Syllabus

UG0804-3/4 Year B.Sc. Biotechnology

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

2025-26

Semester V to VIII

University of Rajasthan,
Jaipur-302004

Signature of Dean	Signature of CoC Convenor	Signature Of DR (Academic-II)
	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

Vision:

To create potential and competent professionals in Biotechnology through career-oriented courses with practical training and advanced technical skills, equipped with societal and environmental responsibility.

Mission:

- Dissemination of global demand-based knowledge through teaching with technical professionalism.
- Creation of individuals with social and environmental concern.
- Training the students to create economically and environmentally viable solutions.

Programme Outcomes:

PO1. Developing the potential for vertical career growth in biotech industries, 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 related to the Bio-technology field.
PO3. Proficient knowledge in the major domains of biotechnology, including plant Biotechnology, Industrial Biotechnology, Bioprocess technology, Animal biotechnology, etc.
PO4. Students can successfully learn tools and techniques related to biotechnology.
PO5. Development of Analysis and solving problems related to biology with the help of modern technology.
PO6. After completion of the course, students would be able to execute their professional roles in society as biotechnology professionals in pharma, medical, industry, academia, etc.
PO7. Students will be able to learn skills to work as a team with people from a multidisciplinary environment.
PO8. To design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
PO9. Develop skills, attitude, and values required for self-directed, lifelong learning and professional development.
PO10. Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

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

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology (I –VIII SEM)	**Credits**			
#	**Level**	**Semester**	**Type**	**Title**	**L**	**T**	**P**	**Total**
1.	5	I	MJR	UG0804 - BTH-51T-151 CELL BIOLOGY AND GENETICS	4	0	0	4
2.	5	I	MJR	UG0804 - BTH-51P-152 CELL BIOLOGY AND GENETICS - PRACTICAL	0	0	2	2
3.	5	I	MJR	UG0804 - BTH-51T-153 MICROBIOLOGY	4	0	0	4
4.	5	I	MJR	UG0804 - BTH-51P-154 MICROBIOLOGY - PRACTICAL	0	0	2	2
5.	5	I	MJR	UG0804- BTH-51T-155 BIOPROCESS TECHNOLOGY	4	0	0	4
6.	5	I	MJR	UG0804- BTH-51P-156 BIOPROCESS TECHNOLOGY - PRACTICAL	0	0	2	2
7.	5	II	MJR	UG0804 -BTH-52T-251 MOLECULAR BIOLOGY	4	0	0	4
8.	5	II	MJR	UG0804 BTH-52P-252 MOLECULAR BIOLOGY - PRACTICAL	0	0	2	2
9.	5	II	MJR	UG0804 BTH- 52T-253 BIOINFORMATICS AND BIOSTATISTICS	4	0	0	4
10.	5	II	MJR	UG0804 -BTH-52P-254 BIOINFORMATICS AND BIOSTATISTICS - PRACTICAL	0	0	2	2
11.	5	II	MJR	UG0804 -BTH- 52T-255 INSTRUMENTATION AND BIOTECHNIQUES	4	0	0	4
12.	5	II	MJR	UG0804 -BTH-52P-256 INSTRUMENTATION AND BIOTECHNIQUES - PRACTICAL	0	0	2	2
13.	6	III	MJR	UG0804 – BTH- 63T-351 PLANT BIOCHEMISTRY	4	0	0	4

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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology (I –VIII SEM)	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
14.	6	III	MJR	UG0804 – BTH-63P-352 PLANT BIOCHEMISTRY - PRACTICAL	0	0	2	2
15.	6	III	MJR	UG0804 -BTH-63T-353 ANIMAL BIOCHEMISTRY	4	0	0	4
16.	6	III	MJR	UG0804 -BTH- 63P-354 ANIMAL BIOCHEMISTRY - PRACTICAL	0	0	2	2
17.	6	III	MJR	UG0804 -BTH- 63T-355 IMMUNOLOGY	4	0	0	4
18.	6	III	MJR	UG0804 -BTH- 63P-356 IMMUNOLOGY-PRACTICAL	0	0	2	2
19.	6	IV	MJR	UG0804 -BTH-64T-451 PLANT PHYSIOLOGY	4	0	0	4
20.	6	IV	MJR	UG0804 -BTH-64P-452 PLANT PHYSIOLOGY-PRACTICAL	0	0	2	2
21.	6	IV	MJR	UG0804 -BTH-64T-453 ANIMAL PHYSIOLOGY	4	0	0	4
22.	6	IV	MJR	UG0804 -BTH-64P-454 ANIMAL PHYSIOLOGY - PRACTICAL	0	0	2	2
23.	6	IV	MJR	UG0804 -BTH-64T-455 MOLECULAR GENETICS	4	0	0	4
24.	6	IV	MJR	UG0804 -BTH-64P-456 MOLECULAR GENETICS - PRACTICAL	0	0	2	2
25.	7	V	MJR	UG0804 -BTH-75T-551 ANIMAL BIOTECHNOLOGY	4	0	0	4
26.	7	V	MJR	UG0804 -BTH-75P-552 ANIMAL BIOTECHNOLOGY- PRACTICAL	0	0	2	2
27.	7	V	MJR	UG0804 -BTH-75T-553 PLANT BIOTECHNOLOGY	4	0	0	4
28.	7	V	MJR	UG0804 -BTH-75P-554 PLANT BIOTECHNOLOGY - PRACTICAL	0	0	2	2
29.	7	V	MJR	UG0804 -BTH-75T-555 BIORESOURCE WASTE MANAGEMENT	4	0	0	4
30.	7	V	MJR	UG0804 -BTH-75P-556 BIORESOURCE WASTE MANAGEMENT - PRACTICAL	0	0	2	2
31.	7	VI	MJR	UG0804 -BTH-76T-651 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP	4	0	0	4
32.	7	VI	MJR	UG0804 -BTH-76P-652 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP	0	0	2	2

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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology (I –VIII SEM)	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
				- PRACTICAL				
33.	7	VI	MJR	UG0804 -BTH-76T-653 BIOETHICS AND IPR	4	0	0	4
34.	7	VI	MJR	UG0804 -BTH-76P-654 BIOETHICS AND IPR - PRACTICAL	0	0	2	2
35.	7	VI	MJR	UG0804 -BTH-76P-655 DISSERTATION - PRACTICAL	0	0	6	6
36.	8	VII	MJR	UG0804 -BTH-87T-751 RECOMBINANT DNA TECHNOLOGY	4	0	0	4
37.	8	VII	MJR	UG0804 -BTH-87P-752 RECOMBINANT DNA TECHNOLOGY - PRACTICAL	0	0	2	2
38.	8	VII	MJR	UG0804 -BTH-87T-753 SCIENTIFIC WRITING AND PRESENTATION	4	0	0	4
39.	8	VII	MJR	UG0804 -BTH-87P- 754 SCIENTIFIC WRITING AND PRESENTATION - PRACTICAL	0	0	2	2
40.	8	VII	MJR	UG0804 -BTH-87T-755 FOOD AND DAIRY TECHNOLOGY	4	0	0	4
41.	8	VII	MJR	UG0804 -BTH-87P-756 FOOD AND DAIRY TECHNOLOGY - PRACTICAL	0	0	2	2
42.	8	VIII	MJR	UG0804 -BTH-88T-851 ENVIRONMENTAL BIOTECHNOLOGY	4	0	0	4
43.	8	VIII	MJR	UG0804 -BTH-88P-852 ENVIRONMENTAL BIOTECHNOLOGY - PRACTICAL	0	0	2	2
44.	8	VIII	MJR	UG0804 -BTH-88T-853 GENOMICS AND PROTEOMICS	4	0	0	4
45.	8	VIII	MJR	UG0804 -BTH-88P- 854 GENOMICS AND PROTEOMICS - PRACTICAL	0	0	2	2
46.	8	VIII	MJR	UG0804 -BTH-88P-855 INDUSTRIAL TRAINING AND PROJECT REPORT -PRACTICAL	0	0	6	6

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Examination Scheme

1. 1 credit = 25 marks for examination/evaluation
2. For Regular Students, there will be a 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.
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.
6. In the case of Non-Collegiate Students, there will be no Continuous assessment, and credit points in a course/subject will be assigned only if the non-collegiate student obtains at least a C grade in the EoSE examination of a Course/Subject.

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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's concern.
4. For continuous assessment, no Answer sheets/question papers, etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance, etc.

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B. **Sc. Biotechnology**

Scheme of Practical Examination and Distribution of Marks

S. No.	Exercise	Marks
1	Exercise-based on Unit I	8
2	Exercise-based on Unit II	7
3	Exercise-based on Unit III	8
4	Exercise-based on Unit IV	7
5	Comment upon the spots – identify with reasons (1 to 5)	10
6	Viva-voce	5
7	Record	5
	Total	50

- ✓ Candidates must maintain a **record** of all practical work for evaluation.

