University of Rajasthan

Jaipur

SYLLABUS

(UG0804 – Three/Four Year Bachelor of Science)

(Bio-Technology)

Semester I-II
Session 2024-25

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(From the Academic Year 2024-25 onwards)

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

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 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 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 the people from 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 Programme 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 --VI 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**	4	0	0	4

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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology (I --VI SEM)	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
				BIOSTATISTICS				
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
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

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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.
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 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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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	BTH-51T-151 CELL BIOLOGY AND GENETICS	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-51P-152 CELL BIOLOGY AND GENETICS - PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BTH-51T-153 MICROBIOLOGY	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-51P-154 MICROBIOLOGY-PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BTH-51T-155 BIOPROCESS TECHNOLOGY	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-51P-156 BIOPROCESS TECHNOLOGY-PRACTICAL	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

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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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				Bio-Technology 1st YEAR SEM-I	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

BTH-51T-151CELL BIOLOGY AND GENETICS

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	BTH-51T-151	CELL BIOLOGY AND GENETICS				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	

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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 of cells. ➢ To understand functions of organelles in the cell. ➢ To differentiate between plant and animal cells and to analyze different stages of mitosis and meiosis.

Course Outcomes:

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

Cognitive level	Course outcomes
1. Understanding	➢ The functions and structural properties of different cells. ➢ Differentiation between prokaryotic and eukaryotic cells. ➢ learn, understand and develop skill and hands on training in basics of cell biology and genetics.
2. Memorizing	➢ The structural and functional aspects of cellular organelles. ➢ Diagrammatic representation of prokaryotic, plant, and animal cell.
3. Applying	➢ Variations in functions of cell organelles. ➢ Mendel's Law on heredity. ➢ Monohybrid, dihybrid, trihybrid, test and back cross ➢ Concept of cell cycle, abnormalities, cell membrane, cell-cell interactions. ➢ Possibilities of mutations and mutagens. ➢ Concept of C-value paradox.

Detailed Syllabus

BTH-51T-151 CELL BIOLOGY AND GENETICS

UNIT-I

Cell: Typical structure of Prokaryotic and eukaryotic (animal and plant) cells, Diversity of cell size and shape; Cell theory, C-value paradox, Cell Membrane: Chemical components of biological membranes,

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organization and Fluid Mosaic Model. **Structure and Function of Cell organelles:** Cytoskeleton and Extra cellular matrix; Vacuoles and micro bodies: Structure and functions of Ribosomes, Mitochondria, Chloroplasts, Genome and biogenesis of mitochondria and chloroplast; Nucleus: Structure and function, nuclear envelope. **15 Lectures**

UNIT-II

Chromosome organization and cell division: Chromosomes: chromatin and chromosomes organization, euchromatin and heterochromatin, nucleosome model, genes, DNA as genetic material, Chromosome morphology; specialized types of chromosomes (Sex chromosomes, lampbrush Chromosomes, Polytene chromosome). 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

Cell cycle, Cancer and Cell Signaling: Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast and higher organisms; programmed cell death; Cancer – chromosomal disorders, oncogenes and tumor suppressor genes. Introduction to cell signalling and cell –cell interaction. Sex determination and sex linkage: Mechanism of sex determination, environmental factors and sex determination, sex differentiation, barr bodies, dosage compensation, genetic balance theory. **15 Lectures**

UNIT-IV

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 (different types of leaves in *Mirabilis jalapa*); Mitochondrial inheritance (Cytoplasmic male sterility in plants). **Evolution and Population genetics:** Hardy Weinberg law (Prediction, derivation), Allelic and genotype frequencies, changes in allelic frequencies, evolutionary genetics, natural selection. **15 Lectures**

BTH-51P-152 CELL BIOLOGY AND GENETICS-PRACTICAL

1. Study of cell structure from Onion, *Hydrilla* and *Spirogyra*.
2. Study of electron microphotographs of eukaryotic cells for various cell organelles.
3. Study of electron microphotographs of virus, bacteria and eukaryotic cells for comparative study of cellular organization
4. Study of different stages of mitosis and meiosis in root-tip cells and flower buds respectively of onion.
5. Demonstration of sex chromatin in buccal smear
6. Karyotype preparation
7. Preparation of polytene chromosomes from salivary gland of Chironomus larvae.
8. Genetic experiment- Drosophila model
9. To solve genetic problems based upon Mendel's Law of inheritance: Monohybrid, Dihybrid, back cross and test cross
10. Permanent slides /Photographs if different stages of mitosis and meiosis, sex chromosome,

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polytene chromosomes and salivary gland chromosomes.

