NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(An Autonomous Institute)

Affiliated to

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, UTTAR PRADESH LUCKNOW

Evaluation Scheme & Syllabus

For

B.Tech in Biotechnology (BT)

Second Year

(Effective from the Session: 2026-27)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute)

B. TECH (BT)
Evaluation Scheme
SEMESTER III

S. No.	Subject Code	Subject	Types of Subjects	Periods			Evaluation Schemes			End Semester			Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	CCSCC301	Employability Skill Development-I	Mandatory	2	0	0	60	40	100				100	2
2	CASL0301	Technical Communications	Mandatory	2	0	0	30	20	50		50		100	2
3	CBT0303	Genetics and Molecular Biology	Mandatory	2	0	0	30	20	50		50		100	2
4	CBT0304	Microbiology	Mandatory	3	0	0	30	20	50		100		150	3
5	CBT0302	Biochemistry	Mandatory	2	0	0	30	20	50		50		100	2
6	CBT0301	Analytical Techniques	Mandatory	3	0	0	30	20	50		100		150	3
7	CBT0353	Genetics and Molecular Biology Lab	Mandatory	0	0	4				50		50	100	2
8	CBT0354	Microbiology and Biochemistry Lab	Mandatory	0	0	4				50		50	100	2
9	CBT0351	Analytical Techniques Lab	Mandatory	0	0	2				25		25	50	1
10	CBT0355	Bioinformatics	Mandatory	0	0	6				50		100	150	3
11	CBT0359	Internship-I	Mandatory	0	0	2				50			50	1
12	CNC0301/ CNC0302	Artificial Intelligence and Cyber Ethics / Environmental Science	Compulsory Audit	2	0	0	30	20	50				50	NA
13		MOOCs (For B.Tech. Hons. Degree)	*MOOCs											
		TOTAL		**16**	**0**	**18**	**210**	**140**	**350**	**225**	**350**	**225**	**1150**	**23**

*** List of MOOCs (NPTEL) Based Recommended Courses for Second year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	CMC0028	Probability and Statistics using Python	Infosys Wingspan (Infosys Springboard)	16h	1
2.	CMC0045	Prompt Engineering for Developers	Infosys Wingspan (Infosys Springboard)	7 h 25 min	0.5

PLEASE NOTE:

A 3-4 weeks Internship shall be conducted during summer break after semester-II and will be assessed during semester-III

Compulsory Audit (CA) Courses (Non-Credit - CNC0301/CNC0302)

- ➢ All Compulsory Audit Courses (a qualifying exam) do not require any credit.
- ➢ The total and obtained marks are not added in the grand total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam.
CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit,
MOOCs: Massive Open Online Courses.

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA

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B. TECH (BT)
Evaluation Scheme
SEMESTER IV

Sl. No.	Subject Codes	Subject Name	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	CASCC0401	Employability Skill Development – II	Mandatory	2	0	0	60	40	100				100	2
2	CBT0402	Fermentation Engineering	Mandatory	2	0	0	30	20	50		50		100	2
3	CBT0403	Immunology and Immunotechnology	Mandatory	3	0	0	30	20	50		100		150	3
4	CBT0404	r-DNA Technology	Mandatory	3	0	0	30	20	50		100		150	3
5		Departmental Elective I	Departmental Elective	3	0	0	30	20	50		100		150	3
6	CBT0401	Biophysics and Bioinstrumentation	Mandatory	3	1	0	30	20	50		100		150	4
7	CBT0452	Fermentation Engineering Lab	Mandatory	0	0	4				50		50	100	2
8	CBT0453	Immunology and Immunotechnology Lab	Mandatory	0	0	2				25		25	50	1
9	CBT0455	Structural Bioinformatics	Mandatory	0	0	6				50		100	150	3
10	CBT0459	Mini Project	Mandatory	0	0	2				50			50	1
11	CCSCC0452	Problem Solving Approaches	Mandatory	0	0	2				50			50	1
12	CNC0402/ CNC0401	Environmental Science / Artificial Intelligence and Cyber Ethics	Compulsory Audit	2	0	0	30	20	50				50	NA
		MOOCs (For B.Tech. Hons. Degree)	*MOOCs											
		TOTAL		**18**	**1**	**16**	**210**	**140**	**350**	**225**	**450**	**175**	**1200**	**25**

*** List of MOOCs (NPTEL) Based Recommended Courses for Second year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	CMC0073	Financial Modelling - Biotech Company	IIHT	20h 18 min	1.5
2.	CMC0074	Introduction to AI & ML	Infosys Wingspan (Infosys Springboard)	64 h 13 min	4

PLEASE NOTE:
A 3-4 weeks Internship shall be conducted during summer break after semester-II and will be assessed during semester-III
Compulsory Audit (CA) Courses (Non-Credit - **CNC0402/CNC0401**)

- ➢ All Compulsory Audit Courses (a qualifying exam) do not require any credit.
- ➢ The total and obtained marks are not added in the grand total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam.
CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit,
MOOCs: Massive Open Online Courses.