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Examination Scheme for Semester-V

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Scheme of Examination	Duration of Examination	Maximum Marks	Minimum Marks
Theory	UG0804 -BTH-75T-551 ANIMAL BIOTECHNOLOGY	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	UG0804 -BTH-75P-552 ANIMAL BIOTECHNOLOGY-PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Theory	UG0804 -BTH-75T-553 PLANT BIOTECHNOLOGY	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	UG0804 -BTH-75P-554 PLANT BIOTECHNOLOGY - PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Theory	UG0804 -BTH-75T-555 BIORESOURCE WASTE MANAGEMENT	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	UG0804 -BTH-75P-556 BIORESOURCE WASTE MANAGEMENT-PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	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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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology 3rd YEAR SEM-V	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
1.	7	V	MJR	UG0804 -BTH-75T-551 ANIMAL BIOTECHNOLOGY	4	0	0	4
2.	7	V	MJR	UG0804 -BTH-75P-552 ANIMAL BIOTECHNOLOGY-PRACTICAL	0	0	2	2
3.	7	V	MJR	UG0804 -BTH-75T-553 PLANT BIOTECHNOLOGY	4	0	0	4
4.	7	V	MJR	UG0804 -BTH-75P-554 PLANT BIOTECHNOLOGY -PRACTICAL	0	0	2	2
5.	7	V	MJR	UG0804 -BTH-75T-555 BIORESOURCE WASTE MANAGEMENT	4	0	0	4
6.	7	V	MJR	UG0804 -BTH-75P-556 BIORESOURCE WASTE MANAGEMENT-PRACTICAL	0	0	2	2

BTH-75T-551 ANIMAL BIOTECHNOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
V	BTH-75T-551	ANIMAL BIOTECHNOLOGY				7	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		----------					

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Prerequisites	Introductory course of Biotechnology
Objectives	➢ To enable students to understand the achievements and principles of Biotechnology, Genetic Engineering, and Recombinant DNA (r-DNA) technology. ➢ To educate students about cloning vectors and their applications in gene cloning technologies.

Detailed Syllabus
BTH-75T-551 ANIMAL BIOTECHNOLOGY

UNIT-I

Animal Cell Culture – Basics and Applications: Structure of animal cells, history of cell culture; cell culture media and reagents, culture techniques for mammalian cells, tissues and organs. Types of cultures: primary, secondary, continuous, and suspension. Somatic cell cloning, hybridization, transfection, transformation, and large-scale cell production. Applications in drug testing, toxicity studies, vaccine and pharmaceutical protein production. Animal cell signaling pathway growth factors, 3D organoid culture, and scaffold-based techniques.

15 Lectures

UNIT-II

Cell Lines, Stem Cells, and Medical Biotechnology: Types and preparation of cell lines, stem cells, and stem cell therapy. Veterinary applications in disease diagnosis, vaccine and hormone production. Vaccine development through conventional and recombinant methods, monoclonal antibody production via hybridoma technology, growth hormone production, and phage display technology. Gene therapy principles with examples such as ADA deficiency, Duchenne muscular dystrophy, and cystic fibrosis. **15 Lectures**

UNIT-III

Transgenic and Genetic Engineering Techniques: Reproductive technologies in animals: artificial insemination, superovulation, in vitro fertilization, and embryo transfer. Gene transfer methods: microinjection, electroporation, lipofection, and viral vectors. Generation and characterization of chimeric, transgenic and knockout animals. Gene editing and silencing using CRISPR-Cas9.Applications in disease models, molecular farming, and studies of genetic disorders. **15 Lectures**

UNIT-IV

Animal Genomics and Livestock Improvement: Genetic characterization and marker-assisted breeding of livestock. Genome analysis techniques: SNP, STR, QTL. Genetic basis of disease resistance, expression of therapeutic proteins using transgenic animals. Species identification through immunological and DNA-based methods. Detection of adulteration in meat and feed,

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and forensic identification of wild animals using biological samples. Role of CRISPR-Cas9 in animal models and biotechnology in livestock enhancement. **15 Lectures**

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BTH-75P-552 ANIMAL BIOTECHNOLOGY-PRACTICAL

1. Basic Setup of an Animal Tissue Culture Laboratory
2. Preparation of media, sterilization, and practices in a tissue culture laboratory
3. Estimation of RBC, WBC, Hb, and hematocrit value in a given blood sample.
4. Counting of viable cells by TTC methods
5. Isolation of DNA from Blood
6. Trypsinization of monolayer and subculturing
7. Cryopreservation and thawing
8. Measurement of doubling time
9. Role of serum in cell culture
10. Cell fusion with PEG
11. MTT assay for cell viability and growth
12. Preparation of Phosphate Buffered Saline (PBS).
13. Trypan blue dye exclusion test for cell viability.
14. ELISA technique for antigen-antibody detection.

Suggested Books & Text

1. A textbook of Biotechnology-R. C. Dubey, S. Chand & Company Ltd., New Delhi -1996.
2. A textbook on Biotechnology-(n Ed.) H.D. Kumar. EWP - Private Ltd., New Delhi -1998.
3. Animal Biotechnology-M.M. Ranga, Agrobios (India), 2000.
4. Biotechnology-Fundamentals & Applications-S.S. Purohit & S.K. Mathur, Agro Botonics-1999.
5. Biotechnology-V. Kumaresan. Saras Publication-1994
6. GordonI.2005. Reproductive Techniques in Farm Animals. CABI
7. Kindt TJ, Golds by RA &Osbrne BA. 2007. Kuby Immunology. WH Freeman
8. Kun LY. 2006. Microbial Biotechnology. World Scientific
9. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare
10. Lincoln PJ & Thomson J. 1998. Forensic DNA Profiling Protocols. Humana Press.
11. Portner, R. 2007. Animal Cell Biotechnology. Humana Press.
12. Spinger TA. 1985. Hybridoma Technology in Biosciences and Medicine. Plenum Press.
13. TwymanRM.2003. Advanced Molecular Biology. Bios Scientific.

Course Learning Outcomes:

On successful completion of this course, students will be able to:

1. Define and explain basic concepts of animal cell culture, types of cultures, and their applications in research and diagnostics.
2. Describe the preparation and use of cell lines and stem cells in veterinary biotechnology and regenerative medicine.
3. Interpret the process of recombinant vaccine development, monoclonal antibody production, and gene therapy with relevant examples.

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4. Explain reproductive and gene transfer technologies like IVF, embryo transfer, electroporation, and microinjection used in animal improvement.
5. Understand the principles and applications of gene editing tools such as CRISPR-Cas9 in creating transgenic and disease-model animals.
6. Analyze the use of molecular markers and DNA-based tools for species identification, meat authentication, and livestock breeding programs.
7. Demonstrate basic biotechnology lab skills, including DNA isolation, cell viability assays, ELISA, and media preparation under sterile conditions.
8. Apply biotechnological knowledge to improve animal health, productivity, and reproduction in the context of veterinary and livestock sciences.

BTH-75T-553 PLANT BIOTECHNOLOGY

<table>
<tr><th>Semester</th><th>Code of the Course</th><th colspan="4">Title of the Course/Paper</th><th>NHEQ F Level</th><th>Credits</th></tr>
<tr><td>V</td><td>BTH-75T-553</td><td colspan="4">PLANT BIOTECHNOLOGY</td><td>7</td><td>4</td></tr>
<tr><th rowspan="2">Level of Course</th><th rowspan="2">Type of the Course</th><th colspan="3">Credit Distribution</th><th rowspan="2">Offered to NC Student</th><th colspan="2" rowspan="2">Course Delivery Method</th></tr>
<tr><th>Theory</th><th>Practical</th><th>Total</th></tr>
<tr><td>Intermediate</td><td>Major</td><td>4</td><td>2</td><td>6</td><td>NO</td><td colspan="2">60 lectures with diagrammatic and informative assessments during lecture hours</td></tr>
<tr><th colspan="2">List of Programme Codes in which Offered as Minor Discipline</th><td colspan="6">----------</td></tr>
<tr><th colspan="2">Prerequisites</th><td colspan="6">Introductory course of Biotechnology</td></tr>
<tr><th colspan="2">Course Objectives</th><td colspan="6">➢ To introduce students to the principles and practices of plant biotechnology, including plant tissue culture, genetic transformation, and molecular breeding.
➢ To familiarize students with the applications of plant genomics in crop improvement and biotechnology research.</td></tr>
</table>

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Detailed Syllabus
BTH-75T-553 PLANT BIOTECHNOLOGY

UNIT-I

Fundamentals of Plant Tissue Culture: Historical background, terminology, basic techniques of cell and tissue culture, surface sterilization, and aseptic tissue transfer. Concept of totipotency—dedifferentiation and redifferentiation. Nutritional requirements in vitro, types of nutrient media including inorganic and organic supplements, plant growth regulators, gelling agents, and defined media. Development of explants through somatic embryogenesis and organogenesis. Micropropagation and plant cloning—process, limitations, and applications in agriculture, horticulture, and forestry.

15 Lectures

UNIT-II

Somaclonal Variation and Haploid Technology: Tissue culture variability, somaclonal and other variations—process, advantages, limitations, screening, and verification. Haploid production through androgenesis and gynogenesis, diploidization, and applications. Disease-free plant production using tissue culture—Methods, applications, limitations and virus indexing.

15 Lectures

UNIT-III

Cell and Protoplast Culture: Isolation of cells from plants using mechanical and enzymatic methods, suspension cultures, and single-cell cloning techniques—Bergmann plating, filter paper raft, microculture chamber, microdrop, and feeder layer methods. Protoplast isolation, culture, and fusion—mechanical, enzymatic, and chemical/electrical methods. Protoplast purification, quality assessment, somatic hybridization, and hybridity verification. Use of molecular markers and marker-assisted selection (MAS). **15 Lectures**

UNIT-IV

Genetic Engineering and Crop Improvement: *Agrobacterium tumefaciens* and *A. rhizogenes*-mediated transformation, features of Ti and Ri plasmids, DNA transfer mechanisms. Genetic engineering for enhanced photosynthesis, nitrogen fixation, nutrient uptake, and crop productivity.GM crop regulations and biosafety norms in India. Engineering tolerance to biotic stresses (insects, fungi, bacteria, viruses, weeds) and abiotic stresses (drought, salt, temperature, flooding). Quality improvement targeting proteins, lipids, carbohydrates, vitamins, and minerals. Germplasm conservation, identity preservation in GM crops, and bioinformatics tools in plant biotechnology. **15 Lectures**

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BTH-75P-554 PLANT BIOTECHNOLOGY -PRACTICAL

1. Preparation of stock solutions of Murashige and Skoog medium
2. Preparation of Murashige and Skoog medium
3. Aseptic handling of explants and Surface sterilization of explants
4. Explant culture
5. Callus culture
6. Anther Culture
7. Demonstration of the Production of synthetic seeds
8. Development of virus-free plants from meristematic tips
9. CTAB method for plant DNA extraction.
10. PCR Demonstration.
11. Agarose gel electrophoresis.
12. *Agrobacterium*-mediated transformation (demonstration).

