnosperms. ➢ To have a basic idea of Fossil plants.					

Detailed Syllabus

BOT-52T-155 – Genetics, Plant Breeding and Diversity of Plant Kingdom-II

Unit – I

Genetic inheritance: Mendel's laws of inheritance and their exceptions; Allelic (incomplete dominance, co-dominance, lethality) and Non-allelic interactions (complementary genes, epistasis and duplicate genes); Multiple allelism (ABO blood groups in men); Quantitative inheritance (Grain color in wheat). **Cytoplasmic inheritance:** Plastid inheritance (leaf variegation in *Mirabilis jalapa*); Mitochondrial inheritance (Cytoplasmic male sterility in plants).

Plant breeding: History and objectives of plant breeding; relevance of mode of reproduction to plant breeding; their effect on generating and fixing genotypic variation. Types of crop plants for plant

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breeding (self-pollinated, cross-pollinated and vegetatively propagated crop plants). General idea of methods of selection in crop improvement. **15 Lectures**

Unit – II

Plant introduction: purpose, types (primary and secondary), procedure, merits, demerits and achievements.Acclimatization.

Hybridization: Meaning, objectives, types, procedure, various methods of emasculation, Hybrid Vigor, applications. Inbreeding depression and its practical applications. Role of mutation and polyploidy in plant breeding (with examples); Green revolution.

Plant breeding work done on wheat and rice in India, Plant introduction agencies in India (NBPGR, FRI, BSI). Famous Indian and International plant breeders and their contributions. National and International agricultural research institutes.

15 Lectures

Unit -III

Pteridophytes: General characteristics; Affinities with bryophytes & gymnosperm; Heterosporyand seed habit; Evolution of stele in Pteridophytes; Economic importance. Classification (Riemers,1954); Study of life history of fossil Pteridophyte – *Rhynia*. Life history of Psiloptopsida-*Psilotum;*Lycopsida-*Selaginella*; Sphenopsida-*Equisetum*; Pteropsida-*Marsilea*. **15 Lectures**

Unit-IV

Gymnosperms: General characteristics; Affinities with Pteridophytes and Angiosperms, Distribution; Economic importance. Classification (Sporne, 1965); Life history of Cycadopsia-*Cycas*; Coniferopsida-*Pinus*; Gnetopsida-*Ephedra*.

Paleobotany: Introduction, Basic concept and significance, Geological time scale; Types of Fossils.

15 Lectures

Suggested Books and References:

- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6thEd.). New York: Garland Science.
- Cooper, G. M., and Hausman, R. E. (2013). **The Cell: A Molecular Approach** (6th Ed.). Washington: ASM; Sunderland.
- Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York.
- Lodish, HF. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman.
- Gupta P.K. **Cell and Molecular Biology** 2018. 5th edition Rastogi Publication India.
- Veer Bala Rastogi. **Genetics.** Medtech.
- Veer Bala Rastogi. **A Textbook of Cell Biology and Genetics.** Kedarnath Ramnath
- B. D. Singh. **Plant Breeding: Principles and Methods,** Kalyani Publishers.
- Choudhary, H.K. **Elementary Principles of Plant Breeding**. Oxford and IBM Publishing Co., New Delhi, 1989.
- Singh, R. B.: **Text Book of Plant Breeding**, Kalyani Publishers, Ludhiana (1999).

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- Singh, Pande and Jain**. A Textbook of Botany,** Rastogi publications.
- B.R. Vashishta and P.C. Vashishta. **Botany for Degree Students: Pteridophyta - Vascular Cryptogams),** S.Chand (G/L) & Company Ltd.
- B.R. Vashishta and P.C. Vashishta. **Gymnsperms (Botany for Degree Students),** S.Chand (G/L) & Company Ltd.
- Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

Suggested E-resources:

Online Lecture Notes and Course Materials:

1. **https://youtu.be/K2teJ6-DBLw**
2. nptel.ac.in

B.Sc. Botany Semester-II
BOT-52P-156 Practical-I
Genetics, Plant Breeding and Diversity of Plant Kingdom-II

Suggested Laboratory Exercises:

Practicals related to Genetics-

- To solve genetic problems based upon Mendel's laws of inheritance: Monohybrid cross, Dihybrid cross, Back cross and test cross.
- Induction of polyploidy using colchicine.

Practicals related to Plant Breeding-

- Emasculation, Bagging and Tagging
- Study of Famous Indian and International plant breeders and their contributions.
- Study of National and International agricultural research institutes.

Pteridophytes-

- **S**tudy ofvegetative and reproductive stages of *Selaginella*, *Equisetum* and *Marsilea* by preparing temporary slides and studying permanent slides.

Gymnosperms-

- Study of Vegetative and reproductive stages of *Cycas*, *Pinus* and *Ephedra* by preparing temporary slides and studying permanent slides.

Fossil plant-*Rhynia.*

Any other exercise based on theory syllabus.

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester-II
BOT-52P-156 Practical-I
Genetics, Plant Breeding and Diversity of Plant Kingdom-II
Scheme of Practical Examination and Distribution of marks

BOT-52P-156 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise-based on Genetics.	**5**	**7**
2. Exercise-based on Plant Breeding.	**5**	**7**
3. Make a suitable stained preparation of the given material **A** (vegetative/Reproductive part). Draw a labelled diagram and identify giving reasons (**Pteridophyte).**	**5**	**8**
4. Make a suitable stained preparation of the given material **B** (vegetative/Reproductive part). Draw a labelled diagram and identify giving reasons (**Gymnosperm**).	**5**	**8**
5. Comment upon the spots- identify giving reasons (1 to 5).	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:
At the completion of the course, the student would be able to:

1. Learn,understandanddevelopskillandhandsontraininginbasicsofgenetics and plant breeding.
2. Acquire basic knowledge of Mendel's laws of genetics.
3. Learn and understand inheritance and various types of gene interactions.
4. Understand basic methods of plant breeding and crop improvement.
5. Identify the role of gene interactions in phenotype development.
6. Apply plant breeding methods for crop improvement.
7. Learn about institutes and scientists in the field of crop improvement.
8. Understand characteristic feature and life cycle pattern of pteridophytes and gymnosperms.
9. Apply the economic importance and evolutionary concepts of pteridophytes and gymnosperms.
10. Comprehend information about fossil plants.
11. Promote shared learning through practical classes, presentations and assignments.

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Syllabus
UG0805-Three/Four Year Bachelor of Science (Botany)

Semester- II
UG0805 - BOT-52T-157-Molecular Biology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	BOT-52T-157	Molecular Biology				5	4
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		------					
Prerequisites		Botany Course of Foundation or Introductory Level					
Objectives of the Course		➢ To understand structure of nucleic acid (DNA and RNA). ➢ To understand DNA organization in chromosomes and the mechanism of DNA replication. ➢ To understand the genetic code and structure of gene. ➢ To understand molecular mechanism of transcription and translation. ➢ To understand gene regulation at all levels, and the structure-function relationships of nucleic acids and proteins. ➢ To provide the students practical skills in molecular biology.					

Detailed Syllabus
BOT-52T-157- Molecular Biology

Unit-I

Nucleic Acids: Discovery of Nuclein by Fredrich Miescher. Nucleic Acids as genetic material; Experiments by Griffith, Hershey and Chase, Avery, McLeod and McCarty. Building blocks of nucleic acid: Nucleotide, Nucleoside, Ribose sugar, Purine, Pyrimidine, phosphate.

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DNA and RNA: Structure of DNA and RNA, Watson and Crick's model of DNA, DNA types (A, B, Z type), RNA structure and functions (tRNA, mRNA, rRNA, miRNA and siRNA). **15 Lectures**

Unit-II

Nucleosome: Chromatin structure; Euchromatin and Heterochromatin.

DNA Replication: Semi-conservative mode of DNA replication; bidirectional and semi-discontinuous replication. Various models of DNA replication including rolling circle, D-loop (mitochondrial), theta mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Okazaki fragments. Enzymes involved in DNA replication. **15 Lectures**

Unit-III

Central Dogma of Life: Concept of Central dogma; Salient features of the genetic code, deciphering the genetic code (Contribution of Nirenberg and H.G. Khorana). Gene, ORF, Intron, Exon, Gene expression. Prokaryotic and eukaryotic gene structure.