11. Emasculation, bagging and tagging techniques
12. Any other exercises related to syllabus.

Suggested Readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science.
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: A Molecular Approach** (6th Ed.). Washington: ASM; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York
4. Lodish, H F. 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.
5. Gupta P.K. **Cell and Molecular Biology** 2018. 5th edition Rastogi Publication India.
6. Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis**. Sudbury, MA: Jones and Bartlett.
7. Pandey, B.P. (2022). **Cell Biology and Genetics**. S. Chand publication.
8. Tamarin, R.H. and Leavitt, R. W. (1991). **Principles of Genetics**. Dubuque, IA: Win C Brown.
9. Smith, J.M (1998). **Evolutionary Genetics**. Oxford: Oxford University Press Genetics: Principles and Analysis-Hartl and Jones.
10. Gardner EJ, Simmons MJ, Sunstad DP. **Principle of Genetics**. 8th Edition, John and Wiley and sons.

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. Understand the structure and diversity of prokaryotic and eukaryotic cells, including the cell theory and the C-value paradox.
3. Learn the chemical components and organization of biological membranes, the Fluid Mosaic Model, and the structure and function of various cell organelles.
4. Comprehend chromosome organization, types of chromosomes, structural and numerical chromosomal aberrations, and types of mutations.
5. Gain knowledge of the cell cycle, mitosis and meiosis, control points in cell-cycle progression, programmed cell death, and the basics of cancer biology and cell signaling.
6. Understand mechanisms of sex determination, sex differentiation, and genetic theories such as dosage compensation and genetic balance theory.
7. Understand Mendel's laws of inheritance, including allelic and non-allelic interactions, multiple allelism, and quantitative inheritance.
8. Explore concepts in cytoplasmic inheritance, evolution, population genetics, and the application of Hardy-Weinberg equilibrium in understanding allelic and genotype frequencies.

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BTH-51T-153 MICROBIOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	BTH-51T-153	MICROBIOLOGY				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		➢ Understand the basics of classification, types of microbes and its existence ➢ Understand the requirements of bacteria for its growth and will be able to quantify it by various techniques and methods of controlling it. ➢ Learn the application of microbes in industries and other bioremediation strategies.					

Course Outcomes:

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

Cognitive level	Course outcomes
1. Understanding	➢ Understand the Morphology, cell structure, growth and metabolism of Micro organisms
2. Memorizing	➢ Demonstrate the ubiquity and diversity of microorganisms in the environment. ➢ Differentiate the various types of microorganisms.
3. Applying	➢ Identify the importance of microbes in applied microbiology and biotechnology.

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Detailed Syllabus

BTH-51T-153 MICROBIOLOGY

UNIT-I

An Introduction to microbiology: History of microbiology, concepts of microbial diversity, scope and applications of microbiology. Microbial Diversity, Basic concept of Taxonomy; Prokaryotes types of microorganism; Classification System: Three kingdom Classification, Five Kingdom Classification; Characteristic & Structure of Microbes-Algae, Fungi, Mycoplasma, Virus, Protozoa, Helminthes.
Virus: General characteristics, Nomenclature, classification, structure of TMV, Pox virus and Bacteriophage. Lytic and Lysogenic cycle. **15 Lectures**

UNIT-II

Morphology and Ultra structure of Bacteria: Structure of Cell Wall: Bacterial Cell Wall (Gram Positive Bacteria & Gram Negative Bacteria), Archaebacteria Cell Wall (Gram Positive Bacteria & Gram Negative Bacteria) Plasmid, Chromosome, mesosomes Bacterial Endospore- structure formation and germination, Cillia & Flagella – Structure and Function, Carboxysomes, Microbial Diversity of Nutritional Classification : Heterotrophic, Autotrophic. General characters and multiplication of mollicutes. **15 Lectures**