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List of Department Elective (if any):-

S. No.	Subject Code	Subject Name	Types of subjects	Bucket Name	Semester
1	CBT0411	Biosimilar Technology	Departmental Elective I	Bioprocess	IV
2	CBT0413	System Biology	Departmental Elective I	Computational	IV
3	CBT0412	Environmental Biotechnology	Departmental Elective I	Environmental	IV

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
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AICTE Guidelines in Model Curriculum:

A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as Infosys Springboard/NASSCOM/CISCO (as applicable) certifications, or any other online courses recommended by the Institute (Equivalent to 20 credits). During Complete B.Tech. Program Guidelines for credit calculations are as follows.

1. For 6 to 12 Hours =0.5 Credit
2. For 13 to18 =1 Credit
3. For 19 to 24 =1.5 Credit
4. For 25 to 30 =2 Credit
5. For 31 to 35 =2.5 Credit
6. For 36 to 41 =3 Credit
7. For 42 to 47 =3.5 Credit
8. For 48 and above =4 Credit

For registration to MOOCs Courses, the students shall follow Infosys Springboard/NASSCOM/CISCO (as applicable) registration details as per the assigned login and password by the Institute these courses may be cleared during the B. Tech degree program (as per the list provided). After successful completion of these MOOCs courses, the students shall provide their successful completion status/certificates to the Controller of Examination (COE) of the Institute through their coordinators/Mentors only.

The students shall be awarded Honours Degree as per following criterion.

i. If he / she secures 7.50 as above CGPA.
ii. Passed each subject of that degree program in the single attempt without any grace.
iii. Successful completion of MOOCs based 20 credits

Course Code: CASL0301	Course Name: Technical Communication	L	T	P	C
Course Offered in: CSE/CSE (R)/ IT/ CSE(Twin) /IT(Twin)/CSE(Prof)/IT(Prof)/M. Tech (Int.)/ME/BT/EC		2	0	0	2

Prerequisite: Intermediate level (CEFR) and above

Course Objectives:

1. Demonstrate effective verbal and non-verbal communication skills in diverse professional settings, including meetings, presentations, and interpersonal interactions.
2. Develop and apply clear, concise, and audience-appropriate written communication, such as emails, letters, memos, resume', using correct grammar, tone, and format.
3. Adapt communication style based on cultural, organizational, and situational contexts to foster inclusive and respectful professional relationships.
4. Employ digital communication tools and platforms (e.g., video conferencing, business messaging apps) responsibly and effectively in remote or hybrid work environments.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Comprehend the principles and functions of technical communication.	K2
CO2	Write for specific audience and purpose to fulfil the provided brief.	K3
CO3	Recognize and produce different kinds of technical documents.	K3
CO4	Apply effective speaking skills to efficiently carry out official discourses.	K3
CO5	Demonstrate their understanding of communication through digital media.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	1	2	3	1	1			
CO2	1	1	1	1	1	1	1	2	3	1	1			
CO3	1	1	1	1	1	1	1	2	3	1	1			
CO4	1	1	1	1	1	1	1	2	3	1	1			
CO5	1	1	1	1	1	1	1	2	3	1	1			

Course Contents / Syllabus

Module 1	**Introduction to Technical Communication**	**4 Hrs**
Module 1.1: Technical Communication Definition, Process, Types, Levels, and Flow Module 1.2: Barriers to Communication Emphasis on gender neutral language and cultural sensitivity Module 1.3: Significance of audience in technical communication Audience analysis – interests, background, requirements, current knowledge level		
Module 2	**Technical Writing 1**	**5 Hrs**
Module 2.1: Technical Writing Skill Characteristics, examples Module 2.2: Business Letters and Emails Content organization, tone, and intent Module 2.3: Agenda and Minutes of a Meeting (MoM) Preparing agenda for a meeting and the minutes; formats; examples		
Module 3	**Technical Writing 2**	**5 Hrs**
Module 3.1: Job Application & Resume Preparing effective job applications and Resumes; writing, objectives; brief profiles Module 3.2: Report, Proposal & technical Paper Writing Abstracts Introductions & Conclusions; important parts; and formats Module 3.3: Ethical Writing Copy Editing, Referencing and Plagiarism		
Module 4	**Public Speaking**	**6 Hrs**
Module 4.1: Components of effective speaking Simplicity, order, balance in arranging ideas. Importance of KOPPACT Module 4.2: Appearing for a job interview FAQs; Telephonic & Online Interviews		
Module 5	**Virtual/Remote Communication**	**4 Hrs**
Module 5.1: Remote Work Online platforms; Video conferencing Greedy Methods with Examples Such as Activity Selection, Task Scheduling, Fractional Knapsack Problem. Module 2: Virtual Etiquette Professional email ids; usernames Module 3: Creating Blogs & Vlogs Online content, sources		
	Total ours	**24 Hrs**