Transcription in prokaryotes: mechanism, initiation, elongation and termination. Introduction to split genes, splicing and Ribozymes. **15 Lectures**

Unit-IV

Translation in prokaryotes: Ribosome structure and assembly, charging of tRNA, aminoacyl tRNA synthetases; Mechanism; initiation, elongation and termination. Inhibitors of protein synthesis.

Gene regulation in Prokaryotes: Operon concept: inducible and repressible operon; regulation of lactose (lac) and tryptophan (trp) in *Escherichia coli*; attenuation regulation. **15 Lectures**

Suggested Books and References:

- Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). **Molecular Biology of the Gene,** Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006. **Cell and Molecular Biology**. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. 2010. **Cell and Molecular Biology: Concepts and Experiments.** 6th edition. John Wiley & Sons. Inc.
- Snustad, D.P. and Simmons, M.J. (2010). **Principles of Genetics.** John Wiley and Sons Inc., U.S.A. 5th edition.
- **The World of the Cell.** 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009**). Concepts of Genetics.** Benjamin Cummings. U.S.A. 9th edition.
- Russell, P. J. (2010**). i-Genetics- A Molecular Approach.** Benjamin Cummings, U.S.A. 3rd edition.
- 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.
- Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

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Suggested E-resources:
Online Lecture Notes and Course Materials:

1. https://onlinecourses.nptel.ac.in/noc24_bt07/preview
2. https://nptel.ac.in/courses/102106025
3. https://archive.nptel.ac.in/courses/102/106/102106096/

B.Sc. Botany Semester- II
BOT-52P-158 Practical-II
Molecular Biology

Suggested Laboratory Exercises:

1. Preparation of LB medium and raising *E. Coli*.
2. Isolation of DNA from bacterial or plant samples.
3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
4. Separation of DNA using Agarose gel electrophoresis.
5. Determination of DNA fragment size comparing with DNA marker using Agarose gel electrophoresis.
6. Perform or digitally demonstrate DNA amplification by PCR.
7. Perform or digitally demonstrate Southern Blot Hybridization.
8. Perform or digitally demonstrate Northern Blotting.
9. Perform or digitally demonstrate Western Blotting.
10. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel &Conrat's experiments).
11. Study of semiconservative replication of DNA through micrographs/schematic representations.
12. Any other exercise based on theory syllabus.

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester- II
BOT-52P-158 Practical-II
Molecular Biology
Scheme of Practical Examination and Distribution of marks

BOT-52P-158 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

	Regular	**Ex students**
1. Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C	**5**	**7**
4. Exercise D	**5**	**7**
5. Comment upon the spots- identify giving reasons. (1 to 5)	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:

At the completion of the course, the student would be able to:

- Develop sufficient knowledge about the characteristics of the genetic material and structure of DNA and RNA.
- Recognize DNA organization in chromosomes and molecular mechanism of DNA replication, and transcription.
- Understand characteristic and importance of genetic code and molecular mechanism of translation.
- Understand molecular structure of the gene and regulatory mechanisms for gene expression.
- Understand thestructure, function, and variations in DNA and RNA.
- Have insights into the various models for chromatin organization.
- Understand step wise processes of replication, transcription and translation.
- Develop knowledge and understanding of the operon concept and gene regulation mechanisms.
- Understand the role of protein and its modification in DNA packaging.
- Have knowledge about the differentiation of molecular mechanism of replication, transcription and translation.
- Understand the role of protein/transcriptional factor in gene regulation.
- Develop acumen about the variation in gene regulation processes.
- Use scientific methods, and critical thinking skills to ask questions and solve problems.

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Examination Scheme for EoSE for Semester-III

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	BOT-63T-251 - Plant Biochemistry and Physiology	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-63P-252 - Practical-IPlant Biochemistry and Physiology	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BOT-63T-253 - Ecology and Plant Resource Utilization	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-63P-254 - Practical-II- Ecology and Plant Resource Utilization	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks

The theory question paper will consist of **two** parts **A&B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

Syllabus

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UG0805-Three/Four Year Bachelor of Science (Botany)
Semester-III
BOT-63T-251- Plant Biochemistry and Physiology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	BOT-63T-251	Plant Biochemistry and Physiology				6	4
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
Intermediate	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline	------						
Prerequisites	Botany Course of Foundation or Introductory Level						
Objectives of the Course	➢ Provide students with learning experiences that help in deep interests in learning plant biochemistry and physiology. ➢ Develop broad and balanced knowledge and understanding of biomolecules, key biochemical concepts, principles and theories related to biochemistry. ➢ Equip students with appropriate tools of analysis and with theoretical, technical and analytical skills to tackle issues and problems in the field of biochemistry and plant physiology. ➢ Understand the plant nutrient uptake and translocation, photosynthesis, respiration and nitrogen metabolism. ➢ Understand the effects of various factors on the growth and development of plants.						

Detailed Syllabus
BOT-63T-251 - Plant Biochemistry and Physiology

Unit – I

Overview of Biochemistry: Definition, scope, and significance of Biochemistry. Important discoveries in Biochemistry. A summary of elements, chemical reactions, and biomolecules in living organisms. Properties of water: Molecular structure of water, physico-chemical properties of water. Its effect on biomolecules, its importance to plant life, and the concept of water potential.

Proteins: Amino acids-structure, electrochemical properties, peptide bonds, chemical bonds and nomenclature, structure and classification of proteins, physical and chemical properties. Enzymes: Structure, nomenclature & classification of enzymes. Characteristics of enzymes, mechanism of action, multi-enzyme system, and regulation of enzyme activity.

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15 Lectures

Unit – II

Carbohydrates: Introduction, importance, nomenclature, classification, molecular structure & functions of mono, di, and polysaccharides, their properties, glycosidic linkages, and glycoproteins. Lipids: Introduction, nomenclature, classification, molecular structure & functions. Importance of fatty acids (saturated and unsaturated). Alpha and Beta oxidation.

Nucleic acids: DNA: Composition, Nucleosides and nucleotides. Chargaff's rule. Watson and Crick model of DNA. Melting of DNA (T_m). RNA: Composition, types (mRNA, rRNA, and tRNA), secondary structures of tRNA – clover leaf model. Chemical reactions of RNA and DNA with acids and alkali.

15 Lectures

Unit – III

Plant-water relations: Absorption and Transport of water, Ascent of sap, Transpiration and its significance; factors affecting transpiration; root pressure and guttation. Mineral nutrition: role of essential elements; transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Transport of organic substances: Mechanisms of phloem transport, factors regulating the translocations of nutrients.

Photosynthesis: Pigments, Photosynthetic apparatus, light reaction, photosystem I & II, Z scheme, photophosphorylation, C3 (Calvin cycle), C4 cycle, and factors affecting the photosynthesis.

Respiration: Aerobic and anaerobic respiration, RQ (Respiratory Quotient), Krebs' cycle, electron transport system, oxidative phosphorylation, and factors affecting the process. Fermentation.

15 Lectures

Unit-IV

Nitrogen metabolism: Biological nitrogen fixation; nitrate and ammonia assimilation. Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Phases of growth and development: Seed dormancy and germination, plant movement, Biological clock-their regulatory factors. Photoperiodism &vernalisation; physiology and mechanism of action, concept of florigen and phytochrome.

15 Lectures

Suggested Books and References:

- Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
- Davies P. J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, the Netherlands.
- Hopkins, W. G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.
- Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th Ed.).
- W.H. Freeman & Co., New York. Parashar, A. N. and Bhatia, K. N.: Plant physiology. Trueman Book Company, 1985.

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- Verma, S. K. and Verma, M.: A textbook of plant physiology, biochemistry and biotechnology. S. Chand Ltd., 2000.
- Biochemistry by U. Satyanarayana Books and Allied (P) Ltd. Kolkata, ISBN 0-87893-214-3, (2014).
- Text book of Biochemistry by J.L. Jain (2016). Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
- Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc. U.S.A. 6 th Edition. Verma, S.K.: Textbook of plant physiology. S. Chand & Company, 1999.
- Parashar, A. N. and Bhatka, K. N.: Plant physiology. Trueman Book Company, 1985. Jain, V. K.: Fundamentals of plant physiology. S. Chand & Company Ltd., 2013.
- Verma, S. K., Textbook of Plant Physiology. ANE Books, India, 2007.
- Malik, C. P. and Srivastava, A. K.: Textbook of plant physiology. Kalyani publication, 1982.