UNIT-III

Growth of Microbial Population and its genetics: Principles of growth and growth curve Batch culture, Continuous Culture, Effects of Environmental factors on Microbial Growth: pH, Temperature, Radiation & atmosphere, Microbial Metabolism, Pure culture techniques. Gene Transfer in bacteria: Conjugation, Transformation, Transduction **15 Lectures**

UNIT-IV

Applied Microbiology: Economic importance of virus, bacteria, mollicutes and other microbes. Microbes in Wastewater treatment – aerobic and anaerobic digestion; Biogas; bioremediation; leaching of ores by microorganisms. Applications of microbial enzymes in dairy industries, Microbial production of Plastics (PHB, PHA). **15 Lectures**

BTH-51P-154 MICROBIOLOGY-PRACTICAL

1. Laboratory safety and sterilization techniques.
2. Microscopic Methods- Identification of Microorganisms.
3. Preparation of culture media– nutrient broth and nutrient agar.
4. Culturing of microorganisms in broth and in plates (pour plates, streak plates and preservation of bacterial cultures).
5. Staining techniques – simple and Gram staining.

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6. Motility Test- Hanging drop technique.
7. Serial Dilution method and pour plate method.
8. Growth kinetics- Growth curve of Bacteria and Yeast.

Suggested readings:

1. Atlas RM. (1997). **Principles of Microbiology**. 2nd edition. WM.T. Brown Publishers.
2. Madigan MT, and Martinko JM. (2014). **Brock Biology of Micro-organisms**. 14th edition. Parker J. Prentice Hall International, Inc.
3. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). **Microbiology**. 5th edition Tata McGraw Hill.
4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). **General Microbiology**. 5th edition McMillan.
5. Tortora GJ, Funke BR, and Case CL. (2008). **Microbiology**: An Introduction. 9th edition Pearson Education.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). **Prescott's Microbiology**. 9th edition. McGraw Hill Higher Education.
7. Cappucino J and Sherman N. (2010). **Microbiology: A Laboratory Manual**. 9th edition. Pearson Education Limited.
8. **Fundamentals of Microbiology** –Frobisher, Saunders & Toppan Publications.
9. **General Microbiology** –C.B. Powar.
10. Karen C. Carroll, Michael A. Pfaller. **Manual of Clinical Microbiology**, 4 Volume set, 13th edition (2023) ASM Press.
11. Michele S. Swanson, Elizabeth A. Joyee, Rachel E.A. Horak. **Microbe,** 3rd Edition (2022) ASM Press.

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. Acquire skills in several laboratory methods.
3. Understand the history, diversity, scope, and applications of microbiology, including microbial taxonomy and classification systems.
4. Comprehend the morphology and ultrastructure of bacteria.
5. Gain knowledge of microbial growth principles, population dynamics, growth curves, and the effects of environmental factors on microbial metabolism.
6. Learn about gene transfer mechanisms in bacteria such as conjugation, transformation, and transduction, and their implications in microbial genetics and biotechnology.
7. Understand the economic importance of microbes in various fields.

BTH-51T-155 BIOPROCESS TECHNOLOGY

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits

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I	BTH-51T-155	BIOPROCESS TECHNOLOGY				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		➢ Understand the basics of classification, types of microbes and its existence ➢ To understand the basics of traditional and modern industrial fermentation process. ➢ To gain the knowledge about the primary and secondary microbial metabolites ➢ To learn about the production process of pharmaceutically important bioproducts.					

Course Outcomes:

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

Cognitive level	Course outcomes
1. Understanding	➢ Understand the basics of fermentation process which helps to develop new microbial product. ➢ Gain the knowledge about the steps and operations involved in microbial primary metabolites production. ➢ Illustrate the secondary metabolites production with flow-sheeting
2. Memorizing	➢ Acquire knowledge about the industrially relevant microbial strains and processes for production of enzyme, biopolymer and food products
3. Applying	➢ Learn about the use of recombinant technology in pharmaceutically important microbial bioproducts production.