Textbook:

S.No	Book Title with publication agency & year	Author
1	**Technical Communication – Principles and Practices, 4th Edition by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2022, New Delhi.**	

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Technical Communication, 15th Edition by John M. Lannon & Laura J. Gurak, Pearson, 2021.	
2	Spoken English- A Manual of Speech and Phonetics (5th Edition) by R K Bansal & J B Harrison, Orient Blackswan, 2024, New Delhi.	
3	Business Correspondence and Report Writing by Prof. R C Sharma, Krishna Mohan, and Virendra Singh Nirban (6th Edition), Tata McGraw Hill & Co. Ltd., 2020, New Delhi.	
4	Technical Communication in Virtual Exchange by Francesca Helm, Cambridge Univ. Press, 2024.	
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	https://onlinecourses.nptel.ac.in/noc24_ge37/preview https://archive.nptel.ac.in/courses/109/106/109106094/ https://www.youtube.com/watch?v=kOJlwMJxEG0&t=8s https://www.youtube.com/watch?v=Sg7Q_dC_fWU&list=PLPuC5CMHiqmuzq_KQ4aw0V9Q7xJY6aezb https://www.youtube.com/watch?v=ymLFJDpjgCk&list=PLPuC5CMHiqmuzq_KQ4aw0V9Q7xJY6aezb&index=6	
Web References		

Course Code: CBT0303	Course Name: Genetics and Molecular Biology	L	T	P	C
Course Offered in: Department of Biotechnology		2	0	0	2

Prerequisite: Basics of Biology. .

Course Objective: To provide knowledge of fundamental genetics, molecular biological processes, gene regulation, and modern molecular techniques with applications in diagnostics and research.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain principles of inheritance, gene interactions, and population genetics.	K2
CO2	Explain chromosome structure, mutations, and genetic analysis techniques.	K2
CO3	Apply concepts of gene expression and PCR in diagnostic and research applications.	K3
CO4	Analyze mechanisms of gene regulation and methylation in disease diagnosis.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2		3	3	2		3	3	3	2	3
CO2	3	3	2	2	3	3	3	2	1	3	3	3	2	3
CO3	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO4	3	3	2	3	3	3	3	2	2	3	3	3	2	3

Course Contents / Syllabus

Unit 1	**Qualitative and Quantitative Genetics**	**8 Hrs**

Fundamental principles of genetics, chi square test, gene interaction, multiple alleles, sex determination, sex linked inheritance, sex limited and sex, influenced inheritance, extra-chromosomal inheritance, Linkage, crossing over, recombination, gene mapping, two-point, three-point test crosses. Introduction to quantitative genetics, genotypic & allelic frequencies, calculating genotypic and allelic frequencies, Hardy-Weinberg equilibrium.

Unit 2	**Chromosomes and Mutations**	**7 Hrs**

Chromosomes structures and functions, karyotyping, chromosomal microarray analysis, fluorescence in situ hybridization (FISH), chromosomal disorders. Mutation, Types of mutations, Techniques to detect mutations, DNA repair mechanism.

Unit 3	**Genetic material, DNA Replication, Transcription and Translation**	**8 Hrs**

Nucleic acids: structure of DNA, RNA, and Proteins, experiments related to discovery of nucleic acids, DNA Replication in prokaryotes and eukaryotes, PCR amplification of DNA, Transcription in prokaryotes and eukaryotes, Genetic code: Brief account, RNA processing, Translation in prokaryotes and eukaryotes.		
Unit 4	**Gene Expression and Gene regulation**	**7 Hrs**
Gene regulation, attenuation, post-transcriptional regulation; Eukaryotic transcription factors, enhancers, silencers, insulators, Post-translational modifications and protein stability. Epigenetics and methylation assays in disease diagnostics.		
	Total h	**30 Hrs**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Molecular Biology, latest edition, Elsevier	U. Satyanarayana
2	Genetics, latest edition S. Chand Publishing	P.S. Verma and V.K. Agarwal
3	Molecular Biology of the Cell 7th ed. 2022, New York: Garland Science.	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walte

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Molecular Cell Biology, 8th ed. 2016	Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon and Kelsey C. Martin
2	Genetics a conceptual approach, 6th ed. 2017 WH freeman and, company, New York. Publisher	Benjamin A. Pierce
3	Principles of Genetics, 7th ed. 2018	D. Peter Snustad, Michael J. Simmons
4	Cell and Molecular Biology-Concepts and Experiments 8th ed. 2015 : John Wiley.	Gerald Karp et al.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013842537987334144168 91_shared/overview	6 hours 26 mins
	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013366416183664640247/overview	9 hours
	https://infyspringboard.onwingspan.com/web/en/app/t	12 hours

	oc/lex_auth_013361338918821888105/overview https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013366389213388800244/overview	36 hours
Video Lectures		
Web References		

Course Code: CBT0304	Course Name: Microbiology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Prerequisite: Basics of Biology..