B.Sc. Botany Semester-III
BOT-63P-252 Practical-I
Plant Biochemistry and Physiology

Suggested Laboratory Exercises:

1. To separate amino acids in a mixture by paper chromatography.
2. To prepare the standard curve of protein.
3. To demonstrate the tests for proteins in the unknown samples.
4. To demonstrate the enzyme activity – Catalase, peroxidase and amylase.
5. To demonstrate the tests for different types of carbohydrates and lipids.
6. Conductometric titration of strong acid against strong base.
7. Conductometric titration of weak acid (amino acid) against strong base.
8. Carbohydrates – Molisch, Benedict's / Fehling's, picric acid, Barfoed's, Bial's, Selivanoff's, osazone tests. Glucose, fructose, lactose, maltose and sucrose.
9. Proteins – Precipitation reactions of proteins, colour reactions of proteins -Biuret, xanthoproteic, Millon's,
10. Colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.
11. Lipids – sulphide, acrolein test, Salkowski test, Liebermann-Burchard test.
12. Qualitative tests for nucleic acid.
13. To determine the osmotic potential of vacuolar sap by plasmolytic method.
14. To study the permeability of plasma membrane using different concentrations of organic solvents.
15. To study the effect of temperature of permeability of plasma membrane.
16. To separate chloroplast pigments by solvent method.
17. To separate chloroplast pigments using paper chromatography.
18. Bioassay of growth hormone (auxin, cytokinin, gibberellin).
19. Demonstration of phenomenon of osmosis by use of potato osmometer.
20. To demonstrate root pressure.
21. To demonstrate rate of transpiration by use of potometers.

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22. Photosynthesis by inverted funnel method, Moll's experiment.
23. To demonstrate anaerobic and aerobic respiration.
24. R. Q. by Ganong's respirometer.
25. Measurement of growth using auxanometer.

Suggested E-resources:nptel.ac.in

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester-III
BOT-63P-252 Practical-I
Plant Biochemistry and Physiology
Scheme of Practical Examination and Distribution of Marks

BOT-63P-252 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

Exercise	Regular	Ex-students
1.Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C	**5**	**7**
4. Exercise D	**5**	**7**
5. Comment upon the spots- identify giving reasons (1 to 5).	**10**	**15**
6.Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:
After completing this course, the learner will be able to:

1. Demonstrate foundational knowledge of biochemistry, including water properties, amino acids, proteins, enzymes, carbohydrates, lipids, and nucleic acids.
2. Explain and analyze plant–water relations, mineral nutrition, and mechanisms of uptake, transport, and translocation in plants.
3. Describe and evaluate the processes of photosynthesis and respiration (aerobic, anaerobic, fermentation), including energy transformations and regulatory factors.
4. Interpret nitrogen metabolism pathways and the physiological role of major plant growth regulators in plant growth and development.
5. Explain phases of growth, seed dormancy, germination, biological rhythms, photoperiodism, vernalisation, and flowering mechanisms (florigen and phytochrome).
6. Integrate biochemical and physiological concepts to understand plant life processes and apply them in experimental, analytical, and applied biological contexts.

Signature of Dean	Signature of BoS Convenor	Signature Of DR (Academic-II)
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Syllabus
UG0805-Three/Four Year Bachelor of Science (Botany)

Semester-III
BOT-63T-253 - Ecology and Plant Resource Utilization

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	BOT-63T-253	Ecology and Plant Resource Utilization				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Botany Course of Foundation or Introductory Level					
Objectives of the Course		➢ To make students understand ecology and basic ecological concepts. ➢ To gain the knowledge on the economically important plants. ➢ To study interrelation between the living world and environment. ➢ To make aware about environmental issues. ➢ To understand plant part used of economic plants. ➢ To understand processing of plant part used as economic importance. ➢ To interpret the application of ethnobotany					

Detailed Syllabus
BOT-63T-253 - Ecology and Plant Resource Utilization

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 plant: megatherm, mesotherm, microtherm, hekiotherm, thermoperiodicity and vernalisation), soil (development, soil profile, properties). Ecological adaptations of hydrophytes, xerophytes, epiphytes and halophytes. Population ecology: growth curve, ecotypes, ecads. Population interaction among organisms (neutralism, amensalism, allelopathy), competition, predation, parasitism and mutualism.

Community characteristics and succession:

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Frequency, density, cover, life forms, biological spectrum, ecological succession. Ecosystem: Structure, components, food chain, food web, energy flow, trophic levels and ecological pyramids, primary and secondary productivity, biogeochemical cycle of carbon and phosphorus. **15 Lectures**

Unit-II

Biogeographic regions and vegetation types of India:

Forest grassland with special reference to Rajasthan. Environmental pollution- air, water and soil, WWF, chipko movement, greenhouse effect, ozone depletion, loss of biodiversity and extinction of species, red data book.

Concept and principles of environmental management:

Principle of optimized use and sustainable development, threats to sustainable development, ecological footprint, National Environmental Policy, management of forest and degraded lands, concepts and principles of environmental management, efforts to control these effects (Vienna Convention, Montreal Protocol, Earth summit, Kyoto Protocol, World Summit on sustainable development, 2002. Carbon trade). IPCC.

15 Lectures

Unit-III

Origin of Cultivated Plants:

Concept of centres of origin, their importance with reference to Vavilov's work. History, origin, distribution, cultivation, and processing of cereals: wheat, maize, rice, and bajra. General account of pulses: pea, chana, and moong. Identification and medicinal value of locally available medicinal plants. General account and identification of spices and condiments of Rajasthan**,** Characteristics and uses of timber yielding plants: teak and sal, dyes (Indigo and *Lawsoni*a), beverages (tea and coffee), fumigators and masticatories, fat and oil yielding plants (*Brassi*ca and *Cocos*). **15 Lectures**

Unit-IV

General account and identification of locally available fruits, vegetable and ornamental plant**,** History, cultivation, processing and economic use of sugar and rubber, fiber yielding plants (cotton and jute).

Ethnobotany and its concepts and relevance:

Ethnobotanical areas of Rajasthan, ethnic groups in India and ethnobotanical study of any tribal area of Rajasthan. Ethical aspect of ethnobotany. **15 Lectures**

Suggested Books and References:

1. Koromondy, E.J.1996. Concepts of Ecology. 4th Edition Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Misra, K.C. 1988. Manuals of Plant Ecology. (3rd Edition) Oxford and IBH Publishing Co., New Delhi.
3. Odum, E.P. 1983. Basic Ecology. 5th Edition Thomson Business International, USA.
4. Odum, E.P. 2008. Ecology. Oxford and IBH Publisher.
5. Sharma, P.D. 2010. Ecology and Environment, (8th Edition) Rastogi Publications, Meerut.
6. Singh, J.S., Singh, S.P. and Gupta, S. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
7. Gupta, S.K. and Kaushik, M.P. 1973. An Introduction to Economic Botany. K Nath and Co., Meerut.
8. Hill, A.F. 1952. Economic Botany. McGraw Hill Book Co., New York.
9. Jain, S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
10. Jain, S.K. 1997. A Manual on Ethnobotany. Scientific Publisher, Jodhpur.
11. Prakesh, G., Sharma, K. 1975. Introductory Economic Botany. Jai Prakash Nath & Co., Meerut.
12. Sambamurty, A.V.S.S. and Subrahmanyam, N.S.1989. A Text Book of Economic Botany. Wiley Eastern Ltd., New Delhi.
13. Sen, S.1992.Economic botany. New Central Book Agency, Calcutta.
14. Singh, V.P. and Pandey, P.C. and Jain, D.K.1999. Economic Botany. Rastogi publications, Meerut.
15. Verma, V. 1974.A Textbook of Economic Botany. Enkay Publications, New Delhi

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B.Sc. Botany Semester-III
BOT-63P-254Practical-II
Ecology and Plant Resource Utilization

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 water holding 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. To study different statistical methods: mean, median and mode, standard error, standard deviation.
6. Regression analysis and application of statistical tests in environmental problems.
7. Study and Submission of economically important plants and plant products (cereals, pulses, spices, fibers, condiments, fat and oils, tea, coffee, wood, dyes, tobacco).
8. Study of wood specimens with special reference to: Botany of the economically important plant. Processing if any involved. Specimens of cereals, pulses, fibres, spices, beverage (tea, coffee), sugar, oil yielding plants and medicinal plants (mentioned in theory).
9. Microchemical test for starch, sugar, oils, proteins, fat, carbohydrate, lignin using wheat, maize, soyabean. Chana, sweet potato, clove, ground nut, mustard and match sticks.
10. Study of starch grains in potato and pea.
11. Field trip to economically important place.
12. Collection, description and submission of at least 5 plants of ethnobotanical importance.