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Detailed Syllabus

BTH-51T-155 BIOPROCESS TECHNOLOGY

UNIT-I

Introduction to Industrial Bioprocess: Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process-traditional and modern Biotechnology. Industrial Fermentation- microorganisms, mode of operation, fermentation processes-pictorial representation. Basic Principle of Biochemical engineering: Isolation, screening and maintenance of industrially important microbes. Microbial growth and death kinetics with reference to industrially useful microorganisms. Strain improvement for increases yield and other desirable characteristics.

15 Lectures

UNIT-II

Concepts of basic mode of fermentation processes: Bioreactor designs and types of fermentation and fermenters. Concepts and basic modes of fermentation- Batch, fed batch and continuous fermentation. Conventional fermentation verses biotransformation. Solid substrate, surface and submerged fermentation. Fermentation economics and fermentation media. Fermenter design- mechanically agitated, pneumatic and hydrodynamic fermenters. Large scale animal and plant cell cultivation and air sterilization**.**

15 Lectures

UNIT -III

Upstream Processing: Media formulation, sterilization, aeration and agitation. Measurement and control of bioprocess parameters, scale up and scale down process. Downstream processing: Bio separation-filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication. Cell disruption-Enzymatic lysis and liquid-liquid extraction, purification by precipitation (ammonium sulphate, solvent), electrophoresis and crystallization. Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques. Reverse osmosis and ultra filtration, Drying crystallization, storage and packaging. Treatment of effluent and its disposal. **15 Lectures**

UNIT-IV

Application of Microbes in Food Processing and Production: Fermented foods and beverages, food s ingredients and additives used in fermentation and their purification. Fermentation in preparing and preserving foods. Microbes and their use in pickling, producing colors and flavors, alcoholic beverages and other products. A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol). **15 Lectures**

BTH-51P-156 BIOPROCESS TECHNOLOGY-PRACTICAL

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1. Isolation of microorganism and screening of industrially important microorganism
2. Study of growth substrate utilization and product formation kinetics in shake flask cultures
3. Cell disruption techniques-Detergent and enzyme
4. Membrane based filtration- Ultrafiltration and micro filtration
5. Centrifugation and sedimentation

Suggested readings:

1. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., **Industrial Biotechnology: Products and Processes**, John Wiley & Sons, 2016.
2. Waites, M.J., Morgan, N.L., Rockey, J.S., Higton, G., **Industrial Microbiology: An Introduction** Blackwell, 2001.
3. Cruger, W., Cruger, A., **A Textbook of Industrial Microbiology**, Panima Publishing Corporation, 2nd Edition, 2005.
4. Pandey, A., Negi, S., Soccol, C.R., **Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products**, Elsevier, 2016.
5. Okafor, N., **Modern Industrial Microbiology and Biotechnology**, CRC Press, 2007.
6. Presscott and Dunn's **Industrial Microbiology**, CBS Publisher, 1987.
7. Casida Jr, L. E., **Industrial Microbiology**, Wiley, 1968.
8. Ashok Pandey, Ranjana Sirohi, Christian Larroche, Mohammad Taherzadeh, **Current Developments in Biotechnology and Bioengineering, Advances in Bioprocess engineering,** 1st edition- august 18, 2022.

Course Learning Outcomes:

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

1. Understand the scope and commercial potential of biotechnology, particularly in the context of India.
2. Gain a historical perspective on industrial fermentation processes, comparing traditional and modern biotechnology.
3. Learn the principles of biochemical engineering, including the isolation, screening, and maintenance of industrially important microbes.
4. Analyze microbial growth and death kinetics and strategies for strain improvement to enhance yield and desirable characteristics.
5. Comprehend various bioreactor designs and types of fermentation processes, including batch, fed-batch, and continuous fermentation.
6. Compare conventional fermentation with biotransformation and understand solid substrate, surface, and submerged fermentation.
7. Explore fermentation economics, media formulation, sterilization, and bioprocess parameter control.

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8. Acquire knowledge of upstream and downstream processing techniques, including bioseparation, cell disruption, and chromatographic methods.
9. Apply microbial technology in food processing and production, understanding the role of microbes in fermentation, preservation, and the production of commercially important organic acids, amino acids, and alcohols.