Course Objective: To provide fundamental knowledge of microbiology, including microbial structure, function, diversity, and their role in environment and human health, along with practical skills in microbial isolation and cultivation.

Course Outcome: After completion of the course, the student will be able to		Bloom's Level
CO1	Define the science of microbiology, its development, and importance in human welfare.	K2
CO2	Discuss some of the general methods used in the study of microorganisms.	K2
CO3	Understand the nutritional and physical importance of autotrophs, heterotrophs and chemotrophs	K2
CO4	Recognize and compare the structure and function of microbes and factors affecting microbial growth.	K2
CO5	Apply the knowledge of microorganisms in environmental, industrial and healthcare applications.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	2	2	2	-	2	3	3	–	2
CO2	3	3	2	2	3	–	–	–	1	2	–	3	3	2
CO3	3	2	–	–	–	2	2	–	–	1	–	3	–	2
CO4	3	2	2	2	2	–	1	–	1	2	2	3	2	2
CO5	3	2	2	2	2	3	3	2	1	2	3	3	3	3

Course Contents / Syllabus

Unit 1	History and scope of microbiology	10 Hrs

Introduction to microbiology: history and scope of microbiology, major contribution and events in microbiology. Classification and identification of microorganisms. Prokaryotes and eukaryotes, bacterial diversity

Unit 2	Morphology and fine structure of microorganisms:	9 Hrs

Morphology features, bacterial cell structures, Gram positive and Gram-negative bacteria, characteristics of cellular (bacteria, fungi, algae, protozoa) and acellular (viruses) organisms, Identification of microorganisms on the basis of colony morphology.		
Unit 3	**Microbial requirements**	**9 Hrs**
Microbial Metabolism (Aerobic and anaerobic respiration, fermentation, photosynthesis, nitrogen fixation). Nutritional and physical requirements of autotrophs, heterotrophs, chemotrophs and lithotrophs, types of culture media, enumeration of microbial populations, pure culture and cultural characteristics.		
Unit 4	**Microbial Growth and Microbial Control**	**8 Hrs**
Physical and chemical agents for control of microbial growth, their mode of action, sterilization, disinfectants and antiseptics, chemotherapeutic agents, Maintenance and preservation of microbial cultures and its importance, culture banks.		
Unit 5	**Environmental, industrial and medical microorganisms**	**9 Hrs**
Water microbiology—sewage treatment plant; microbiology Treatment Plant, Microbiology of food- Single Cell Proteins, Cheese, Wine, Beer, probiotics. Bioremediation. Biofertilizer Major diseases caused by different microorganism, Methods for the determination of antimicrobial efficacy of natural products		
Total		**45 Hrs**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	Microbiology: Pelczar, 5th Edition	Michael J. (Michael Joseph)

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Brock Biology of Microorganisms (12th ed.). Pearson Education (2013).	Brock, T. D., and Madigan, M. T.
2	Dictionary of Microbiology and Molecular Biology	Paul Singleton & Diana Sainsbury
3	Bergey's Manual of Systematic Bacteriology	John G. Holt (Editor); Noel R. Krieg (Editor)

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_bt05	36-48 **Hrs**
Video Lectures		
Web References		

Course Code: CBT0302	Course Name: Biochemistry	L	T	P	C
Course Offered in: Department of Biotechnology		**2**	**0**	**0**	**2**

Prerequisite: Basics of Biology and chemistry

Course Objective: To provide fundamental knowledge of biomolecules, metabolic pathways, and biochemical principles governing living systems, and to develop an understanding of biochemical techniques and their applications in health, disease, and biomedical research.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain the chemistry, functions, and metabolism of carbohydrates and relate them to the biochemical basis of metabolic diseases.	K2
CO2	Explain and associate the chemistry of fatty acids, their function and metabolism in the body, and apply the earned knowledge to understand the biochemical basis of metabolic diseases.	K2
CO3	Explain the structure and metabolism of amino acids and proteins and apply this knowledge to interpret the biochemical basis of metabolic diseases.	K3
CO4	I. Explain the structure and metabolism of nucleic acids and apply the acquired knowledge to solve related metabolic problems.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	1	1	2	2	1	2	3	2	2
CO2	3	3	2	2	2	1	1	2	2	1	2	3	2	2
CO3	3	2	2	2	2	2	1	2	2	1	2	3	3	3
CO4	3	3	2	2	2	2	1	2	3	1	3	3	3	2

Course Contents / Syllabus

Unit 1	**Buffer system and Carbohydrates**	**9 Hrs**

Ionization of water, pH and buffers, buffering mechanism, Henderson-Hasselbalch equation, Buffering against pH Changes in Biological Systems: Phosphate buffer, Bicarbonate buffer Classification of carbohydrates, Glycosidic bonds, Structure and function of carbohydrates, Ring structure and mutarotation. Glucose metabolism: Glycolysis and oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway. Etiology of Diabetes.