Suggested E-resources:

Online Lecture Notes and Course Materials:

5. Vidhya Mitra Integrated E-Content Portal
6. eGyanKosh-
7. NPTEL

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester-III
BOT-63P-254Practical-II
Ecology and Plant Resource Utilization
Scheme of Practical Examination and Distribution of marks

BOT-63P-254 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C	**5**	**7**
4. Exercise D	**5**	**7**
5. Comment upon the spots- identify giving reasons. (1 to 5)	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. Explain ecological factors, plant adaptations, ecosystem structure, energy flow, and biogeochemical cycles.
2. Analyze vegetation types, biogeographic regions, and evaluate environmental issues such as pollution, biodiversity loss, and climate change.
3. Apply principles of environmental management, sustainable development, and conservation policies at local, national, and global levels.
4. Demonstrate knowledge of the origin, cultivation, processing, and economic uses of cereals, pulses, spices, condiments, medicinal, and other economically important plants.
5. Assess the ethnobotanical significance of plants, particularly in Rajasthan, and evaluate their cultural, economic, and ethical dimensions.
6. Integrate ecological, biochemical, and ethnobotanical knowledge to address contemporary challenges in plant sciences and sustainable resource use.

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Examination Scheme for EoSE for Semester IV

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	UG0805 - BOT-64T-255-Fundamentals of Plant Pathology	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	UG0805 - BOT-64P-256-Practical I Fundamentals of Plant Pathology	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	UG0805 - BOT-64T-257-Fundamentals of Analytical Techniques	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	UG0805 - BOT-64P-258-Practical IIFundamentals of Analytical Techniques	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks

The theory question paper will consist of **two** parts, **A&B**.

PART-A: 20 Marks

Part A will be compulsory, having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with an internal choice. Each question will carry 15 marks.

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Semester-IV
UG0805 - BOT-64T-255-Fundamentals of Plant Pathology

Semester	Code of the Course	Title of the Course/Paper			NHEQF Level	Credits
IV	BOT-64T-255	Fundamentals of Plant Pathology			6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours
List of Programme Codes in which Offered as Minor Discipline is offered		------				
Prerequisites		Botany Course of Foundation or Introductory Level				
Objectives of the Course		➢ To acquire an understanding of plant pathogens. ➢ To explore the relationships between plants and microorganisms. ➢ To understand the factors contributing to disease development and methods of control. ➢ To recognize the economic disadvantages of the important crops due to pathogens. ➢ To understand the need to protect important crops from pathogens.				

Detailed Syllabus
UG0805 - BOT-64T-255 - Fundamentals of Plant Pathology
UNIT -I

Concepts of Plant Pathology: History of plant pathology, Definitions (Primary and Secondary inoculum; Infection, Pathogenicity, Pathogenesis, Disease Cycle), biotic and abiotic factors,
General symptoms caused by Viruses, Viroids, Bacteria, Fungi, Mycoplasma, Nematodes, Insects (smut, rust, mildews, canker, mosaic, vein clearing, spots, lesion, nodules, galls). **15 Lectures**

UNIT-II

Signature of Dean	Signature of BoS Convenor	Signature Of DR (Academic-II)
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Host-Pathogen interaction: Disease triangle, recognition of host by pathogens, mode of host penetration, role of enzymes, toxins, growth regulators, and polysaccharides in disease development.

Plant Defense: Strategies- Physical and biochemical (preformed and post-infectional). Induced Systemic Resistance (ISR) and Systemic Acquired Resistance (SAR), Physiological changes in the host after infection. **15**

Lectures

UNIT -III

Viral, Viroidal, Mycoplasmal and Bacterial diseases: Occurrence, disease symptoms, Etiology, treatment & control of the following plant diseases:- Tobacco Mosaic, Bunchy top of Banana, Coconut CadangCadang, Little leaf of Brinjal, Citrus canker and Angular leaf spot of Cotton.

Diseases caused by insects and nematodes: Brief account and histopathology of root knot of vegetables (tomato), Ear Cockle of Wheat, leaf gall of *Pongamia*. **15**

Lectures

UNIT-IV

Fungal Diseases: Occurrence, Disease symptoms, Etiology, Treatment & Control of the following plant diseases with special reference to Rajasthan: White rust of crucifers, Downy mildew/green ear disease of Bajra, Black/stem rust of Wheat, Loose and covered smut of Barley, Smut of Bajra, Early blight of Potato,

Control Methods: Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Predation), Integrated Pest Management.

15

Lectures

Suggested Books and References:

- Alexopolus, C.J., Mims, C.W., and Blackwell, M. 1996. **Introductory Mycology,** John Wiley Estern Private Limited, New York
- Agrios G.N. (2004) **Plant Pathology**, 5th Edition, Academic Press, New Delhi
- Pandey B.P. (2001) **Plant Pathology (Pathogen and Plant Disease**), S. Chand Publishing
- Sharma P.D. (2014). **Plant Pathology,** Rastogi Publications, Meerut, UP
- Mehrotra, R.S. and Aggarwal, A. 2007. **Plant Pathology.** Tata McGraw-Hill Publishing Co. Ltd., New Delhi
- Singh, R.S. 1996. **An Introduction to Principles of Plant Pathology.** Oxford & IBH, New Delhi.
- Singh, R.S. (2021**). Plant Diseases, 10th revised edition**, Medtech, New Delhi.
- Nene Y.L. and Thapliyal, P.N. 1993. **Fungicides in Plant Disease Control**. 3rd Edn. Oxford & IBH published Co. Pvt. Ltd., New Delhi.
- Gupta, V.K. and Sharma, R.C. (2020). **Integrated Disease Management and Plant Health**, Scientific Publishers, India.
- Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

Suggested E-resources:

Online Lecture Notes and Course Materials:

1. https://www.pdfdrive.com/fundamentals-of-plant-pathology-e42642753.html
2. https://onlinecourses.swayam2.ac.in/cec21_bt16/preview
3. https://www.pdfdrive.com/plant-pathology-concepts-and-laboratory-exercises-e179105354.html

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B.Sc. Botany Semester-IV

BOT-64P-256 Practical-I

Fundamentals of Plant Pathology

Suggested Laboratory Exercises:

1. Study of morphology and symptomology of TMV, Viroids, Mycoplasma, Bacteria, Nematode, Insects, Mites, and other causal organisms mentioned in the syllabus. (Photographs/3D Models)
2. Study of Bacteria by Gram Staining, Negative Staining)
3. Preparation of Liquid and solid media for culturing microbes from infected plant tissues (Nutrient Agar/ Broth, Potato Dextrose Agar).
4. Histological study of different plant defense structures with the help of charts/ 3D models/farm or field visits.
5. Study of symptoms of plant diseases (specimen/permanent slide)- Downy mildew/green ear disease of Bajra, Tobacco Mosaic, Citrus canker, Little leaf of Brinjal,
6. Study of spores of *Alternaria* from Early Blight of Potato.
7. Study of histopathology using temporary slide preparation of the infected part of the root knot of tomato.
8. Study of histopathology using temporary slide preparation of the Leaf gall of *Pongamia*.
9. Study and identification of spores from temporary slide preparation from infected plant material:- white rust of crucifers (conidia stage).
10. Study and identification of spores from temporary slide preparation from infected plant material, Blackstem rust of Wheat (all stages).
11. Demonstration and application of basic control techniques such as soil solarization and roguing in the field.
12. Demonstration of biocontrol of diseases using *Trichoderma viridae*/*Bacillus thuringiensis* and other biocontrol microorganisms.
13. Comparative quantification of biomolecules in diseased v/s normal plants.
14. Any other exercise based on the syllabus.

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester-IV
BOT-64P-256 Practical-I
Fundamentals of Plant Pathology
Scheme of Practical Examination and Distribution of Marks

BOT-64P-256 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C	**5**	**7**
4. Exercise D	**5**	**7**
5. Comment upon the spots- identify giving reasons (1 to 5).	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of the practical examination.		