Suggested Books & Text

1. Plant Tissue Culture: Theory and Practice: Theory and Practice by S.S. and M. K. Razdan
2. Introduction to Plant Biotechnology: H.S. Chawla
3. Introduction to Plant Biotechnology – Razdan
4. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W. Scott, Mark R. Fowler
5. Recent advances in Plant Biotechnology and its application- Ashwini Kumar and Sudhir K Sapory

Course Learning Outcomes:

On successful completion of this course, students will be able to:

1. Define and explain basic concepts and terminology of plant tissue culture, including totipotency, organogenesis, and micropropagation.
2. Establish different types of in vitro plant cultures such as callus, anther, and meristem cultures, using standard lab techniques.
3. Prepare nutrient media like Murashige and Skoog medium and calculate media components with accuracy.
4. Compare the environmental impact of genetically modified (GM) plants and understand related biosafety guidelines.
5. Explain the methods of haploid production, somaclonal variation, and their use in developing improved plant varieties.
6. Perform basic techniques such as explant sterilization, synthetic seed production, DNA extraction, PCR, and gel electrophoresis.
7. Understand principles of protoplast culture, somatic hybridization, and the use of molecular markers in plant selection.
8. Apply knowledge of plant genetic engineering (Agrobacterium-mediated transformation) for crop improvement and stress tolerance.

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BTH-75T-555 BIORESOURCE WASTE MANAGEMENT

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
V	BTH-75T-555	BIORESOURCE WASTE MANAGEMENT				7	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		Introductory course of Biotechnology					
Course Objectives		➢ To examine the various types of solid waste and methods to categorize it. ➢ To find out methods to reduce solid waste at the source. ➢ To understand people's responsibility in reducing and managing waste.					

Detailed Syllabus
BTH-75T-555 BIORESOURCE WASTE MANAGEMENT

UNIT-I

Bioresources and Waste Characterization: Bioresources as biomass for food, fuel and chemicals. Biodiversity characterization, circular bioeconomy concept, and GPS applications in bioresource management. Introduction to waste problems, types and categories of solid waste, environmental and health impacts of excess waste generation. Factors influencing waste generation, waste characteristics and analysis. Major issues related to solid waste disposal.

15 Lectures

Signature of Dean	Signature of CoC Convenor	Signature Of DR (Academic-II)
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UNIT-II

Waste Minimization and Management Techniques: Source reduction strategies, economic benefits of waste minimization, steps to initiate waste reduction programs, and daily operational guidelines. Onsite handling, storage (dustbins, containers, placement), and processing of solid waste. Waste collection methods, equipment, labor needs, and route planning. Processing and disposal through landfilling, composting, incineration, vermicomposting, and bioremediation. Resource recovery and energy generation from waste, reuse in industries, role of fungi and algae in bioremediation and composting of plant and animal waste.

15 Lectures

UNIT-III

Waste Audit and Public Responsibility: Waste terminology, waste analysis methods and waste audit processes. Performance checklists for waste collection, segregation, transport, and treatment. Public responsibility in waste management, Polluter Pays Principle (PPP), Precautionary Principle, Assimilative and Carrying Capacity concepts, Global scenario in scrap trade. Extended Producer Responsibility (EPR), adoption of bioplastics and biodegradable polymers.

15 Lectures

UNIT-IV

Zero Waste and Sustainable Practices: Concept of zero waste living and sustainable lifestyle approaches. Waste reduction strategies at producer, individual, and community levels. Role of awareness, behavioral change, and community participation in promoting sustainable waste reduction. Circular economy and its relevance to zero waste. Role of sustainable consumption, green packaging, and eco-friendly product design. Community-led waste segregation, composting, and recycling models. Importance of policy support, Extended Producer Responsibility (EPR), and Sustainable Development Goals (SDG-12). Emerging innovations in waste-to-resource technologies and upcycling practices.

15 Lectures

BTH-75P-556 BIORESOURCE WASTE MANAGEMENT -PRACTICAL

1. Field report on Biodiversity Park
2. Shelf life management of flowers of importance
3. Study of industrially important plants (Specimens/ products) morphology, botany, and uses
4. Study on the disposal and treatment of biomedical waste
5. Waste water treatment
6. Study on the disposal and treatment of solid waste
7. Study on Waste wastewater treatment plant
8. Visit to Vermiculture unit
9. To study bioresources from plant & animal sources
10. Preparation of compost from organic waste.

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	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

11. BOD and COD measurement from water samples.
12. Isolation of fungi from decaying waste.
13. Bioassay of compost using seed germination.

Suggested Books & Text

1. Solid waste Engineering: Principles & management. Issue: G. Techobanogious, H. Theisen, R. Blassen
2. C.L. Mantell, Solid waste management, John Wiley, New York, 1975
3. Bhide and Sudershen, Solid waste management in developing countries
4. Gitanjali Nain Gill, 2011, SAGE Publications' Green Technology: An A-Z Guide (2011), whose work for that encyclopedia formed the basis of her contributions to Britannica. PG Diploma in Waste Management and Environmental Hygiene (PGDWMEH)
5. Hester, R. E. and R. M. Harrison (2002). Environmental and health impact of solid waste management activities. Cambridge: The Royal Society of Chemistry.
6. https://www.downtoearth.org.in/coverage/costs-and-benefits-of-india-swaste-disposal-options-5623
7. https://swachhindia.ndtv.com/national-aluminium-company-limitedadvocates-for-use-of-aluminium-foil-as-alternative-to-plastic-26056/
8. https://www.downtoearth.org.in/blog/india-s-challenges-in-wastemanagement-56753
9. http://rsos.royalsocietypublishing.org/content/4/3/160764#sec-17
10. https://www.downtoearth.org.in/coverage/waste-smart-cities-54119

Course Learning Outcomes:

On successful completion of this course, students will be able to:

1. Define and classify different types of bioresources and solid waste based on their origin and characteristics.
2. Explain the environmental and health impacts of improper solid waste disposal and the importance of sustainable waste management.
3. Describe various methods of waste minimization, handling, storage, transportation, and disposal including composting, landfilling, and vermiculture.
4. Understand the role of fungi, algae, and microbes in waste bioremediation and compost preparation.
5. Perform basic waste audit techniques and analyze waste samples using standard parameters.
6. Recognize the responsibilities of individuals and industries in waste management through principles like EPR and Polluter Pays.
7. Demonstrate practical knowledge of wastewater treatment, compost preparation, BOD and COD measurement, and fungal isolation from waste.
8. Apply the concept of zero waste and sustainable lifestyle strategies at the community and individual levels to promote environmental responsibility.

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	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

Examination Scheme for EoSE for Semester-VI

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Scheme pf Examination	Duration of Examination	Maximum Marks	Minimum Marks
Theory	BTH-76T-651 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	BTH-76P-652 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP - PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Theory	BTH-76T-653 BIOETHICS AND IPR	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	BTH-76P-654 BIOETHICS AND IPR - PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Practical	BTH-76P-655 **DISSERTATION*** (PRACTICAL)	**CA**	1 Hr	30 Marks	12 Marks
		EoSE	03 Hrs	120 Marks	48 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.

***Dissertation**- Based on the lab work practical exam will be of 120 marks distributed as below:- (a) 100 marks viva voce and (b) 20 marks report of dissertation (evaluation by external examiner)

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	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology 3rd YEAR SEM-VI	**Credits**			
#	**Level**	**Semester**	**Type**	**Title**	**L**	**T**	**P**	**Total**
1.	5	VI	MJR	UG0804 - BTH-76T-651 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP	4	0	0	4
2.	5	VI	MJR	UG0804-BTH-76P-652 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP - PRACTICAL	0	0	2	2
3.	5	VI	MJR	UG0804 - BTH-76T-653 BIOETHICS AND IPR	4	0	0	4
4.	5	VI	MJR	UG0804 - BTH-76P-654 BIOETHICS AND IPR - PRACTICAL	0	0	2	2
5.	5	VI	MJR	UG0804- BTH-76P-655 DISSERTATION-PRACTICAL	0	0	6	6

UG0804 - BTH-76T-651 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP

Semester	**Code of the Course**	**Title of the Course/Paper**			**NHEQF Level**	**Credits**
VI	BTH-76T-651	HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP			7	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		Introductory course of Biotechnology				

Signature of Dean	**Signature of CoC Convenor**	**Signature Of DR (Academic-II)**
	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

Course Objectives	➢ Understand the principles and types of vaccines, including traditional and advanced generation vaccines. ➢ Comprehend various biotechnological tools for disease diagnosis, treatment, and drug designing. ➢ Explore the role of microorganisms in agriculture, the environment, industry, and fuel generation. ➢ Analyze the applications of biotechnology in medical, forensic, and industrial sectors. ➢ Develop an understanding of entrepreneurship principles, types, and processes with relevance to biotechnology. ➢ Cultivate awareness about ethical values, motivation, and innovation related to entrepreneurial ventures in the bio-sector.