Unit 2	**Fatty acids and lipids**	**8 Hrs**

Structure and classification of fatty acids and lipids, nomenclature of lipids, Metabolism: Oxidation of fatty acids (beta oxidation, omega oxidation, alpha oxidation), carnitine shuttle, Biosynthesis of fatty acids. Electron transport chain and Oxidative phosphorylation. Etiology of Obesity.		
Unit 3	**Amino acids and peptides**	**8 Hrs**
Structure and classification, pKa and pI values of amino acids, Peptide bond, torsional angles in proteins- omega, phi and psi angle, Secondary structures: Alpha helix, beta sheets, Beta turns and Random coils, Ramachandran plot, Protein metabolism and function: Catabolism of proteins in body deamination, transamination, Urea cycle, Glucose Alanine cycle; Overview of amino acid biosynthesis- Role of Glutamine.		
Unit 4	**Nucleic acids**	**7 Hrs**
Purines and pyrimidines, Structure of nucleotides, Phosphodiester bond, Deoxyribonucleotides and ribonucleotides. Metabolism of Nucleotides: Purines and Pyrimidines synthesis: de Novo and salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Catabolism and salvage of Purine and Pyrimidine nucleotides.		
Total ours		**32 Hrs**
Textbook:		
S.No	**Book Title with publication agency & year**	**Author**
1	Principles of Biochemistry McMillan Worth Publishers.	A.L. Lehninger, Nelson and Cox
2	Harper's Biochemistry- 25th edition.	Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange Medical Books.
3	Biochemistry: Third Edition; Tata McGraw Hill Education Pvt. Ltd. New Delhi.	S.C. Rastogi
4	Biochemistry: Fourth Edition; Reed Elsevier India Pvt. Ltd. and Books and Allied Pvt. Ltd.	Dr. U. Satyanarayana Dr. U. Chakrapani
Reference Books:		
S. No	**Book Title with publication agency & year**	**Author**
1	Biochemistry:, W. H. Freeman	Stryer
2	Biochemistry:, John Wiley and Sons, Inc. USA	Voet and Voet
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://nptel.ac.in/courses/104105076 https://www.coursera.org/learn/energy-metabolism	24 hours 36 min 12 hours

Video Lectures		
Web References		

Course Code: CBT0301	Course Name: Analytical Techniques	L	T	P	C
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

Prerequisite: Basic concepts of physics and chemistry, particularly light, electromagnetic radiation, atomic structure, and chemical interactions

Course Objective: The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques and to provide scientific understanding of analytical techniques and detail interpretation of results that will help them to demonstrate a broad understanding of life science technologies.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	**Identify** the principles and various components of different microscopes used to analyze and characterize biomolecules.	K1
CO2	**Explain** the general principle of chromatographic separations and **apply** these techniques for the separation of a hypothetical protein sample.	K3
CO3	**Understand** the regions of the electromagnetic spectrum and **relate** them to spectroscopic methods.	K2
CO4	**Explain** the concept and principle of gel electrophoresis.	K2
CO5	Apply centrifugation techniques for the separation of biological samples.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	3	3	3	3			3	3	3	3	2
CO2	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO3	3	3	1	3	3	3	3			3	3	3	3	3
CO4	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO5	3	3	3	2	3	3	3			3	3	3	3	3

Course Contents / Syllabus

Unit 1	**Microscopy and its types**	**9 Hrs**

Light microscopy, Bright and Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy: TEM and SEM, Atomic force microscopy.