Course Learning Outcomes: After the course, the student would be able to:

1. Understand various pathogens.
2. Understanding the diagnosis of plant diseases, understanding their causes, and implementing management strategies to control and/or prevent them.
3. Understand and perform different laboratory exercises to further understand microorganisms.
4. Understand the role of biotic and abiotic factors in disease development
5. Understand host-pathogen interaction and its effects on plants.
6. Symptomology, disease cycle, and control of different pathogens causing diseases.
7. Acquire proficiency in various laboratory techniques, such as culturing microorganisms, Gram staining, microscopy, and identification of plant diseases.
8. Develop further interest in agricultural research, crop protection, and pest management to improve crop yield and quality.
9. Work in disease prevention and control, focusing on plant diseases that impact food safety and public health.

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Syllabus
UG0805-Three/Four Year Bachelor of Science (Botany)
Semester-IV
UG0805 - BOT-64T-257 - Fundamentals of Analytical Techniques

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
IV	BOT-64T-257	Fundamentals of Analytical Techniques				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline is offered		---					
Prerequisites		Botany Course of Foundation or Introductory Level					
Objectives of the Course		➢ To equip students with appropriate tools of analysis and theoretical, technical, and analytical skills to tackle issues and problems in the field of plant sciences. ➢ To gain knowledge on various techniques and instruments used for the study of plant biology. ➢ To understand the principles of various biophysical techniques available for the characterization of biological molecules. ➢ To investigate natural metabolic products of plants using various techniques. ➢ To understand growth and development in plant cells through various techniques. ➢ To use knowledge in diverse applications, such as the separation of biomolecules.					

Detailed Syllabus
UG0805 - BOT-64T-257 - Fundamentals of Analytical Techniques
Unit-I

Imaging and related techniques

Stains and Basic staining procedure, Positive and Negative staining, Fixation and Freeze-fracture. Microscopy- Principles, Magnification, Resolving power, Types (Light, Bright Field, Phase Contrast, Fluorescence, Confocal), and Applications. Introduction to Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). Micrometry. **15 Lectures**

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Unit-II

Photometry: Concept and types (UV-Visible) of spectroscopy,Beer-Lambert's law.

Principles and applications of Colorimetry. Principles and applications of Spectrophotometryin biological research.

Chromatography: Principles, Elementary knowledge, R_f value, Types: Thin Layer, Paper, Ion exchange, Gel permeation, and Applications.

15 Lectures

Unit-III

Centrifugation: BasicPrinciples, Elementary knowledge, RCF, Sedimentation coefficient, Svedberg Unit, Types: Density Gradient and Differential, and Applications. Ultracentrifuge, Microcentrifuge.

Electrophoresis: Agarose Gel Electrophoresis; Principle, Methodology and Applications.Isoelectric focusing, Introduction to Native and SDS-PAGE. **15 Lectures**

Unit-IV

Radiotracer techniques: Nature of radioactivity, Use of Radioisotopes in biological research, Autoradiography, Radiolabelling techniques, Safety aspects.

Instrumentation: Working Principle, Operation, and Application ofpH meter, Weighing Balance, Water bath, Autoclave, Laminar Airflow chamber, Centrifuge, Hot Air Oven, Growth Chamber, Shaker Incubator, Microtome, Tissue Homogenizer, Spectrophotometer, Electrophoresis Apparatus, Thermal Cycler (PCR), Gel Documentation system (Gel DOC).

15 Lectures

Suggested Books and References:

- K. Wilson, J. Walker (2010), **Principles and Techniques of Biochemistry and Molecular Biology,** Seventh Edition, Cambridge University Press, New York, USA.
- Pearse**, Histochemistry: Theoretical and applied**, Volume I-III (1980-1993), Churchill. Livingstones.
- Plummer, **An Introduction to Practical Biochemistry** (1989), 3rd edition, McGraw-Hill, London.
- Simon Roe, ed. (2001), **Protein purification techniques: A practical approach**, 2nd edition, Oxford University Press.
- Phillip Sheeler and Donald E Bianchi (2006), **Cell and Molecular Biology**, John Wiley and Sons, Inc., U.K.
- Skoog and Leary (1992), **Principles of Instrumental Analysis**, 4th Edition. Saunder's College Publishing, New York.
- R. Boyer (2000), **Modern Experimental Biochemistry**, Pearson Education, Asia.
- S.E. Ruzin (1999), **Plant Microtechnique and Microscopy,** Oxford University Press, New York.
- S.K. Sawhney, Randhir Singh (2000**), Introductory Practical Biochemistry,** Narosa Publishing House, New Delhi.
- L. Veerkumari (2011), **Bioinstrumentation**, MJP Publishers, Chennai.
- N. Arumugam and V. Kumaresan (2015), **Biophysics and Bioinstrumentation**, Saras Publication, Nagercoil, Tamil Nadu.
- Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

Suggested E-resources:

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Online Lecture Notes and Course Materials:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=282
2. https://www.docsity.com/en/subjects/biochemistry-and-instrumentation/
3. NPTEL:: Biotechnology - Bioanalytical Techniques and Bioinformatics
4. Analytical Techniques - Course (swayam2.ac.in)

B.Sc. Botany Semester-IV
BOT- 64P-258Practical-II
Fundamentals of Analytical Techniques

Suggested Laboratory Exercises:

1. Preparation of a permanent slide of any plant material (Whole mount/Section).
2. Study of microscopic techniques using digital resources (Freeze-fracture, Negative staining).
3. Demonstration of microscopes.
4. Use of a centrifuge for various applications.
5. Numerical exercise based on centrifugation.
6. Measurement of the size of microscopic objects using Micrometry.
7. Quantification of biomolecules using Beer-Lambert's law (Numerical exercise).
8. Estimation of Optical Density (OD) using a spectrophotometer.
9. Demonstration of the SDS-PAGE Unit.
10. Demonstration of DNA gel electrophoresis.
11. Estimation of Protein by the Bradford Method.
12. Separation of Amino acids using chromatography.
13. Separation of chloroplast pigments using chromatography.
14. Digital Demonstration of Thermal Cycler (PCR)
15. Demonstration of instruments in the above-mentioned syllabus.
16. Visit any tissue culture lab.
17. Any other exercise based on the theory syllabus.

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester-IV
BOT- 64P-258Practical-II
Fundamentals of Analytical Techniques
Scheme of Practical Examination and Distribution of Marks

BOT-64P-258 **Max. Marks: 10*+40** **Min. Marks: 4*+16**

Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C	**5**	**7**
4. Exercise D	**5**	**7**
5. Comment upon the spots- identify giving reasons (1 to 5).	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of the practical examination.		

Course Learning Outcomes:

After the course, the student would be able to:

1. Develop ample disciplinary knowledge and understanding of biotechniques, principles, and applications of instrumentation.
2. Understand the various physiological responses in plants through techniques.
3. Recall procedures for microscopy, electrophoresis, and photometric methods.
4. Develop insights into various principles, precautions, laws, and applications behind various techniques.
5. Technically handle microscopes, pH meter, Colorimeter, Autoclave, Centrifuge, Oven, Incubator, Laminar air flow chamber, Spectrophotometer, etc.
6. Apply the concepts of biotechniques in other disciplines to make significant contributions to interdisciplinary sciences.
7. Apply these techniques to characterize proteins and nucleic acids, providing insights into their structure and function.

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Examination Scheme for EoSE for Semester-V

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	BOT-75T-351 - Plant Biotechnology-I	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-75P-352 – Practical-I Plant Biotechnology-I	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BOT-75T-353 Systematics of Angiosperms	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-75P-354 - Practical-IISystematics of Angiosperms	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks

The theory question paper will consist of **two** parts **A&B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

Syllabus

UG0805-Three/Four Year Bachelor of Science (Botany)

Semester V

UG0805 - BOT-75T-351 - Plant Biotechnology-I

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
V	BOT-75T-351	Plant Biotechnology-I				7	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Botany course of Introductory/intermediate level					
Objectives of the Course		To introduce the fundamental concepts of plant biotechnology and its historical and scientific development. To illustrate the principles and applications of tissue culture techniques, including callus culture, micro propagation, and somatic embryogenesis etc. To explore the genetic manipulation of plants through genetic engineering, including gene transfer methods like Agrobacterium-mediated transformation and direct gene transfer methods. To develop an understanding of transgenic plants, their production, biosafety, ethical issues, and regulatory frameworks. To examine the role of plant biotechnology in agriculture, industry, and environmental sustainability, including the production of disease-resistant crops. To encourage critical thinking and research aptitude by familiarizing students with current trends and breakthroughs in plant biotechnology.					