Detailed Syllabus
BTH-76T-651 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP

Unit–I

Disease prevention: Generation of vaccine-First generation vaccines, Second generation vaccine (Cell Culture vaccine), Third generation vaccine (Recombinant and subunit and synthetic vaccines), Fourth generation vaccine (DNA vaccine), Medical Applications; Edible vaccines. Disease Diagnosis: identification of genes causing genetic disorders, DNA/RNA probes, and Commercial potential of diagnostics. **15 Lectures**

Unit-II

Treatment and Drug Designing: Recombinant technology for disease treatment, Interferons, Oligonucleotides, Artificial tissues/organs. **Drug designing**- Drug delivery and targeting, Gene therapy, Autoimmunity, DNA fingerprinting in Forensic sciences. **15 Lectures**

Unit-III

Entrepreneurship: Concept, Functions and need; Entrepreneurship: Characteristics and Theories; Relevance of Entrepreneurship to Socio-Economic Gain: Generating National Wealth, creating Wage and Self-Employment, Micro, Small and Medium Enterprises; Process of Entrepreneurship Development – Start-up and its stages.

15 Lectures

UNIT-IV

Types of Entrepreneurs: Competencies and characteristics: Ethical Entrepreneurship; Entrepreneurial Values, Attitudes and Motivation; Mindset of an employee and an entrepreneur - difference; Intrapreneur. **Innovations and Entrepreneurial Ventures** (Global and Indian) related to Biotechnology; New Industries of New Age Economy. **15 Lectures**

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BTH-76P-652 HEALTHCARE BIOTECHNOLOGY AND ENTREPRENEURSHIP PRACTICAL

1. Mock design of first-, second, and third-generation vaccines using diagrams and flowcharts.
2. **ELISA (Enzyme-Linked Immunosorbent Assay)-**To detect antigens or antibodies as a model for disease diagnosis
3. Demonstration of DNA/RNA Probe Hybridization (Dot Blot or Southern/Northern Blot).
4. Case Study Analysis on Edible Vaccines
5. **DNA Fingerprinting using Agarose Gel Electrophoresis-** Simulate forensic applications and disease identification.
6. **PCR (Polymerase Chain Reaction) Demonstration or Virtual Lab**- Amplification of DNA for gene identification or disease-linked gene sequences.
7. **Study and Presentation on Artificial Organs and Interferons**- Literature-based group discussion or PowerPoint presentation.
8. Students form groups and develop a mini business plan related to a biotech product/service (e.g., diagnostic kits, organic fertilizers).
9. **SWOT Analysis Activity-** Identify Strengths, Weaknesses, Opportunities, and Threats for a biotechnology start-up.
10. **Case Study Analysis-** on successful biotech entrepreneurs or start-ups (e.g., Biocon, Serum Institute of India, Bharat Biotech).
11. **Mock Pitch Session**- Role-play: students act as entrepreneurs and present an idea to a panel of peers acting as investors.

Suggested Books & Text

1. **Biotechnology: Expanding Horizons"** – B.D. Singh
2. **Introduction to Biotechnology"** – William J. Thieman, Michael A. Palladino
3. **Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies"** – Craig D. Shimasaki
4. **Entrepreneurship Development"** – S.S. Khanka
5. **Innovation and Entrepreneurship"** – Peter F. Drucker
6. Fayolle A (2007) Entrepreneurship and new value creation. Cambridge, Cambridge University Press
7. Hougaard S. (2005) The business idea. Berlin, Springer
8. Lowe, R., & S Mariott (2006). Enterprise: Entrepreneurship & Innovation. Burlington, Butterworth Heinemann

E-learning resources:

1. https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2. https://kpu.pressbooks.pub/introtoentrepreneurship/

Course Learning Outcomes:-

On successful completion of the course, students will be able to:

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1. **Explain** the classification and mechanisms of vaccine generations, including DNA and edible vaccines.
2. **Describe** modern tools for disease diagnosis, such as monoclonal antibodies, gene probes, and their commercial applications.
3. **Apply** recombinant DNA technology and gene therapy principles in the treatment of diseases and drug delivery systems.
4. **Analyze** the roles of microorganisms in bioremediation, agriculture, industrial product synthesis, and fuel generation.
5. **Assess** biotechnological innovations in industries including textile, paper, and surface deterioration control.
6. **Differentiate** between types of entrepreneurs and intrapreneurs, and explain entrepreneurial mindset, values, and motivation.
7. **Demonstrate** knowledge of entrepreneurship development processes, including start-ups and MSMEs.
8. **Evaluate** global and Indian entrepreneurial ventures and innovations in the biotechnology domain.

BTH-76T-653 BIOETHICS AND IPR

<table>
<tr><th>Semester</th><th>Code of the Course</th><th colspan="4">Title of the Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>VI</td><td>BTH-76T-653</td><td colspan="4">Bioethics and IPR</td><td>7</td><td>4</td></tr>
<tr><td rowspan="2">Level of Course</td><td rowspan="2">Type of the Course</td><td colspan="3">Credit Distribution</td><td rowspan="2">Offered to NC Student</td><td colspan="2" rowspan="2">Course Delivery Method</td></tr>
<tr><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>Intermediate</td><td>Major</td><td>4</td><td>2</td><td>6</td><td>NO</td><td colspan="2">60 lectures with diagrammatic and informative assessments during lecture hours</td></tr>
<tr><td colspan="2">List of Programme Codes in which Offered as Minor Discipline</td><td colspan="6">----------</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="6">Basic Knowledge of Introductory/Foundation level</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">➢ To understand the fundamentals of Intellectual Property Rights (IPRs) and their various forms in the context of biotechnology and agriculture.</td></tr>
</table>

Signature of Dean	Signature of CoC Convenor	Signature Of DR (Academic-II)
	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

	➢ To analyze national and international legal frameworks like TRIPS, WTO, WIPO, and the Budapest Treaty related to patents and plant breeders' rights. ➢ To examine issues related to patentability, commercialization, and biopiracy in biotechnology and traditional knowledge. ➢ To recognize ethical concerns and regulatory aspects of molecular biotechnology and genetically modified organisms (GMOs). ➢ To gain insights into the protection of traditional knowledge and the socio-economic and ecological implications of IPR and biosafety regulations.

Detailed Syllabus
BTH-76T-653 BIOETHICS AND IPR

Unit-I

Intellectual property rights: General Introduction to intellectual property rights, its different forms: Patents, trademarks, copyrights, trade secrets, Geographical indicators. Basic requirements of patentability, patentable subject matter, novelty, and the Public Domain; Nonobviousness, Patent infringements and revocation. **15 Lectures**

Unit-II

Patentability of Biotechnology inventions and their commercialization, Budapest treaty. GATT, TRIPS, WIPO, Plant breeders' rights, international conventions, biopiracy. Biotechnology: Basic features of Indian Plant Varieties Protection & Farmer's Rights Act.

15 Lectures

Unit-III

Traditional Knowledge and Intellectual Property Rights: The importance of Traditional Knowledge (TK) for developing nations, protecting TK, The local, national and global dimensions of the issues in TK and IPRs, Traditional Medicine & IP Protection, Folklore, Patenting of Health Foods: Case studies **15 Lectures**

Unit-IV

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies Regulatory Aspects: Direct Non-target effects on beneficial and native organisms, Indirect effects, Regulating Recombinant DNA technology, Biohazards, Environmental and regulatory aspects of using GM plants, Monitoring of introduced microorganisms, Biological weapons, Risk assessment. Brief account of bioethics in Biotechnology. **15 Lectures**

BTH-76P-654 BIOETHICS AND IPR Practical

1. Proxy filing of an Indian Product patent

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2. Proxy filing of Indian Process patent
3. Planning for establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women's health ethics
6. Case study on medical errors and negligence
7. Explain the different Forms for the grant of a patent
8. Comment on biopiracy with examples
9. Comment on biological weapons with examples
10. TRIPS, WTO, WIPO case studies

Suggested Books & Text

1. IPR, biosafety and Bioethics – Deepa Goel and Shomini Parashar
2. Bioethics and Biosafety – M K Sateesh
3. Plant biotech – Slater and Scott
4. Fleming, D.A., Hunt, D.L. (2000). Biotechnology and Safety Assessment (3rd Ed). Academic Press.ISBN-1555811804, 9781555811808.
5. Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC Press, Washington. ISBN: 1560327219, 9781560327219
6. Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445
7. H.K.Das. Textbook of Biotechnology, 3rd edition
8. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)
9. Singh, I., and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006)
10. Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)
11. Deepa Goel, Shomini Parashar (2013), IPR, Biosafety and Bioethics, Pearson.

E-learning resources

1. https://archive.org/details/bioethicsprincip0000vaug/page/n5/mode/2up
2. http://rguir.inflibnet.ac.in:8080/jspui/bitstream/123456789/16305/1/9789354968761.PDF
3.https://www.icsi.edu/media/webmodules/publications/9.4%20Intellectual%20Property%20Rights.pdf
4.https://www.icsi.edu/media/webmodules/publications/9.4%20Intellectual%20Property%20Rights.pdf

Course Learning Outcomes:

On successful completion of this course, students will be able to:

1. **Define and differentiate** various forms of intellectual property rights, including patents, plant breeders' rights, and farmers' rights.
2. **Explain** the development of patent systems in India and globally, including TRIPS, WTO, GATT, WIPO, and Budapest Treaty.
3. **Analyze** the legal, ethical, and regulatory implications of patenting biotechnology inventions and protecting traditional knowledge.

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4. **Evaluate** the relevance and application of laws such as UPOV, PVPFR Act, Bayh-Dole Act, and provisions like compulsory licensing and Bolar exemption.
5. **Discuss** major bioethical concerns related to GMOs, molecular biotechnology, and biological weapons.
6. **Identify** and **describe** biosafety levels, containment systems, and national guidelines for safe use of GMOs and LMOs.
7. **Illustrate** the role of regulatory bodies such as IBSC, RCGM, and GEAC in biosafety governance in India.
8. **Interpret** risk assessment, management, and communication strategies for biosafety in agricultural and medical biotechnology.