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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		Maximum Marks		Minimum Marks	
Theory	BTH-52T-251 MOLECULAR BIOLOGY	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-52P-252 MOLECULAR BIOLOGY-PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BTH- 52T-253 BIOINFORMATICS AND BIOSTATISTICS	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-52P-254 BIOINFORMATICS AND BIOSTATISTICS-PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BTH- 52T-255 INSTRUMENTATION AND BIOTECHNIQUES	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-52P-256 INSTRUMENTATION AND BIOTECHNIQUES-PRACTICAL	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.

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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.

UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology 1st YEAR SEM-II	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
1.	5	II	MJR	UG0804 -BTH-52T-251 MOLECULAR BIOLOGY	4	0	0	4
2.	5	II	MJR	UG0804 BTH-52P-252 MOLECULAR BIOLOGY - PRACTICAL	0	0	2	2
3.	5	II	MJR	UG0804 BTH- 52T-253 BIOINFORMATICS AND BIOSTATISTICS	4	0	0	4
4.	5	II	MJR	UG0804 -BTH-52P-254 BIOINFORMATICS AND BIOSTATISTICS -PRACTICAL	0	0	2	2
5.	5	II	MJR	UG0804 -BTH- 52T-255 INSTRUMENTATION AND BIOTECHNIQUES	4	0	0	4
6.	5	II	MJR	UG0804 -BTH-52P-256 INSTRUMENTATION AND BIOTECHNIQUES -PRACTICAL	0	0	2	2

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	BTH-52T-251	MOLECULAR BIOLOGY				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		----------					

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Prerequisites	Biology Courses of Senior Secondary level
Objectives of the Course	➢ To learn and understand the important discoveries that are made in the field of molecular biology. ➢ To learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept. ➢ gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.

Course Outcomes:

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

Cognitive level	Course outcomes
1. Understanding	➢ Learn and understand the important discoveries that are made in the field of molecular biology. ➢ Learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept.
2. Memorizing	➢ Understand molecules involved in cell functioning and their importance.
3. Applying	➢ Acquainted with gene organization and regulation of gene expression and its importance in biology

Detailed Syllabus

BTH- 52T-251 MOLECULAR BIOLOGY

Unit-I

Genes and DNA: Genome, Gene Double helical structure of DNA, DNA supercoiling, Gene structure, Non-coding DNA and RNA. **DNA Replication**: Mechanisms of prokaryotic DNA replication: Initiation, Elongation and Termination; DNA Polymerases, Helicase, other enzymes and accessory proteins involved in DNA replication. Fidelity of replication and coordinating synthesis of the leading and lagging strands, Okazaki fragments. **15 Lectures**

Unit-II

DNA Damage and Repair: Causes of DNA damage and molecular mechanisms of repair, excision repair system in bacteria and eukaryotes, base excision, recombination repair systems and SOS repair.

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Transcription and post transcriptional changes. **15 Lectures**

Unit-III

Transcription: Types of RNA, mRNA structure, prokaryotic and eukaryotic RNA polymerases, transcriptional factors, Promoter sequences, binding sites for RNA polymerases, transcription initiation, elongation, termination, attenuation and antitermination. **15 Lectures**

Unit-IV

Translation: Structure of tRNA, ribosome, genetic code, translation formation of initiation complex, initiation factors and their regulation elongation and elongation factors, aminoacylation of tRNA, aminoacyl tRNA synthetases, and termination in Prokaryotes and eukaryotes. Co and post-translational modifications of proteins. **15 Lectures**

BTH- 52P-252 MOLECULAR BIOLOGY -PRACTICAL

1. Building of a model of B-DNA.
2. Isolation of Plant DNA and its quantification by spectrophotometric method.
3. Separation and visualization of DNA fragments by Agarose gel electrophoresis.
4. Demonstration of SDS-PAGE.
5. Determination of denaturation and renaturation of DNA double helix.
6. Isolation of RNA and quantification by spectrophotometric method.
7. Polymerase chain reaction.
8. Southern blot analysis using a gene specific probe.