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Detailed Syllabus

BOT-75T-351 - Plant Biotechnology-I

Unit – I

Introduction to Plant Biotechnology: Definition, scope, and historical development of plant biotechnology, Totipotency and plant cell culture concepts: differentiation, dedifferentiation and redifferentiation.Laboratory organization and aseptic culture techniques, Sterilization methods: autoclaving, filtration, chemical sterilants, Nutritional requirements of plant cells: MS and B5 medium- composition and preparation, vitamins, hormones (auxins, cytokinins, etc.), Types of culture: callus, suspension, meristem, protoplast, anther, embryo. **15 lectures**

Unit – II

Micropropagation and In Vitro Techniques

Micropropagation: stages, advantages, limitations and commercial applications, Somatic embryogenesis and organogenesis, Applications in clonal propagation and conservation of germplasm, Somaclonal variation: causes and significance, Somatic hybridization and cybridization, Haploid production and its significance, production of virus free plants bymeristem, shoot-tip culture; Cell Suspension cultures; In vitro pollination, fertilization, embryo rescue, Synthetic seeds: production and applications. **15 lectures**

Unit – III

Plant Genetic Engineering and Production of Transgenic Plants

Genetic material of plant cells with an introduction tochloroplast and mitochondrial DNA; Restrictionenzymes, Gene cloning techniques, Protoplast isolation, culture, fusion, and regeneration, Vectors: plasmids, Ti and Ri plasmids, binary vectors, Gene transfer methods in plants:*Agrobacterium*-mediated transformation, Direct gene transfer (biolistics, microinjection, electroporation, PEG); Screening and selection of transformants,Selectable marker and reporter genes, Chloroplast transformation and gene silencing techniques, Plant gene expression systems, Bioreactors. **15 lectures**

Unit – IV

Applications and Biosafety

Production of transgenic plants: Bt crops, herbicide resistance, virus resistance, Applications in agriculture, horticulture, forestry, and industry,Intellectual Property Rights (IPR) in plant biotechnology, Biosafety regulations and risk assessment of GMOs, Ethical issues and public concerns regarding GM crops, Role of plant biotechnology in sustainable agriculture. **15 lectures**

Suggested Books and References:

1. Plant Biotechnology by*B.D. Singh*
2. An Introduction to Plant Biotechnologyby *H.S. Chawla*
3. Plant Tissue Culture: Theory and Practiceby *S.S. Bhojwani and M.K. Razdan*
4. Plant Biotechnology: The Genetic Manipulation of Plantsby *Adrian Slater, Nigel Scott, and Mark Fowler*
5. Biotechnology: Expanding Horizons by *B.D. Singh*
6. Molecular Biology and Biotechnologyby *J.M. Walker and R. Rapley*
7. Plant Tissue Culture: Techniques and Experiments by *Roberta H. Smith*

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8. Plant Tissue Culture: Practices and New Experimental Protocolsby *B. N. Sathyanarayana and Dalia B. Verghese*
9. Plant Biotechnology-Current and Future Applications of Genetically Modified Crops by *Halford N.*

Suggested E-resources:

1. **https://nptel.ac.in/courses/102103016**
2. **https://onlinecourses.nptel.ac.in/noc24_ag08/preview**
3. **https://onlinecourses.swayam2.ac.in/cec21_bt03/preview**
4. **https://egyankosh.ac.in/handle/123456789/86105**

B.Sc. Botany Semester- V

BOT-75P-352 Practical-I

Plant Biotechnology-I

Suggested Laboratory Exercises:

1. Preparation and sterilization of MS (Murashige and Skoog) medium
2. Surface sterilization of plant explants (Leaf, stem, nodal segment, or embryo)
3. Initiation of callus culture (From leaf or stem explants on MS medium)
4. To perform regeneration of the plant from shoot tip of *Bougainvillea*
5. To isolate embryos of *Cicer arietinum*and perform in vitro culture
6. Establishment of suspension cultures
7. Micropropagation by shoot tip/meristem culture
8. Somatic embryogenesis from callus
9. Induction of organogenesis (shoot and root) from callus
10. Anther culture for haploid production
11. Embryo rescue technique
12. Synthetic seed preparation using sodium alginate method
13. Isolation of protoplasts from leaf tissue
14. Isolation of genomic DNA from plant tissues
15. Demonstration of Agrobacterium-mediated gene transfer
16. Biolistic (gene gun) transformation demonstration (if facility available)
17. Demonstration of Biosafety Guidelines of GM crops in India.
18. Process if IPR filing in India.
19. Any other exercise based on theory syllabus

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester- V
BOT-75P-352 Practical-I
Plant Biotechnology-I

Scheme of Practical Examination and Distribution of marks

BOT-75P-352 **Duration- 4 hrs**
Max. Marks: 10*+40 **Min. Marks: 4*+16**

S.No.	Exercise	Regular	NC/Ex students
1.	Exercise-based on Unit I	5	7
2.	Exercise-based on Unit II	5	7
3.	Exercise-based on Unit III	5	8
4.	Exercise-based on Unit IV	5	8
5.	Comment upon the spots- identify giving reasons. (1 to 5)	10	15
6.	Viva-voce	5	5
7.	Record	5	-
	Total	10*+40=50	50
	*Internal marks for regular students only		
	Regular Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

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Syllabus
UG0805 – Three/Four Year Bachelor of Science (Botany)
Semester V
UG0805BOT-75T-353Systematics of Angiosperms

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
V	BOT-75T-353	Systematics of Angiosperms				7	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Botany course of Introductory/intermediate level					
Objectives of the Course		This course will enable the students: ➢ To understand the principles, tools, and modern approaches in the taxonomy ➢ To understand the systematics of angiosperms, including classification systems, taxonomic literature. ➢ To make the students learn interdisciplinary evidence from molecular biology, embryology, cytology, and phytochemistry. ➢ To provide detailed knowledge of the diversity of plants by plant family studies. ➢ To provide basic knowledge on importance of plants.					

Detailed Syllabus

UG0805 BOT-75T-353Systematics of Angiosperms

Unit-I

Introduction of Taxonomy: History of taxonomy, Botanical Nomenclature, International Code of Botanical Nomenclature: principles, rules and recommendations, Concept of BioCode and PhyloCode, Botanical Gardens, Taxonomic hierarchy.

Plant identification, Herbarium: concept, tools &techniques; Taxonomic Keys: Single Access and Multi-access. **15 Lectures**

Unit-II

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Concept and systems of classification with special emphasis on Bentham and Hooker, Engler and Prantl system.

Systematic evidences: Evidence from palynology, embryology, cytology, phytochemistry and molecular biology. Origin and Evolution of Angiosperms, Basal Living Angiosperms.

Taxonomic literature: Flora, E-flora, Monographs, Icones, Journals& E-journals. **15 Lectures**

Unit-III

Diversity of flowering plants illustrated by members, diagnostic characters and importance of families: Ranunculaceae, Brassicaceae, Papaveraceae, Malvaceae, Fabaceae, Caryophyllaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae and Apocynaceae. **15 Lectures**

Unit-IV

Diversity of flowering plants illustrated by members, diagnostic characters and importance of families: Asclepiadaceae, Convolvulaceae, Solanaceae, Acanthaceae, Lamiaceae, Chenopodiaceae, Euphorbiaceae, Liliaceae, Arecaceae and Poaceae. **15 Lectures**

B.Sc. Botany Semester V
UG0805 BOT-75P-354Practical II
Systematics of Angiosperms

Suggested Laboratory Exercises:

1. **Familiarization with Taxonomic Tools:**
   Use of taxonomic keys (Single-access and Multi-access)
   Study of herbarium sheets, floras, monographs, and electronic resources
2. **Plant Identification Using Flora:**
   Identification of local plants using regional floras or e resources
3. **Herbarium Preparation:**
   Collection, pressing, drying, mounting, and labeling of plant specimens
4. **Field Visit to Botanical Garden or Natural Habitat:**
   Field observation, note-making, ecological data collection, and sample documentation
5. **Comparative Study of Classification Systems:**
   Classification of selected plants as per Bentham & Hooker and Engler & Prantl systems
6. **Palynology Practical:**
   Microscopic examination of pollen grains from fresh flowers.
7. **Study of Embryological Features:**
   Observation of permanent slides of embryo sacs, anther cross sections, etc.
8. **Floral Dissection and Description:**
   Dissection of flowers from representative families (Refer Units 3 and 4)
   Preparation of floral formula and floral diagram
9. **Diagnostic Features of Selected Families:**
   Identification based on key morphological characters such as leaf arrangement, inflorescence type, floral parts, ovary position etc
10. Any other exercise related to syllabus.