Semester	**Code of the Course**	**Title of the Course/Paper**				**NHEQF Level**	**Credits**
VI	BTH-76P-655	Dissertation				7	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical (Presentation)**	**Total**			
Intermediate	Major	-	6	6	NO	Lab work on a selected topic	
List of Programme Codes in which Offered as Minor Discipline		----------					
Prerequisites		Intermediate course in Biotechnology					
Course Objectives		✓ **To provide students with hands-on experience** in designing, executing, and presenting independent research in any domain of biotechnology ✓ **To enhance analytical and problem-solving skills** through the application of experimental techniques in real-world biological systems. ✓ **To develop proficiency in data collection, analysis, and interpretation** using standard biotechnological tools and statistical methods. ✓ **To train students in scientific communication skills**, including the ability to write a structured dissertation report, present research findings, and defend conclusions logically and ethically.					

Signature of Dean	**Signature of CoC Convenor**	**Signature Of DR (Academic-II)**
	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

BTH-76P-655 DISSERTATION

Report of Dissertation of 1-2 months: To improve career prospects in industry, clinical environments, in-house or other institute/training house/another university where state-of-the-art research facilities are available, is to be carried out on a selected topic. Students need to select a topic that has not been explored earlier and under the supervision of a faculty/trainer, have to carry out research in wet lab conditions. Students need to interpret results and prepare a report of dissertation at the end comprising, i) Introduction, ii) Review of literature, iii) Objectives of the present work, iv) Experimentation, v) Observation, and Results, vi) prospects of the work, (times new roman font size-12) vii) Figures and Tables (clear and original). The title page should comprise the Topic (font size 16), the name of the student, the name of the supervisor/trainer, name of the institute (font 14) with a diagrammatic representation of the work.

Evaluation Component	DISSERTATION REPORT (with proper certification)
Evaluation Method	Appropriate to the material and specific content
Learning Outcome	**Designing and conducting research** in a selected area of biotechnology, applying modern laboratory or computational techniques under guided supervision

Course Learning Outcomes:
Upon completion of the course, the student will know about

1. **Exposure to** hands-on experience in advanced instrumentation, experimental protocols, or bioinformatics tools relevant to academic, clinical, or industrial biotechnology.
2. **Critically analyze scientific data** and interpret results in the context of existing research, applying logical reasoning and evidence-based conclusions.
3. **Communicate scientific findings effectively**, both in written dissertation form and oral presentations, adhering to professional and ethical standards.
4. **Apply research-based learning** to address real-world problems, enhancing readiness for careers in biotechnology-related industries, clinical laboratories, or research institutions.

Signature of Dean	Signature of CoC Convenor	Signature Of DR (Academic-II)
	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

Examination Scheme for Semester-VII

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Scheme of Examination	Duration of Examination	Maximum Marks	Minimum Marks
Theory	UG0804 -BTH-87T-751 RECOMBINANT DNA TECHNOLOGY	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	UG0804 -BTH-87P-752 RECOMBINANT DNA TECHNOLOGY-PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Theory	UG0804 -BTH-87T-753 SCIENTIFIC WRITING AND PRESENTATION	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	UG0804 -BTH-87P- 754 SCIENTIFIC WRITING AND PRESENTATION-PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Theory	UG0804 -BTH-87T-755 FOOD AND DAIRY TECHNOLOGY	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	UG0804 -BTH-87P-756 FOOD AND DAIRY TECHNOLOGY-PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	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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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology 4th YEAR SEM-VII	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
1.	8	VII	MJR	UG0804 -BTH-87T-751 RECOMBINANT DNA TECHNOLOGY	4	0	0	4
2.	8	VII	MJR	UG0804 -BTH-87P-752 RECOMBINANT DNA TECHNOLOGY-PRACTICAL	0	0	2	2
3.	8	VII	MJR	UG0804 -BTH-87T-753 SCIENTIFIC WRITING AND PRESENTATION	4	0	0	4
4.	8	VII	MJR	UG0804 -BTH-87P- 754 SCIENTIFIC WRITING AND PRESENTATION-PRACTICAL	0	0	2	2
5.	8	VII	MJR	UG0804 -BTH-87T-755 FOOD AND DAIRY TECHNOLOGY	4	0	0	4
6.	8	VII	MJR	UG0804 -BTH-87P-756 FOOD AND DAIRY TECHNOLOGY-PRACTICAL	0	0	2	2

BTH-87T-751 RECOMBINANT DNA TECHNOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
VII	BTH-87T-751	RECOMBINANT DNA TECHNOLOGY				8	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Advanced	Major	4	2	6	NO	60 lectures with diagrammatic and informative assessments during lecture hours	

Signature of Dean	Signature of CoC Convenor	Signature Of DR (Academic-II)
	Rekha	Dy. Registrar (Academic) University of Rajasthan JAIPUR

List of Programme Codes in which Offered as Minor Discipline	----------
Prerequisites	Knowledge of the Intermediate level
Objectives	➢ To familiarize students with the fundamental concepts and tools of genetic engineering and recombinant DNA technology. ➢ To impart knowledge about enzymes, vectors, and techniques used in gene cloning and DNA manipulation. ➢ To understand applications of recombinant DNA technology in agriculture, healthcare, and industry. ➢ To develop skills in gene transfer methods, DNA analysis, and interpretation of results.

Detailed Syllabus
BTH-87T-751 RECOMBINANT DNA TECHNOLOGY

Unit-I

Introduction and Tools of Recombinant DNA Technology: Historical perspective and milestones in recombinant DNA technology. Enzymes used in rDNA technology: Restriction endonucleases, ligases, DNA polymerases, reverse transcriptase, polynucleotide kinase, and alkaline phosphatase. Methods for the isolation of nucleic acid. Gel electrophoresis and blotting techniques (Southern, Northern, Western).

15 Lectures

Unit-II

Vectors and Gene Cloning Strategies: Cloning vectors: Plasmid vectors, bacteriophage vectors (lambda, M13), cosmids, phagemids, BACs and YACs. Expression vectors and shuttle vectors. Construction of recombinant DNA molecules (procedure of cloning a gene of interest). Methods of introducing DNA into host cells: Transformation, transfection, electroporation, microinjection, biolistics. Selection and screening of recombinants: Blue-white screening, colony hybridization, and PCR-based screening. **15 Lectures**

Unit-III

PCR, DNA Sequencing, and Analysis: Polymerase Chain Reaction (PCR): Principles, types (RT-PCR, multiplex PCR). DNA sequencing methods: Sanger sequencing, Next-Generation Sequencing (NGS) overview. DNA fingerprinting and its applications. Restriction Fragment Length Polymorphism (RFLP), RAPD, AFLP, and microsatellite analysis. Bioinformatics tools for sequence analysis and interpretation. **15 Lectures**

Unit-IV

Applications of Recombinant DNA Technology: Production of recombinant proteins: Insulin,

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growth hormones, vaccines. Transgenic plants and animals: Methods, advantages, and examples (Bt cotton, golden rice). Gene therapy: Types, methods, and applications. Ethical, safety, and regulatory issues in recombinant DNA technology. Intellectual Property Rights (IPR).

15 Lectures

BTH-87P-752 RECOMBINANT DNA TECHNOLOGY –PRACTICAL

1. Isolation of genomic DNA from human cheek cells/ plant tissue.
2. Isolation of plasmid from a prokaryotic cell (alkaline lysis method).
3. Agarose gel electrophoresis for DNA analysis.
4. Assessment of DNA purity and quantity using spectrophotometry.
5. Culture of *E. coli* and yeast, including streaking and subculture.
6. Preparation of Competent Cells ($CaCl_2$ method)
7. PCR amplification of a target DNA sequence
8. Restriction digestion of DNA
9. DNA ligation
10. Transformation of bacteria and selection of transformations
11. Screening of transformations
12. Blue/white screening
13. Protein profiling by SDS-PAGE
14. Demonstration of cDNA Library Preparation (Chart/Video)
15. Southern Blotting (Demonstration or Chart**)**
16. DNA fingerprinting demonstration using gel electrophoresis.
17. Bioinformatics tools: BLAST, sequence alignment, and ORF prediction.
18. Visit to a Plant Tissue Culture/Transgenic Facility (Virtual/Physical).
19. Visit to a molecular biology laboratory or biotechnology industry for exposure.
20. Any other exercise based on the theory paper.

Suggested Books & Text

1. A textbook of biotechnology – R. C. Dubey
2. Biotechnology Expanding Horizons– B. D. Singh
3. Gene Cloning and DNA Analysis- T.A. Brown
4. Concepts of Genetics – Kluggs and Cummings
5. Molecular Biotechnology- Bernard R. Glick
6. Textbook of biotechnology –H.K. Das
7. Introduction to Plant Biotechnology- H. S. Chawala
8. Principles of Gene Manipulation and Genomics - Primrose and Twyman
9. Genetic Engineering Principles & Practice – Sandhya Mitra
10. From genes to clones- Winacker
11. Gene Cloning- T. A. Brown
12. From genes to genome: concepts and applications of DNA technology- Dale and Schantze
13. Gene Cloning: Principles and Applications- Lodge, Lund and Minchin
14. Gene Biotechnology- S. N. Jogdanand

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15. Biotechnology- U. Satyanarayan
16. Genetic Engineering – Smita Rastogi & Neelam Pathak
17. An Introduction to Genetic Engineering. Nicholl, D.S.T.
18. Molecular Biology and Genetic Engineering. Gupta, P. K.
19. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Glick, B. R., and Pasternak, J. J.
20. Molecular Cloning: A Laboratory Manual. Sambrook, J., and Russell, D.W. (Cold Spring Harbor).
21. Recombinant DNA: Genes and Genomes. Watson, J.D., et al.