Unit 2	**Chromatography**	**10 Hrs**
Principle and Operations of Chromatography, Thin layer chromatography, Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Affinity Chromatography		
Unit 3	**Spectroscopy**	**8 Hrs**
Electromagnetic radiation and spectrum, Atomic absorption and Atomic emission spectroscopy, Principle, working and applications of UV-VIS, NMR, ESR and IR spectrometer, Principle and applications of Mass Spectroscopy, Basics of X-Ray diffraction analysis and their application in biotechnology.		
Unit 4	**Electrophoresis**	**8 Hrs**
Theory of Electrophoresis, Factors affecting the migration of substances Gel electrophoresis, PAGE, SDS-PAGE, Agarose Electrophoresis of Nucleic Acid, Isoelectric Focusing of Protein Pulse Gel Electrophoresis and Western Blotting.		
Unit 5	**Centrifugation and Biosensors**	**10 Hrs**
Theory of centrifugation and sedimentation. Types of centrifuges, Preparative and analytical centrifugation; Density gradient centrifugation. Application of centrifugation for preparative and analytical purpose. Biosensors: Principles and definition, characteristics of Ideal biosensors, Biochemical components of biosensors: Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors.		
	Total	**45 h**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	Principles and Techniques of Practical Biochemistry 5th Edn., Cambridge Knew pros 1997.	Wilson and Walker
2	Biotechniques: Theory and Practice: Second Edition Rustogi Publications.	SVS Rana
3	Bioanalytical Techniques The Energy and Resources Institute (TERI Press)	Shourie & Chapadgaonkar

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Bioanalytical Techniques Narosa Publishing House, New Delhi. 4.: ML Srivastava; Narosa Publishing House, New Delhi.	Saroj Dua And Neera Garg

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_cy02	36-40 Hrs

	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ma03	
Video Lectures		
Web References	https://www.youtube.com/watch?v=7S4WMwesMts https://www.youtube.com/watch?v=0mURpZD-mmU https://www.youtube.com/watch?v=xvWdIi6_fGg&t=118s https://www.youtube.com/watch?v=6gUY5NoX1Lk	

Course Code: CBT0353	Course Name: Genetics and Molecular Biology Lab	L	T	P	C
Course Offered in: Department of Biotechnology		**0**	**0**	**4**	**2**

Prerequisite: Basics of biology

Course Objective: To provide students the knowledge and skill about analysing the genotypic and allelic frequencies, linkage, gene mapping, DNA and RNA extraction, techniques of DNA, RNA and Protein separations, regulation of gene expression and DNA microarray techniques.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Calculate genotypic and allelic frequencies and demonstrate the linkage, crossing over, and gene mapping in Drosophila melanogaster.	K3
CO2	Perform polytene chromosome from insect salivary gland and design their study with drosophila mutants	K3
CO3	Enhance their knowledge and skills for extraction of genomic DNA and RNA from biological samples, and evaluation of DNA concentration and protein molecular weight using electrophoretic techniques.	K4
CO4	Enhance their knowledge in gene expression, regulation of gene expression and gene expression using DNA microarray.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	1	1	-	2	1	1	3	2	2
CO2	3	2	2	2	2	1	1	-	2	1	1	3	2	2
CO3	3	3	2	3	3	1	1	-	2	1	2	3	3	3
CO4	3	3	2	3	3	2	2	1	2	2	2	3	3	3

List of Practical's (Indicative & Not Limited To)	**CO**
1. To understand and calculate the genotypic and allelic frequencies in a given population using the Hardy–Weinberg equilibrium principle.	CO1
2. Study on linkage, crossing over, and gene mapping in *Drosophila melanogaster.*	CO1
3. Study and observation of mutants in *Drosophila*.	CO2
4. Study of polytene chromosomes from insect salivary gland.	CO2
5. To prepare and observe chromosome spread using onion root tip cells.	CO2

6. Extraction of genomic DNA from *Drosophila*/animal cell.	CO3
7. To isolate plasmid DNA from bacterial culture by alkaline lysis method.	CO3
8. To understand the principles and applications of Polymerase Chain Reaction (PCR) amplification and gel electrophoresis in molecular biology.	CO3
9. Estimation of size in bp of DNA using agarose gel electrophoresis.	CO3
10. Polyacrylamide gel electrophoresis and estimation of molecular weight of proteins.	CO3
11. To study the effect of UV radiation on microbial survival and mutation frequency.	CO1
12. To study blood group inheritance patterns using pedigree analysis.	CO2
13. Demonstration of gene expression and regulation of gene expression using a digital platform.	CO4
14. Demonstration of gene expression using DNA microarray by using a digital platform.	CO4
Total h: 60 Hrs	

Lab Course Code: CBT0354	Lab Course Name: Microbiology and Biochemistry Lab	L	T	P	C
Course Offered in: Department of Biotechnology		**0**	**0**	**4**	**2**

Prerequisite: Basics of Biology

Course Objective: The course aims to equip students with practical skills and theoretical knowledge in microbial techniques, biosafety practices, and the identification and analysis of microorganisms using various methods.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Demonstrate proficiency in good microbial laboratory practices and biosafety protocols.	K2
CO2	Identify microorganisms based on colony morphology and Gram staining techniques.	K2
CO3	Prepare, sterilize, and inoculate culture media, and enumerate microbes from environmental samples.	K3
CO4	Cultivate and isolate microorganisms using various microbiological techniques, and analyze microbial samples from soil and analyze protein, amino acids, nucleotides, and sugars in samples	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	2	3	2	2	2	1	3	3	2
CO2	3	2	2	1	3	1	2	1	3	2	1	3	3	2
CO3	3	2	2	2	3	2	2	1	2	2	1	3	3	3
CO4	3	3	2	2	3	2	2	2	3	2	2	3	3	3