Suggested readings:

1. Lewis, B. (2001). **Genes X**, Oxford University Press, New York.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (1999). **Molecular Biology of the cell**. Garland Publishing Inc. New York.
3. Wolfe, S.L. (1993). **Molecular and Cellular Biology**. Wadsworth Publishing Co., California, USA.
4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., And Damell, J. 2000. **Molecular Cell Biology** (4th Edition). W.H. Freeman and Co., New York, USA.
5. Glick, B. R. and Thompson, J.F. (1993). **Methods in Plant Molecular Biology and Biotechnology**, CRC press Boca Raton, Florida.
6. Malacinski, G.M. and Friedfirlder, D. (1998). **Essentials of Molecular Biology** (3rd Edition). Jones and B Artlet Publishers, inc. London.
7. Jordanka Zlatanov. (2023). **Molecular Biology: Structure and Dynamics of Genomes and Proteomes** (2nd Edition).

Course Learning Outcomes:

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

1. Develop sufficient knowledge about the characteristics of the genetic material and structure of DNA and RNA.
2. Recognize DNA organization in chromosomes and molecular mechanism of DNA replication, and transcription.

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3. Understand characteristic and importance of genetic code and molecular mechanism of translation.
4. Understand molecular structure of the gene and regulatory mechanisms for gene expression.
5. Understand the structure, function, and variations in DNA and RNA.
6. Have insights into the various models for chromatin organization.
7. Understand step wise processes of replication, transcription and translation.
8. Develop knowledge and understanding of the operon concept and gene regulation mechanisms.
9. Understand the role of protein and its modification in DNA packaging.
10. Have knowledge about the differentiation of molecular mechanism of replication, transcription and translation.
11. Understand the role of protein/transcriptional factor in gene regulation.
12. Develop acumen about the variation in gene regulation processes.
13. Use scientific methods, and critical thinking skills to ask questions and solve problems.

BTH-52T-253 BIOINFORMATICS AND BIOSTATISTICS

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	BTH-52T-253	BIOINFORMATICS AND BIOSTATISTICS				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	----------						

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Prerequisites	Biology Courses of Senior Secondary level
Objectives of the Course	➢ The aim of this module to provide practical training in bioinformatics including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages

Course Outcomes:

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

Cognitive level	Course outcomes
1. Understanding	➢ Various resources or tools available for bioinformatics. ➢ Sequence similarity and alignment using the bioinformatics tools. ➢ The principal concepts about biostatistics. ➢ Compute statistical problems using computer and graphical means. ➢ Solve mean and variance of discrete and continuous distribution.
2. Memorizing	➢ Sequence alignment for various molecules and phylogenetic analysis.
3. Applying	➢ The students will be knowing the diagnostic procedures and collection and processing of specimen. ➢ Appraise statistical test, t distribution and the standard error formulas.

Detailed Syllabus

BTH-52T-253 BIOINFORMATICS AND BIOSTATISTICS

UNIT-I

Concept of Bioinformatics: Introduction and future prospects; Applications in genomics and proteomics; Public databases; Gene bank: Database searches; sequence retrieval systems; similarity searching; BLAST, FASTA; Multiple sequence alignment: database and online tools: Biological databases: Types and applications; Sequence databases: GenBank, EMBL, DDBJ, PIR-PSD, SWISS PORT; Structure Databases: PDB, SCOP, NDB; Derived Databases:- PROSITE, PRINTS, TIGR **15 Lectures**

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UNIT-II

Applications of Bioinformatics, Computational methods for sequence analysis: Dot Blot and dynamic programming methods; Phylogenetic analysis; Virtual and electronic cell, Internet tools for DNA sequence translation; Restriction enzyme mapping; Prediction of secondary structure of proteins; Applications tools-Primer designing, molecular mapping and concept and tools of computer aided drug designing

15 Lectures

UNIT-III

Fundamentals of statistics: Scope of statistics for biological research, types of Data, Arithmetic mean, median, mode: theory and simple numerical problems; Measures of variation: Standard deviation, Variance, coefficient of variation; Correlation, types and methods: simple, multiple, linear and nonlinear correlation, Regression: Linear and curvilinear regression (for two variable X and Y only). **15 Lectures**