Online Resources: NCBI, EMBL, KEGG Pathway Databases for Practical Bioinformatics Exposure.

Course Learning Outcomes:

On successful completion of this course, students will be able to:

1. Explain the basic principles of recombinant DNA technology and describe the roles of enzymes, vectors, and molecular tools used in gene cloning.
2. Recall key discoveries, gene transfer methods, and types of cloning and expression vectors used in genetic engineering.
3. Perform essential techniques such as plasmid isolation, PCR, restriction digestion, DNA ligation, transformation, and gel electrophoresis.
4. Analyze DNA samples using PCR-based methods, electrophoresis, and DNA fingerprinting for gene detection and variation studies.
5. Describe the production of recombinant proteins (e.g., insulin, vaccines) and the development of transgenic organisms for use in agriculture and medicine.
6. Demonstrate skills in screening of recombinants using blue-white selection, colony hybridization, and bioinformatics tools such as BLAST and sequence alignment.
7. Interpret sequencing results and compare traditional (Sanger) and advanced (NGS) DNA sequencing techniques.
8. Discuss applications, ethical concerns, biosafety guidelines, and IPR or ethical issues associated with recombinant DNA technology and genetic engineering.

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BTH-87T-753 Scientific Writing and Presentation

Semester	Code of the Course	Title of the Course/Paper				NHEQ F Level	Credits
VII	BTH-87T-753	Scientific Writing and Presentation				8	**4**
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
Advanced	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		Knowledge of the Intermediate level					
Course Objectives		➢ To enable students to compose clear, error-free scientific texts, use Word and Excel for editing and data handling, and draft formal correspondence (letters, memos, agendas). ➢ To enhance students' skills to plan and write structured technical reports, produce coherent project/internship reports, and create effective emails, brochures, and leaflets. ➢ To enable students to formulate research questions, search scholarly sources, draft full research proposals using proper citation styles, and practice ethical writing (avoiding plagiarism). ➢ To enable students to design engaging visuals and posters, use tools like PowerPoint, LaTeX Beamer, Adobe, and CorelDRAW, and deliver confident oral presentations with effective audience engagement and Q&A handling.					

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Detailed Syllabus

BTH-87T-753 Scientific Writing and Presentation

UNIT-I

Scientific Writing & Digital Tools: **Scientific Writing Fundamentals**: Introduction to clear, concise scientific English; structuring paragraphs and writing short assignments; efficient note-taking strategies. **Common Writing Pitfalls**: Identifying and avoiding errors—grammar, punctuation, syntax, clarity; self-editing and revision techniques. **Digital Editing & Data Handling**: Mastering editing tools in Microsoft Word and Office; accurate data entry and spreadsheet management using Excel (basic formulas, formatting, tables). **Professional Correspondence**: Crafting formal and informal letters; formatting memos, agendas, meeting minutes, notices, and circulars using standard formats.

15 Lectures

UNIT-II

Report Writing & Professional Documents: **Report Writing Essentials**: Purpose, scope, and structural principles of technical reports. **Project & Internship Reports**: Writing structured, coherent project reports and summer internship reports for academic and industry settings. **Professional Communication Materials**: Designing clear and effective emails, brochures, and leaflets; adapting style and tone for diverse professional audiences.

15 Lectures

UNIT-III

Research Proposals & Ethical Writing: Research Design Skills**:** Identifying research problems/questions/hypotheses; conducting literature searches; organizing information effectively; exploring digital scholarly tools—e-resources, e-journals, INFLIBNET, Shodhganga. **Research Proposal Drafting**: Writing structured proposals: Title & Abstract, Introduction/Background, Literature Review, Objectives, Methodology, Expected Outcomes, **Research Ethics & Integrity**: plagiarism avoidance, proper attribution, and responsible scientific communication with ethical rigor.

15 Lectures

UNIT-IV

Visual & Oral Presentation Skills: Planning and crafting presentations; principles for effective slide layouts and visual information packaging. **Oral Presentation Techniques**: Structuring and delivering an engaging talk; managing nerves and employing nonverbal communication; engaging the audience; handling Q&A effectively. **Poster & Public Display Skills**: Designing and presenting scientific posters and handouts for conferences and academic events with clarity and professionalism.

15 Lectures

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BTH-87P-754 SCIENTIFIC WRITING AND PRESENTATION–PRACTICAL

1. Write a 150–200-word summary on a given scientific topic with clear, concise English.
2. Listen to a 5-minute audio/video on a scientific topic and prepare effective bullet-point notes.
3. Edit a provided draft (with intentional errors) using track changes in MS Word.
4. Practicals on using spelling and grammar checks, comments, track changes, and styles in MS Word.
5. Enter a small dataset (5–6 columns, 10 rows), perform formatting, use basic formulas (SUM, AVERAGE), and create a simple table.
6. Draft a formal leave application, an informal email to a friend, and a thank-you email using clear formatting.
7. Prepare a memo and a notice for a departmental meeting using standard formats.
8. Prepare the structure of a technical report (Title, Abstract, Introduction, Methods, Results, Conclusion).
9. Write a one-page project report on a lab experiment conducted during the semester.
10. Prepare a template for a summer internship report with proper headings and subheadings.
11. Write a professional email requesting a lab visit appointment with appropriate tone and structure.
12. Design a one-page brochure for a lab workshop or departmental event using MS Word/Canva.
13. Search for 2–3 articles using INFLIBNET/Shodhganga/Google Scholar and prepare a reference note.
14. Draft a one-page mini-research proposal with Title, Objectives, Methodology, and Expected Outcomes.
15. Check a provided text for plagiarism using a free tool and write steps to avoid plagiarism in writing.
16. Prepare a 5-slide scientific presentation using effective slide layouts and concise bullet points.
17. Design an academic poster on a given topic using PowerPoint/Canva.
18. Create a bar graph and a table in Excel and insert them into a Word document.
19. Design a simple infographic explaining a scientific process using Canva.
20. Deliver a 3-minute oral presentation on a chosen scientific topic.

Suggested Books & Text

1. Steven, Michael. *How to Be a Better Problem Solver*. Kogan Page, New Delhi, 1999
2. Raman, Prakash. *Business Communication*. Oxford University Press.
3. Krishnaswamy, N. *Creative English for Communication*. Macmillan.
4. Ramaswamy, S. *Textbook of Business Communication*. Macmillan.

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5. Withrow, Jean. *Effective Writing*. Cambridge University Press.
6. Coe, Norman, Robin Rycroft, and Pauline Ernest. *Writing Skills: A Problem-Solving Approach for Upper-Intermediate and More Advanced Students*. Cambridge University Press.
7. Mitra, Barun K. *Effective Technical Communication: A Guide for Scientists and Engineers*. Oxford University Press India, 2006.
8. Raman, Meenakshi, and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 4th ed., Oxford University Press India, 2022.
9. Raman, Meenakshi, and Sangeeta Sharma. *Professional Communication*. 3rd ed., Oxford University Press India, 2017.
10. Kalpana, S., and K. Kanimozhi. *Scientific Writing Handbook*. CBS Publishers, 2025.
Parija, Subhash C., and Peush Sahni. *Reporting and Publishing Research in the Biomedical Sciences*. Springer, 2017.
11. Singh, Kalpana, Monisha Banerjee, and Jyotika Rajawat. *A Concise Guide on Report Writing and Presentation Skills*. IIP Publishers, 2023.
12. Singh, Kalpana. *A Concise Guide to Scientific Writing & Communication*. IIP Publishers, 2024.
13. Sholapurkar, Amar A. *Publish and Flourish: A Practical Guide for Effective Scientific Writing*. Jaypee Brothers, 2021.
14. Becker, Lucinda, and Pam Denicolo. *Presenting Your Research: Conferences, Symposia, Poster Presentations and Beyond*. SAGE Publications, 2013.
15. Hull, Charles L. H. *How to Give a Great Talk*. arXiv, 2020.

Course Learning Outcomes:

At the end of this unit, students will be able to:

1. Compose clear, grammatically correct English tailored to scientific content, including well-structured paragraphs and effective note-taking.
2. Identify and correct common writing errors, revising drafts toward concision and precision.
3. Draft professional correspondence (letters, memos, agendas, minutes, notices, circulars) using appropriate formats and tone.
4. Plan and structure formal scientific reports, understanding their purpose and audience.
5. Write detailed project and internship reports, organizing content logically and formatting consistently.
6. Create effective emails, brochures, and leaflets, with clarity and purpose relevant to scientific and professional contexts.
7. Define a research problem, formulate research questions or hypotheses, and conduct focused literature searches.
8. Apply ethical principles in scientific communication, recognize plagiarism risks, and correctly attribute sources and intellectual contributions.
9. Plan, design, and deliver compelling oral presentations, structuring content for clarity, managing nerves, and engaging audiences.
10. Design scientific visuals (figures, tables, infographics, posters) using tools like PowerPoint

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and LaTeX Beamer, ensuring clarity and data integrity.

11. Use nonverbal communication effectively and respond to audience questions confidently during Q&A sessions.

BTH-87T-755 Food and Dairy Technology

Semester	Code of the Course	Title of the Course/Paper				NHEQ F Level	Credits
VII	BTH-87T-755	FOOD AND DAIRY TECHNOLOGY				8	4
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
Advanced	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		**Knowledge of the Intermediate level**					
Course Objectives		➢ To provide comprehensive knowledge of food processing, emphasizing the nutritive value and perishability of food products. ➢ To impart understanding of key unit operations and principles in dairy processing and dairy engineering. ➢ To explore the role of microorganisms in food production, processing, and preservation, including their use in fermented foods and beverages. ➢ To apply enzymatic and technological methods for enhancing food quality and shelf-life through post-harvest preservation. ➢ To explain milk composition, microbial quality control, and the impact of processing techniques like pasteurization and homogenization on dairy products. ➢ To develop practical knowledge of milk processing operations, plant sanitation, refrigeration, and equipment used in dairy technology.					