List of Practical's (Indicative & Not Limited To)

1. Good microbial lab practices and biosafety.	CO1
2. To prepare solutions of given concentrations in terms of: (i) Percentage (ii) Molarity (iii) Normality	CO1
3. Preparation, sterilization, and inoculation of nutrient agar plate, agar slant, and nutrient broth.	CO3
4. Culture of microorganisms using various techniques. (Spread-plate method, pour-plate method, streaking method)	CO3

5. Isolation and identification (based on colony morphology) of microorganisms from soil samples.	CO4
6. To identify given microorganisms based on gram staining.	CO2
7. Identification of microbes based on biochemical tests.	CO2
8. To study the anti-microbial efficacy of plant extracts.	CO3
9. To perform titration of weak acid and weak base	CO1
10. To test the presence of sugar in a solution and differentiate between reducing sugar in the sample using Benedict's test and Fehling's test.	CO4
11. To perform quantitative analysis of carbohydrates using the phenol-sulphuric acid method.	CO4
12. To test the presence and quantify proteins in a given sample using the Biuret method.	CO4
13. Qualitative analysis of lipids by Grease spot test or Emulsification test.	CO4
14. To quantify the nucleotide sample present in a sample using spectrophotometric method.	CO4
Total H: 60 hrs.	

Lab Course Code: CBT0351	Lab Course Name: Analytical techniques Lab	L	T	P	C
Course Offered in: Department of Biotechnology		**0**	**0**	**2**	**1**

Prerequisite: Basic concepts of physics and chemistry

Course Objective: To provide students with practical skills in using analytical instruments such as electrophoresis and UV spectrophotometry, and to develop their ability to apply these techniques in research and laboratory settings.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the principles and instrumentation of microscopy, chromatography, spectroscopy, electrophoresis, and membrane separation techniques used in biological analysis.	K1
CO2	Explain the methods of separation, extraction, and analytical experiments for biological molecules using standard laboratory techniques and instruments.	K2
CO3	Apply chromatographic spectroscopic and electrophoretic techniques for characterization of biological compounds.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	2	1	1	1	3	2	1
CO2	3	3	2	2	3	2	1	2	2	1	2	3	3	2
CO3	2	3	3	3	2	2	1	2	2	2	2	2	3	3

List of Practical's (Indicative & Not Limited To)	**CO**
1. Demonstration of basic concept of precision and accuracy using appropriate experimental data.	CO2, CO3
2. To study principle and working of laboratory microscope.	CO1, CO2
3. To analyze the isolated plant pigments using paper chromatography	CO2, CO3
4. Separation of amino acids using thin layer chromatography	CO2, CO3
5. Separation of a mixture of polar and non-polar compounds using column chromatographic technique	CO2, CO3
6. Study of Beer-Lambert's law-using UV-Visible spectrophotometer	CO1, CO2, CO3
7. To study and analysis of DNA sample by agarose gel electrophoresis	CO1, CO2, CO3

8. To study and analysis of protein sample by SDS- PAGE.	CO1, CO2, CO3
9. To study the separation of compounds using liquid-liquid extraction experiments.	CO2, CO3
10. To study the separation of biological compounds using various membrane separation.	CO1, CO2, CO3
Total H: 30 hrs.	

LAB Course Code: CBT0355	LAB Course Name: Bioinformatics	L	T	P	C
Course Offered in: Department of Biotechnology		0	0	6	3

Prerequisite: Basics of biology, molecular biology, Biochemistry

Course Objective: To understand the basic concept of Bioinformatics, databases and sequence analysis. To provide knowledge of scoring matrix, phylogenetic analysis and to learn the protein structure prediction and application of bioinformatics in drug designing.

Course Outcome: After completion of the course, the student will be able to

CO1	Understand the theoretical basis behind bioinformatics and concept of Biological Databases.	K2
CO2	Search databases accessible on the internet for literature relating to Molecular Biology and Biotechnology.	K2
CO3	Understand scoring matrices and its types including PAM, BLOSUM series and matrices for nucleic acid and protein sequences.	K2
CO4	Apply phylogeny and its concepts in molecular evolution and different methods of Phylogenetic tree construction.	K3
CO5	Query biological data, interpret and model biological information and apply this to the solution of biological problems in any arena involving molecular data.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	2	3	2	-	3
CO2	2	2	-	-	3	-	-	-	2	3	2	2	-	3
CO3	3	2	-	2	2	-	-	-	-	2	3	2	-	3
CO4	3	3	-	2	2	1	-	-	-	2	2	2	-	3
CO5	3	3	2	3	3	1	1	-	2	3	3	2	1	3

Course Contents / Syllabus

Unit 1	General Introduction	17 Hrs

Exercise 1: Introduction to Bioinformatics; Human Genome Project

Exercise 2: Biological databases: Nucleotide databases, Protein databases, Specialized databases

Exercise 3: Laboratory data submission and data retrieval tools.