Suggested Books and References –

1. Singh, G. (2019). *Plant Systematics: Theory and Practice* (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
2. Pandey, B. P. (2010). *Taxonomy of Angiosperms*. S. Chand & Company Ltd.
3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2015). *Plant Systematics: A Phylogenetic Approach* (4th ed.). Sinauer Associates, Oxford University Press.
4. Lawrence, G. H. M. (1951). *Taxonomy of Vascular Plants*. Macmillan.

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5. Singh, V. (2004). *Modern Plant Taxonomy*. Kalyani Publishers.
6. Davis, P. H., & Heywood, V. H. (1963). *Principles of Angiosperm Taxonomy*. Oliver and Boyd.
7. Simpson, M. G. (2019). *Plant Systematics* (3rd ed.). Academic Press.
8. Jeffrey, C. (1982). *Introduction to Plant Taxonomy* (2nd ed.). Cambridge University Press.

Suggested E-resources:

1. http://www.theplantlist.org
2. https://www.indiabiodiversity.org
3. https://efloraofindia.com

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UNIVERSITY OF RAJASTHAN
B.Sc. Botany Semester V
UG0805 BOT-75P-354Practical II
Systematics of Angiosperms
Scheme of Practical Examination and Distribution of Marks
BOT-75P-354 **Duration- 4 hrs**

Max. Marks: 10*+40 **Min. Marks: 4*+16**

S.No.	Exercise	Regular	Ex students
1.	Identify the family of the given flower and describe floral characters in semi-technical language, draw floral diagram and write floral formula.	7	8
2.	Study of the pollen grain morphology of given plant sample. Draw a labelled diagram and comment.	5	8
3.	Preparation of a taxonomic key of 3-5 plants.	5	7
4.	Examination of diagnostic characters of given plant family.	3	7
5.	Comment upon the spots- identify giving reasons. (1 to 5)	10	15
6.	Viva-voce	5	5
7.	Record	5	-
	Total	10*+40=50	50
	*Internal marks for regular students only		
	Regular Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:
On successful completion of this course, the students will be able to:

- Apply knowledge of plant diversity to identify plant species and interpret their phylogenetic significance
- Understand the process of plant nomenclature.
- Analyse various systems of classification for angiosperms.
- Identify the local flora with the help of flora and e-resources.
- Understand, evaluate and analyze the diagnostic characteristics of families.
- Comparison in pollen grains of different plants and analyze the diversity of their structures.
- Understand the process of herbarium sheet preparation.
- Illustrate and interpret floral formula and floral diagram.

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Examination Scheme for EoSE for Semester-VI

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	BOT-76T-355- Plant Biotechnology-II	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-76P-356 – Practical-I Plant Biotechnology-II	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BOT-76T-357Morphology and Anatomy of Angiosperms	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BOT-76P-358 - Practical-IIMorphology and Anatomy of Angiosperms	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks

The theory question paper will consist of **two** parts **A&B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

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SyllabusUG0805-Three/Four Year Bachelor of Science (Botany)
VI-Semester - Botany
BOT-76T-355- Plant Biotechnology-II

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
VI	BOT-76T-355	Plant Biotechnology-II				7	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Botany course of Introductory/intermediate level					
Objectives of the Course		➢ To understand the fundamental tools and techniques used in recombinant DNA technology. ➢ To explain the mechanisms and applications of various DNA modifying enzymes. ➢ To explore different types of cloning vectors and their structural features. ➢ To understand the principles and protocols of gene amplification and detection techniques such as PCR, blotting etc. ➢ To learn methods of gene cloning, cDNA and genomic DNA library construction and DNA sequencing techniques. ➢ To explore the types and applications of DNA markers in plant genetics and breeding. ➢ To understand the structure, goals, and outcomes of plant genome projects, especially Arabidopsis thaliana. ➢ To introduce and familiarize students with bioinformatics tools and biological databases used in genomics and proteomics. ➢ To provide hands-on experience through practical involving DNA isolation, Polymerase Chain Reaction (PCR), and other biotechnological techniques, along with introducing students to basic bioinformatics tools for sequence analysis, database searching, phylogenetic interpretation, thereby bridging experimental and computational approaches.					

Detailed Syllabus

BOT-76T-355- Plant Biotechnology-II

Unit I

Tools of genetic engineering- Exonucleases, endonucleases (Types I, II & III), ligases, reverse transcriptase, terminal transferase, polymerases, and alkaline phosphatase. Vectors: plasmids, cosmids, bacteriophages, phasmids (advantages and disadvantages), structure of pBR322, artificial chromosome vectors –BAC and YAC, shuttle vectors. Artificial gene synthesis, cDNA

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synthesis, genomic DNA library construction, identification and isolation of genes using probes, PCR and RACE. DNA ligation using linkers, adaptors, and homopolymer tailing. **15 Lectures**

Unit II

Polymerase Chain Reaction (PCR): principle, types of primers, Taq polymerase, protocol, applications and problems, Reverse Transcriptase PCR. DNA sequencing: Maxam-Gilbert method, Sanger's method, automated sequencing. Molecular analysis of genes and gene products: Southern, Northern and Western blotting, ELISA, RIA, 1D and 2D PAGE. **15 Lectures**

Unit III

DNA markers: Restriction Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), Simple Sequence Repeats (SSRs), Single Nucleotide Polymorphisms (SNPs), Applications of molecular marker in plant breeding, diversity analysis, and DNA fingerprinting. Plant genome projects (Arabidopsis): goal, process, outcomes and importance. Comparative genomics: synteny and gene conservation. DNA Barcoding in Plants.

15 Lectures

Unit IV

Introduction to bioinformatics: definition, scope, and significance in plant science. Biological databases: Primary and secondary database, NCBI, GenBank, EMBL, DDBJ, Protein data bank (PDB), Sequence alignment tools: BLAST, FASTA, multiple sequence alignment (ClustalW). Gene prediction and annotation tools, Prediction of secondary structure of protein, Application of bioinformatics. **15 Lectures**

Suggested Books and References:

1. Plant Biotechnologyby B.D. Singh
2. Molecular Biology and Genetic Engineering by P. K. Gupta
3. A Textbook of Biotechnology by R.C. Dubey
4. Basics of Biotechnology byS. Ignacimuthu
5. Gene Cloning and DNA Analysis: An Introductionby T.A. Brown
6. Biotechnology: Expanding Horizons by B.D. Singh
7. Molecular Biology and Biotechnology by J.M. Walker and R. Rapley
8. Introduction to Bioinformatics by Arthur Lesk
9. Bioinformatics: Principles and Applications by Zhumur Ghosh &Bibekanand Mallick
10. Bioinformatics and Functional Genomicsby Jonathan Pevsner

Suggested E-resources:

1. https://www.yourgenome.org
2. https://nptel.ac.in/courses/102103013
3. https://nptel.ac.in/courses/102103045
4. https://nptel.ac.in/courses/102106065
5. https://www.ncbi.nlm.nih.gov
6. https://onlinecourses.nptel.ac.in/noc25_bt54/preview

B.Sc. Botany Semester- VI
BOT-76P-356 Practical-I
Plant Biotechnology-II

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Suggested Laboratory Exercises:

1. Isolation of Genomic DNA from Plant Tissue
2. To detect the presence of DNA in a sample using the Diphenylamine (DPA) test
3. To cast agarose gel and understand its role in the separation of DNA fragments.
4. To perform Agarose Gel Electrophoresis of DNA
5. To demonstration and interpretationof RAPD (Random Amplified Polymorphic DNA) banding patterns using gel electrophoresis images
6. To demonstration and interpretation of RFLP (Restriction Fragment Length Polymorphism) banding patterns using gel electrophoresis images
7. To construct a restriction map of a plasmid DNA using information from single and double enzyme digestion patterns.
8. Observation of Plasmid Maps
9. To set optimal PCR cycling conditions for DNA amplification
10. To calculate the amount of each component required to prepare a PCR reaction mixture for DNA amplification
11. Demonstration of Thermocycler
12. Demonstration of Southern Blotting
13. Demonstration of DNA Sequencing (Sanger's Method) by using virtual lab or video resource
14. Demonstration of 1D and 2D PAGE by using virtual lab or video resource
15. To identify the type of ELISA (Enzyme-Linked Immunosorbent Assay) — Direct, Indirect, Sandwich, or Competitive — through observation of experimental setups or result photographs.
16. To observe, record, and map genetic trait variations among different plant samples
17. To retrieve nucleotide and protein sequences from GenBank.
18. To perform NCBI BLAST to identify homologous sequences
19. DNA Barcoding (Retrieval of matK/rbcL sequences and identification using BOLD/NCBI)
20. To performMultiple Sequence Alignment using ClustalW
21. To identify coding regions and gene structures (Use online tools like ORF Finder (NCBI) or GENSCAN)
22. To predict secondary structure of protein for give amino acid sequence
23. Any other exercise based on syllabi of theory paper

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	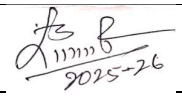	

B.Sc. Botany Semester- VI
BOT-76P-356 Practical-I
Plant Biotechnology-II

Scheme of Practical Examination and Distribution of marks

BOT-76P-356 **Duration- 4 hrs**
Max. Marks: 10*+40 **Min. Marks: 4*+16**

Exercise	Regular	Ex-students
1. Exercise-based on Unit I	**5**	**8**
2. Exercise-based on Unit II	**5**	**8**
3. Exercise-based on Unit III	**5**	**7**
4. Exercise-based on Unit IV	**5**	**7**
5. Comment upon the spots- identify giving reasons. (1 to 5)	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Explain the role and mechanism of key enzymes used in genetic engineering such as restriction endonucleases, ligases, and polymerases.
2. Differentiate various cloning vectors (plasmids, cosmids, BACs, YACs, phasmids) and their applications in gene cloning.
3. Demonstrate understanding of gene isolation and cloning techniques including cDNA synthesis, genomic library construction, and PCR-based methods.
4. Describe the principle and protocol of PCR, RT-PCR, and 1D & 2D PAGE and their relevance in molecular diagnostics.
5. Compare different DNA sequencing methods (Sanger, Maxam-Gilbert, automated) and understand their applications in gene analysis.
6. Apply blotting techniques (Southern, Northern, Western) and immunoassays (ELISA, RIA) for the detection of nucleic acids and proteins.
7. Classify DNA-based molecular markers such as RFLP, RAPD, AFLP, SSRs, and SNPs and their use in plant breeding and biodiversity studies.
8. Assess the significance of plant genome projects (e.g., Arabidopsis) in gene discovery and functional genomics.
9. Utilize biological databases (NCBI, Gene Bank, EMBL, DDBJ, PDB) and sequence analysis tools (BLAST, FASTA) for sequence identification. Application of bioinformatics and its tools

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	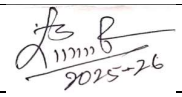	

UG0805-Three/Four Year Bachelor of Science (Botany)
Semester-VI

BOT-76T-357- Morphology and Anatomy of Angiosperms

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
VI	BOT-76T-357	Morphology and Anatomy of Angiosperms				7	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate level	Major	4	2	6	No	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		---					
Prerequisites		Botany Course of Intermediate Level					
Objectives of the Course		➢ To understand the basic body plan and structure of dicot and monocot plants. ➢ To understand themodifications of root, stem, leaves and their significance in plant life. ➢ To understand the tissues and their types in plants. ➢ To understand different tissue systems and their function in plant body. ➢ To be able to comprehend RAM and SAM. ➢ To understand the difference between primary and secondary growth in plants. ➢ To explicate general anatomy of root, stem and leaf (dicot and monocot ➢ To be able to know about abnormal secondary growth in plants and its reasons.					

Detailed Syllabus
Three/Four Year Bachelor of Science (Botany)Sem- VI
BOT-76T-357
Morphology and Anatomy of Angiosperms

Unit-I

Basic body plan of a typical dicot and monocot plant, Plant Diversity based on habitat, habit (longevity), Body forms.
Monopodial and sympodial branching, branching pattern, Canopy architecture in trees, Modular growth. Stem: modifications, Root: modifications.
Leaf: types, phyllotaxy and modifications. Types of inflorescence and fruits. **15 Lectures**

Unit-II

Tissues: Classification and functions of tissues; Meristematic and Permanent tissues. Simple, Complex and Secretory tissues.

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Plant tissue systems: Epidermal, Ground and Vascular tissue systems. Trichomes, Stomata, Hydathodes. **15 Lectures**

Unit-III

Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM): Organizational Theories. Types of vascular bundles. Primary growth in plants: Anatomy of root, stem and leaf of dicot and monocot plants. Kranz anatomy. **15 Lectures**

Unit- IV

Secondary growth in plants:Vascular cambium: structure and functions. Secondary growth in root and stem. Wood: formation, Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Cork Cambium, Periderm and its significance, Dendrochronology. Abnormal secondary growth in plants. **15 Lectures**

B.Sc. Botany Semester-VI

BOT-76P-358Practical II

Morphology and Anatomy of Angiosperms

Suggested Laboratory Exercises:

1. Study of commonly occurring dicotyledonous plant to understand the body plan and modular type of growth.
2. Life forms exhibited by flowering plants (by visit to a forest or a garden).
3. L.S. of shoot tip to study the organization of meristem (demonstration).
4. Modifications: root, stem and leaf (demonstration).
5. Anatomy of primary and secondary growth in monocots and dicots using hand cut sections of Helianthus, Maize, Cucurbita stem and root.
6. Monocot- maize (root, stem and leaf).
7. Dicot-*Helianthus* (root, stem and leaf).
8. Anomalous secondary growth in stem: *Salvadora, Bignonia, Bougainvillea Boerhaavia, Nyctanthes, Leptadenia, Dracaena.*
9. Study of stomatal types, inflorescence and fruits.
10. Study of distribution and types of parenchyma, collenchyma and sclerenchyma, Xylem: Tracheary elements-tracheids, vessel elements. Phloem: Sieve tubes-sieve plates; companion cells.

Suggested Books:

1. Cutter E.G. 1971. Plant Anatomy: Experiment and Interpretation. Part II Organs. Edward Arnold, London.
2. Esau K. 1977. Anatomy of seed plants, 2nd edition, John Wiley and Sons New York.
3. Fahn, A. 1974. Plant anatomy 2nd edition. Pergamon press. Oxford.
4. Crang, R. et al, 2018. Plant anatomy: a concept based approach to the structure of seed plants.

Signature of Dean	Signature of BoS Convenor	Signature Of DR (Academic-II)
	2025-26	

University of Rajasthan
B.Sc. Botany Semester-VI
BOT-76P-358Practical II
Morphology and Anatomy of Angiosperms
Scheme of Practical Examination and Distribution of marks

Max. Marks: 10*+40 Time: **4 Hours**

Exercise	Regular	Ex-students
1. Exercise A	**5**	**8**
2. Exercise B	**5**	**8**
3. Exercise C Make a suitable stained preparation of the given material **A.** Draw a labelled diagram and identify giving reasons.	**5**	**7**
4. Exercise D Make a suitable stained preparation of the given material **B**. Draw a labelled diagram and identify giving reasons.	**5**	**7**
5. Comment upon the spots- identify giving reasons. (1 to 5)	**10**	**15**
6. Viva-voce	**5**	**5**
7. Record	**5**	**-**
Total	**10*+40=50**	**50**
***Internal marks for regular students only**		
Candidates must keep a record of all work done in the practical classes and submit the same for inspection at the time of practical examination.		

Course Learning Outcomes:
After the course, the student would be able to:

12. Learn,understandanddevelopdifference between dicots and monocots.
13. Acquire basic knowledge of plant body, life forms and modular growth.
14. Learn and understand modifications of root, stem and leaf.
15. Understand the basics of plant tissue system and functions.
16. Gain knowledge about the anatomy of different parts of dicot and monocot plants.
17. Able to differentiate primary and secondary growth and understand their role in plant life.
18. Learn about anomalous growth in plants.
19. Comprehend about wood and dendrochronology.
20. Promote shared learning through practical classes, presentations and assignments.

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