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Detailed Syllabus
BTH-87T-755 FOOD AND DAIRY TECHNOLOGY

Unit-I

Microbial role in food process: Production of single-cell protein and new protein foods: Mushroom, food yeast, and algal protein. Fermentation as a method for food preparation and preservation. Food additives: colours, flavours, and vitamins. Organisms and their use for the Production of Fermented Food and Beverages: Pickles, alcoholic beverages, cheese, sauerkraut, idli, and vinegar.

15 Lectures

Unit-II

Deoxygenating and desugaring by glucose oxidase, Beer Mashing & Chill Proofing, Cheese making by protease, Enzyme applications in food processing, Classification of Fruit Juice. Post-Harvest Technology and the process of food Preservation.

15 Lectures

Unit-III

Fundamentals of Dairy Science: Milk: Definition and Composition, Chemical & Functional Properties of milk components: Physicochemical properties of milk protein, aggregation of Casein micelles, factors affecting milk composition, milk secretion and lactation

Microorganism: Importance in dairy science and technology, Microbial Spoilage of Milk, Hydrolytic Rancidity of milk and milk products, Autoxidation of milk fats and effects on milk quality

15 Lectures

Unit-IV

Milk processing operation: Pasteurization: Homogenization, Sterilization. Effects of processing on milk components & their functional properties. Types of milk, Adulteration of milk.

Dairy Engineering: Cleaning & Sanitation: Cleaning agents, CIP & COP. Sanitary milk pump & fittings, Boiler: Properties of steam, steam generation, types of boilers. Refrigeration: Vapor compression refrigeration cycle, common refrigerants, and properties of good refrigerants. Dairy Plant layout, Types of cold storage.

15 Lectures

BTH-87P-756 FOOD AND DAIRY TECHNOLOGY–PRACTICAL

1. Parameters for quality control analysis of milk
2. Production of Sauerkraut
3. Determination of physical characteristics of milk
4. Determination of the chemical properties of milk
5. Determination of the biological characteristics of milk (MBRT test)
6. To detect the number of bacteria in milk by SPC
7. Various methods and tests for adulteration of milk
8. Removal of fat from milk
9. Isolation of proteins from milk

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10. Litmus milk test
11. Production of wine from grape juice
12. Educational tour to the Dairy
13. To study lipid or fat hydrolysis by microbes

Suggested Books & Text

1. Satyanarayana, U. Biotechnology. Elsevier
2. Patel, A.H. Industrial Microbiology. Macmillan India.
3. De, Sukumar. Outlines of Dairy Technology. Oxford University Press, 2014.
4. Singh, R.P. Microbiology. Kalyani Publishers.
5. Singh, B.D. Biotechnology: Expanding Horizons. Kalyani Publisher.
6. Frazier, William C., and Dennis C. Westhoff. Food Microbiology. McGraw-Hill Education, 2014.
7. Jay, James M., Martin J. Loessner, and David A. Golden. Modern Food Microbiology. Springer, 2005.
8. Banwart, George J. Basic Food Microbiology. Springer, 1989.
9. Ranganna, S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw Hill, 1986.
10. Webb, B.H., A.H. Johnson, and J.A. Alford. Fundamentals of Dairy Chemistry. Springer, 1974.
11. De, Sukumar. Outlines of Dairy Technology. Oxford University Press, 2014.
12. Walstra, Pieter, Jan T.M. Wouters, and Tom J. Geurts. Dairy Science and Technology. 2nd ed., CRC Press, 2006.
13. Hui, Y.H., editor. Handbook of Food Science, Technology, and Engineering. CRC Press, 2006.
14. Fox, Patrick F., and Paul L.H. McSweeney. Dairy Chemistry and Biochemistry. Springer, 1998.
15. Joshi, V.K., and A. Pandey. Biotechnology: Food Fermentation (Microbiology, Biochemistry and Technology). Vols. I & II. Educational Publishers & Distributors, 1999.

Course Learning Outcomes:

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

1. Understand the role of microorganisms in producing, processing, and preserving various foods, including fermented products and single-cell proteins.
2. Apply enzymatic and technological methods for food processing and post-harvest preservation to enhance food quality and shelf life.
3. Explain fundamentals of dairy science, including milk composition, properties, and microbial quality control during dairy processing.
4. Demonstrate knowledge of milk processing operations and dairy engineering, including pasteurization, homogenization, sterilization, sanitation, refrigeration, and plant layout.
5. Develop value-added and functional food and dairy products using advanced processing techniques while maintaining nutritional quality and safety.

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Examination Scheme for Semester-VIII

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Scheme of Examination	Duration of Examination	Maximum Marks	Minimum Marks
Theory	BTH-88T-851 ENVIRONMENTAL BIOTECHNOLOGY	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	BTH-88P-852 ENVIRONMENTAL BIOTECHNOLOGY - PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Theory	BTH-88T-853 GENOMICS AND PROTEOMICS	**CA**	01 Hr	20 Marks	08 Marks
		EoSE	03 Hrs	80 Marks	32 Marks
Practical	BTH-88P-854 GENOMICS AND PROTEOMICS - PRACTICAL	**CA**	1 Hr	10 Marks	04 Marks
		EoSE	04 Hrs	40 Marks	16 Marks
Practical	BTH-88P-855 INDUSTRIAL TRAINING AND PROJECT REPORT -PRACTICAL	**CA**	1 Hrs	30 Marks	12 Marks
		EoSE	03 Hrs	120 Marks	48 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

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marks.

***Evaluation of Industrial Training:** The experimental evaluation based on laboratory work will be of a total of 120 marks, distributed as follows:

(A) 100 Marks — Viva Presentation (by External Examiner)

(B) 20 Marks — Evaluation of Dissertation Report (by External Examiner)

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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology 4th YEAR SEM-VIII	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
7.	8	VIII	MJR	UG0804 -BTH-88T-851 ENVIRONMENTAL BIOTECHNOLOGY	4	0	0	4
8.	8	VIII	MJR	UG0804 -BTH-88P-852 ENVIRONMENTAL BIOTECHNOLOGY - PRACTICAL	0	0	2	2
9.	8	VIII	MJR	UG0804 -BTH-88T-853 GENOMICS AND PROTEOMICS	4	0	0	4
10.	8	VIII	MJR	UG0804 -BTH-88P- 854 GENOMICS AND PROTEOMICS - PRACTICAL	0	0	2	2
11.	8	VIII	MJR	UG0804 -BTH-88P-855 INDUSTRIAL TRAINING AND PROJECT REPORT -PRACTICAL	0	0	6	6

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BTH-88T-851 ENVIRONMENTAL BIOTECHNOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQ F Level	Credits
VIII	BTH-88T-851	ENVIRONMENTAL BIOTECHNOLOGY				8	4
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
Advanced	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		Intermediate					
Course Objectives		➢ To understand the components of the environment and major ecological processes. ➢ To introduce the scope and applications of environmental biotechnology in pollution control, waste management, and environmental sustainability. ➢ To study wastewater and industrial effluent treatment techniques ➢ To explore modern biotechnological tools for pollution detection, environmental monitoring, and to understand related laws, policies.					

Detailed Syllabus
BTH-88T-851 ENVIRONMENTAL BIOTECHNOLOGY

Unit-I

Components of the Environment: Hydrosphere, Lithosphere, Atmosphere, Energy transfer in an Ecosystem. **Environmental Biotechnology**: An overview, concept, scope and market, Biological control of air pollution, Bacterial examination of water for potability, Testing of water for physiochemical parameters including BOD & COD, Solid waste: Sources and management (composting, vermicomposting and methane production).

15 Lectures

Unit-II

Waste water: origin, composition and treatment–Physical, chemical and biological treatment of

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waste water. **Aerobic processes**: activated sludge, oxidation ponds, trickling filter towers, and rotating discs. **Anaerobic processes**: anaerobic digesters, anaerobic filters and up-flow sludge blanket reactors. Microbiology and biochemistry of aerobic and anaerobic waste water treatment processes, Treatment of industrial effluents, and removal of heavy metals from waste waters.

15 Lectures

Unit-III

Kinetic models for biological waste treatment, Bioconversion of agricultural and highly organic waste material into utilizable product, Biogas. **Bioremediation**: Introduction of Bioremediation, Types of bioremediation: Natural (attenuation), Ex-situ and In-situ, Bioaugmentation and bio stimulation. **Biodegradation**: Introduction, Microbial basis of Biodegradation, Biodegradation of Xenobiotics, Microbial degradation of pesticides. **15 Lectures**

Unit-IV

Biotechnological methods of pollution detection: General bioassays in pollution monitoring, cell biology in environmental monitoring, molecular biology in environmental monitoring and biosensors in environmental analysis. Environmental Monitoring (Bioindications, Biomarkers, Biosensors). Environment protection act, environmental Laws and Policies. Waste disposal & Management: Microbiological & biochemical aspects of wastewater treatment process, Microbial strain improvement. **15 Lectures**

BTH-88P-852 ENVIRONMENTAL BIOTECHNOLOGY-PRACTICAL

1. Analyze physico-chemical parameters of water and soil samples.
2. Determine BOD, COD, and DO levels in water samples.
3. Measure TDS, suspended solids, pH, and temperature of water.
4. Estimate acidity, alkalinity, and salinity in water samples.
5. Analyze the hardness and free CO_2 content in water.
6. Determine moisture content, organic matter, and biological parameters in soil samples.
7. Perform MPN and SPC methods for microbiological analysis of water.
8. Study microbial mechanisms involved in the biodegradation of pollutants.
9. Visit and report on processes at an industrial wastewater treatment plant.
10. Any other exercise based on the theory syllabus.