UNIT-IV

Tests of significance: Null hypothesis; Standard Error, Level of Significance; Degrees of freedom; Significance of mean for large samples; significance of means for small samples (Student t-test); significance in ratio of two samples; F test (for difference between variance of two samples); Chi square test; Analysis of variance test (ANOVA) for one and two way classification. Laws of probability, theorem of total probability **15 Lectures**

BTH-52P-254 BIOINFORMATICS AND BIOSTATISTICS -PRACTICAL

1. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, uniport, PDB etc.
2. Sequence retrieval using BLAST.
3. Sequence alignment.
4. Protein structure prediction.
5. Prediction of different features of a functional gene.
6. Determination of statistical averages/central tendencies.
    a) Arithmetic mean b) Median c) Mode
7. Determination of measures of Dispersion a) Mean Deviation b) Standard deviation and coefficient of variation c) Quartile deviation
8. Tests of significance-Application of following a) Chi square test b) T-test c) Standard error
9. To learn graphical representation of statistical data with the help of computers (e.g. MS Excel)

Suggested readings:

1. **Introduction to Bioinformatics**, Arthur M. Lesk, Oxford University press.
2. **Introduction to Bioinformatics**, Attawood, Pearson Education.
3. **A textbook of systems biology**, E. Klipp, W. Leibermeister, C. Wieriling, Axel Kowals, H., Lehrach, R. Herwig (2009), Wiley VCH GmbH.
4. **Bioinformatics: Sequence and Genome analysis**, David. W. Mount (2001), Cold Spring House

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Laboratory press.
5. **Plant System biology**, Coruzzi, G.M. (2009) Wiley Publishing House.
6. **Bioinformatics- A Practical guide to the analysis of genes and Proteins**, 2nd Edition by Baxevanis.
7. **Practical Statistics for Experimental Biologist**, Wardlaw, A.C. (1985).
8. **Statistical methods in Biology**, Bailey (2000), N.T.J English Univ Press.
9. **Biostatistics**, 7th Edition by Daniel and Fundamental of biostatistics by Khan.
10. **Introduction to biostatistics**, Le and chap (2009), Wiley and sons.
11. **New frontiers of Biostatistics and bioinformatics** (ICSA Book Series in statistics), 1st Edition 2018, springer.

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

1. Gain an understanding of the concepts and future prospects of bioinformatics, along with its applications in genomics and proteomics.
2. Learn to navigate and utilize public biological databases, including sequence and structure databases like GenBank, EMBL, DDBJ, PIR-PSD, SWISS PORT, PDB, SCOP, NDB, PROSITE, PRINTS, and TIGR.
3. Develop skills in computational methods for sequence analysis, such as Dot Blot and dynamic programming methods, and understand phylogenetic analysis and virtual electronic cell concepts.
4. Utilize internet tools for DNA sequence translation, restriction enzyme mapping, and protein secondary structure prediction, and gain proficiency in application tools for primer designing, molecular mapping, and computer-aided drug design.
5. Understand and apply fundamental statistical concepts to biological research, including measures of central tendency (mean, median, mode), variation (standard deviation, variance, coefficient of variation), and correlation and regression analysis.
6. Master various tests of significance, including t-tests, F-tests, Chi-square tests, and ANOVA, and apply the laws and theorems of probability to biological data analysis.

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BTH- 52T-255 INSTRUMENTATION AND BIOTECHNIQUES

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	BTH- 52T-255	INSTRUMENTATION AND BIOTECHNIQUES				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		➢ The objective of the course is to introduce various techniques to the students, which are used in biological research as well as to provide them with an understanding of the underlying principles of these techniques and experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject and better execution of these techniques.					