Suggested Books & Text

1. Environmental Biotechnology – Indu Shekhar Thakur
2. Environmental Biotechnology – Bimal C. Bhattacharya & Rintu Banerjee
3. Environmental Biotechnology – R. C. Dubey
4. Biological Process Design for Wastewater Treatment – Larry D. Benefield & Clifford W. Randall
5. Wastewater Engineering: Treatment and Reuse – Metcalf & Eddy (Note: Often published under Tchobanoglous, Burton, and Stensel)

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6. Environmental Biotechnology – Allan Scragg

Course Learning Outcomes:

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

1. Understand and explain the basic components of the environment and the principles of energy flow.
2. Apply biotechnological approaches to monitor, manage, and treat environmental pollution, including the biological treatment of air, water, and solid waste.
3. Analyse wastewater composition and treatment processes, including physical, chemical, aerobic, and anaerobic methods, with an understanding of their microbial and biochemical foundations.
4. Evaluate and implement bioremediation and biodegradation techniques for the treatment of pollutants and hazardous compounds using microbial systems.
5. Utilize modern biotechnology tools and legal frameworks for environmental monitoring, biosensor application, and the development of eco-friendly waste management strategies.

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BTH-88T-853 Genomics and Proteomics

Semester	Code of the Course	Title of the Course/Paper				NHEQ F Level	Credits
VIII	BTH-88T-853	GENOMICS AND PROTEOMICS				8	4
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
Advanced	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		Intermediate					
Course Objectives		➢ To understand the organization, structure, and sequencing of genomes in prokaryotes, eukaryotes, and viruses. ➢ To learn various gene identification techniques, genetic mapping tools, and expression analysis methods. ➢ To explore applications of functional genomics and gene editing technologies like CRISPR-Cas9. ➢ To gain knowledge of protein structure, synthesis, and analytical techniques in proteomics.					

Detailed Syllabus

BTH-88T-853 Genomics and Proteomics

Unit-I

Introduction - Organization and structure of genomes (prokaryotic, eukaryotic, viral), concept of gene, genome size, introns & exons, sequence complexity. Genome structure in viruses and prokaryotes. Chromosome isolation, microdissection, and retrofitting. Genes and proteins, types of polymorphisms, genome databases, and gene discovery. DNA extraction and genomic DNA preparation. DNA sequencing methods: Maxam-Gilbert, Sanger, Fluorescence, Shotgun, NGS techniques (overview and principles). **15 Lectures**

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Unit-II

Gene Identification and Expression – Inheritance patterns, mutations, Single Nucleotide Polymorphisms (SNPs), Expressed Sequenced Tags (ESTs), gene-disease links, diagnostic genes, drug targets. Genome projects: *E. coli, Arabidopsis*, rice, Human Genome Project. Genome annotation, gene prediction software, gene function identification, and gene ontology. Comparative & structural genomics. Model systems: *Drosophila*, Yeast, *C. elegans*. Gene expression profiling (traditional and RNA-based), applications in medicine, and gene knockdown.

15 Lectures

Unit-III

Introduction to Proteins – Protein and peptide preparation, Merrifield synthesis, peptides as probes, proteins as drugs. Two-hybrid interaction screens. Mass spectrometry in protein expression analysis. SDS-PAGE, 2D-PAGE, protein cleavage, Edman microsequencing. Automation in proteomics. Proteome mining, linking genomics and proteomics. Applications in drug discovery, toxicology, and the use of phage antibodies. **15 Lectures**

Unit-IV

Analysis of Proteomes – 2D-PAGE: sample preparation, solubilization, reproducibility. Protein detection in gels, image analysis. Mass spectrometry for protein identification: de novo sequencing, correlation-based methods. 2D-electrophoresis with mass spectrometry. Microarray techniques – types, experiment design, disease treatment applications. Genotyping tools – DNA chips, diagnostic assays, and services. **15 Lectures**

BTH-88P-854 GENOMICS AND PROTEOMICS-PRACTICAL

1. Introduction to genome analysis techniques.
2. Linkage analysis and gene mapping problems in *Drosophila*.
3. Linkage and chromosomal mapping problems in *Neurospora*.
4. Exercise based on Pedigree analysis problems in humans.
5. Protein separation using SDS-PAGE.
6. Study of protein sequence databases.
7. Sequence retrieval and alignment methods (demonstration & exercises).
8. Practicals based on theoretical concepts.

Suggested Books & Text

1. S. B. Primrose & R. M. Twyman – *Principles of Genome Analysis and Genomics*, 7th Edition, Blackwell Publishing, 2006.
2. S. Sahai – *Genomics and Proteomics: Functional and Computational Aspects*, Plenum Publishing, 1999.
3. Andrezej K. Konopka & James C. Crabbe – *Compact Handbook of Computational Biology*, Marcel Dekker, USA, 2004.
4. Pennington & Dunn – *Proteomics: From Protein Sequence to Function*, 1st Edition, Academic Press, San Diego, 1996.

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5. Arthur M. Lesk – *Introduction to Genomics*, Oxford University Press, 2007.
6. A.M. Campbell & L. J. Heyer – *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education, 2007.

Course Learning Outcomes:

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

1. Students will be able to explain the structure, organization, and sequencing methods of genomes in prokaryotes, eukaryotes, and viruses.
2. They will develop the ability to identify genes, analyse genetic variations, and apply tools for genetic mapping and genome annotation.
3. Learners will gain insights into functional genomics, and gene expression profiling
4. They will understand protein structure, synthesis, and various techniques used in proteomic analysis, including SDS-PAGE and mass spectrometry.
5. Students will be able to integrate genomic and proteomic knowledge for applications in biomedical research, diagnostics, and drug development.

BTH-88P-855 INDUSTRIAL TRAINING AND PROJECT REPORT

<table>
<tr><th>Semester</th><th>Code of the Course</th><th colspan="4">Title of the Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>VIII</td><td>BTH-88P-855</td><td colspan="4">INDUSTRIAL TRAINING AND PROJECT REPORT- PRACTICAL</td><td>8</td><td>6</td></tr>
<tr><td rowspan="2">Level of Course</td><td rowspan="2">Type of the Course</td><td colspan="3">Credit Distribution</td><td rowspan="2">Offered to NC Student</td><td colspan="2" rowspan="2">Course Delivery Method</td></tr>
<tr><td>Industrial training</td><td>Project report</td><td>Total</td></tr>
<tr><td>Adavnced</td><td>Major</td><td>4</td><td>2</td><td>6</td><td>NO</td><td colspan="2">Industrial Training on a relevant syllabus topic</td></tr>
<tr><td colspan="2">List of Programme Codes in which Offered as Minor Discipline</td><td colspan="6">----------</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="6">Intermediate</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">➢ To provide students with comprehensive exposure to industrial operations and professional environments.
➢ To facilitate the integration of theoretical knowledge with practical industrial applications.
➢ To enhance students' technical proficiency and capacity for analytical problem-solving.</td></tr>
</table>

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	➢ To foster the development of professional competencies, including communication, collaboration, and ethical conduct.

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Report of Industrial Training of 60 days:

As part of the **Industrial Training program**, students are expected to gain practical experience in **industry-oriented, clinical, or production environments**, at recognized industrial/training organizations/company/universities equipped with advanced facilities. The main objective of this training is to enhance students' **employability and technical competence** by exposing them to **real-time industrial processes, workflows, or services**. Students must choose a topic or domain relevant to their field that adds **practical knowledge and skill-based learning**, under the supervision of an assigned **faculty guide or industrial trainer**. They are required to understand operational systems, observe industrial standards, participate in hands-on technical tasks (such as production, quality control, diagnostics, or instrumentation), and document the practical exposure. At the conclusion of training, each student must prepare a well-structured **Industrial Training Report** in **Times New Roman, font size 12**, which should include:

(i) **Title page-** Report title, name of student, name of organisation, duration (start and end dates)
(ii) **Certificate/Declaration-** from training organisation stating that you completed the training.
(iii) Acknowledgement
(iv) Abstract/summary
(v) Table of contents
(vi) **Introduction** – describing the industrial organization, nature of work, and background of the training;
(vii) Organisation Profile: name, background, products/services offered, organisation structure
(viii) Training Details

a) Work description
b) Techniques and procedures learned
c) Observation and Results- with Tables, graphs and photographs
d) Discussion
e) Skill gained and Learning Outcomes
f) Challenges faced and solutions
g) Conclusion
h) References
i) Annexures- if any (Raw data, SOPs etc.)

- The final report should showcase the student's **professional understanding, industrial exposure, and application of academic knowledge to real-world scenarios**, and will serve as an essential academic and career document.

Evaluation of Industrial Training
The experimental evaluation based on laboratory work will be of **120 marks (EOSE)**, distributed as follows:
(A) 100 Marks — Viva Presentation (by External Examiner)

(B) 20 Marks — Evaluation of Training Report (by External Examiner)

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Evaluation Component	INDUSTRIAL TRAINING AND PROJECT REPORT (with proper certification)
Evaluation Method	Appropriate to the material and specific content
Learning Outcome	Students will demonstrate the ability to work at a company or governmental organization

Course Learning Outcomes:

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

1. Students will demonstrate comprehensive proficiency in fundamental and advanced methodologies utilized in biotechnology.
2. Students will exhibit the capability to operate standard and sophisticated laboratory instrumentation, analytical devices, and computational tools in a safe and effective manner.
3. Students will apply independent, analytical, and critical thinking skills in conjunction with the effective utilization of diverse informational and research resources.
4. Students will articulate a thorough understanding of the principles, mechanisms, and interrelationships governing *in vivo* and *in vitro* biochemical, molecular, and genetic processes.

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