Course Outcomes:

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

Cognitive level	Course outcomes
1. Understanding	➢ Various spectroscopic techniques and their application ➢ Define various principles and applications of various chromatography, electrophoresis and of centrifuge techniques. ➢ The principle of various microscopy
2. Memorizing	➢ Define various principles of various techniques

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3. Applying	➢ Define various applications of various techniques

Detailed Syllabus

BTH- 52T-255 INSTRUMENTATION AND BIOTECHNIQUES

UNIT-I

Buffers- Preparation and principle of pH meter

Microscopy – Principle and application of Dissecting and compound Microscope, phase contrast, Fluorescence and Electron microscopy (SEM and TEM)

Spectroscopy: basic principle, instrumentation, application, UV visible spectrophotometer

IR & Raman spectroscopy – Basic principle, theory and qualitative interpretation of I.R. spectra, quantitative methods **15 Lectures**

UNIT-II

Fluorescence spectroscopy- Principle, Instrument Design, Methods & Applications

Centrifugation & Ultracentrifugation-Basic principles, Forces involved, RCF Centrifugation, techniques-principal, types and applications.

Chromatography-Basic Concepts of Adsorption & Partition Chromatography; TLC, Paper, GC, GLC, HPLC, Ion exchange. **15 Lectures**

UNIT-III

Electrophoresis: Principle, Electrophoretic mobility (EPM) estimation, factors affecting EPM, Instrument design & set-up, Methodology & Applications of Free & Zone (Paper, Cellulose acetate, Agarose& Starch gel, Pulse-field, PAGE, SDS-PAGE, Capillary) Applications isoelectric focusing, 2D electrophoresis **15 Lectures**

UNIT-IV

General biophysical methods-Measurement of pH, Radioactive labelling and counting, Autoradiography, X ray crystallography- X Ray diffraction, Bragg equation, Reciprocal lattice, Miller indices and unit cell, concept of different crystal structure, determination of crystal structure (Concept of rotating crystal method, powder method) **15 Lectures**

BTH-52P-256 INSTRUMENTATION AND BIOTECHNIQUES - PRACTICAL

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1. pH Meter- Standardization of pH meter.
2. Preparation of buffers.
3. Verification of Beer Lambert law using UV-Visible spectrophotometer.
4. Principle of TLC and Paper chromatography.
5. Column chromatography for protein /pigment.
6. Microscopy- compound Light microscope: principle, parts and functions.
7. Sterilization: principles and operations autoclave, Hot air oven, filtration, laminar air flow.
8. Principles and operations of Incubators & shakers.
9. Principles and operations of centrifuge.

Suggested readings:

1. **Biochemistry**-J. L. Jain
2. **Instrumental methods of chemical Analysis**- Chaitwal and Anand
3. **Biochemistry and Molecular Biology**-Wilson and Walker
5. **Biophysical Chemistry, Part II: Techniques for the study of biological structure and function**- Cantor & Schimmel
4. **The tools of Biochemistry**- Terrance G. Cooper
5. **Bioinstrumentation** - Veerakumari
6. **Biological Instrumentation and methodology** – Dr P K Bajpai
7. **Tools and techniques of biotechnology** – Mousumi Debnath
8. **Instrumental method of analysis in biotechnology** – Dinesh Kumar Chatanta
9. **Introduction to Instrumentation in Life sciences**-Prakash Singh Bisen, Anjana Sharma

Course Learning Outcomes:

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

1. Understand the principles and applications of buffers in maintaining pH stability and the operational principles of pH meters.
2. Comprehend the principles and applications of various microscopy techniques including dissecting, compound, phase contrast, fluorescence, and electron microscopy (SEM and TEM).
3. Gain knowledge of spectroscopic techniques including UV-visible spectrophotometry, IR spectroscopy, and Raman spectroscopy, focusing on their basic principles, instrumentation, and qualitative/quantitative applications.
4. Learn about fluorescence spectroscopy, centrifugation principles, types, and applications, and the basic concepts and techniques of chromatography (TLC, GC, HPLC, etc.).
5. Understand the principles and methodologies of electrophoresis, including various types (PAGE, SDS-PAGE, etc.), isoelectric focusing, 2D electrophoresis, and their applications in biotechnology.

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6. Explore general biophysical methods such as radioactive labelling, autoradiography, and X-ray crystallography, including the concepts of X-ray diffraction, Bragg's equation, crystal structures, and methods for structure determination.

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