Exercise 4: Various file formats for biomolecular sequences: GenBank, EMBL, FASTA, GCG, MSF, nbrf-pir etc.

Exercise 5: Basic concepts of sequence similarity: identity and homology

Exercise 6: Definitions of homologues, orthologues, paralogues

Exercise 7: Sequence patterns

Exercise 8: Sequence profiles

Unit 2	**Database Searching**	**17 Hrs**

Exercise 9 Sequence Alignment

Exercise 10: Database Searching: Introduction, Evolutionary Basis of Sequence Alignment

Exercise 11: Database similarity searching: FASTA, BLAST

Exercise 12: Various versions of basic BLAST and FASTA,

Exercise 13: Advance version of BLAST: PHI-BLAST and profile-based database searches using PSIBLAST

Exercise 14: Multiple sequence alignment: progressive method and Iterative method

Exercise 15: Applications of pairwise and multiple sequence alignment

Exercise 16: Tools for multiple sequence alignment: CLUSTAL ω and Pileup (Algorithmic concepts)

Unit 3	**Scoring Matrics**	**15 Hrs**

Exercise 17: Basic concept of a scoring matrix, Similarity and distance matrix

Exercise 18: Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series

Exercise 19: Principles based on which these matrices are derived

Exercise 20: Gap Penalty, concept of Gap opening and extension penalty.

Unit 4	**Phylogenetic analysis**	**15 Hrs**

Exercise 21: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny

Exercise 22: Definition and description of Phylogenetic trees

Exercise 23: Various types of Phylogenetic trees

Exercise 24: Phylogenetic tree construction through UPGMA

Exercise 25: Phylogenetic tree construction through Fitch-Margoliash Algorithm

Exercise 26: case studies in phylogenetic sequence analysis

Unit 5	**Applications of Bioinformatics**	**16 Hrs**

Exercise 27: Protein identification based on composition, Physical properties based on sequence, Motif and pattern

Exercise 28: Secondary structure (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and folding classes, specialized structure or features

Exercise 29: Tertiary structures (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.)

Exercise 30: Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.

	Total H:	**80 Hrs**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1.	Bioinformatics: Sequence and Genome Analysis by, 2ND EDITION	David W. Mount
2.	Bioinformatics: A Practical Guide to the Analysis of Genes and Protein.	

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1.	Bioinformatics for Dummies, 2ND EDITION	Jean-Michel Claverie and Cedric Notredame

NPTEL/ Youtube/ Faculty Video Link:

Unit 1	https://www.youtube.com/watch?v=zvyv_snBih8andpp=ygUmR2VuZXJhbCBJbnRyb2R1Y3Rpb24gb2YgYmlvaW5mb3JtYXRpY3M%3D
Unit 2	https://www.youtube.com/watch?v=rDhElW5ox6wandpp=ygUkRGF0YWJhc2UgU2VhcmNoaW5nIG9mIGJpb2luZm9ybWF0aWNz
Unit 3	https://www.youtube.com/watch?v=AgIMm4B_Ticandpp=ygUeU2NvcmluZyBNYXRyaWNzIEJpb2luZm9ybWF0aWNz
Unit 4	https://www.youtube.com/watch?v=Wj0OV2jf1VQandpp=ygUkUGh5bG9nZW5ldGljIGFuYWx5c2lzIEJpb2luZm9ybWF0aWNz0gcJCYsJAYcqIYzv
Unit 5	https://www.youtube.com/watch?v=z2XvrbRw7y8andpp=ygUeQXBwbGljYXRpb25zIG9mIEJpb2luZm9ybWF0aWNz

Course Code: CNC0302/CNC0402	Course Name: Environmental Science	L	T	P	C
Course Offered in: Department of Biotechnology		2	0	0	NA

Pre-requisite: Basic knowledge of biology, chemistry, ecology, geology, mathematics, and understanding of human impacts on natural systems.

Course Objectives:

To help the students in realizing the inter-relationship between man and environment and help the students in acquiring basic
knowledge about environment.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Knowledge Level (KL)**
CO1	Understand the basic principles of ecology and the environment. Ecosystem: Basic concepts, components of ecosystems, food chains and food webs. Ecological pyramids	**K2**
CO2	Understand the different types of natural recourses like food, forest, Minerals and energy and their conservation	**K2**
CO3	Understand the different types of pollution, pollutants, their sources, effects, and their control methods.	**K2**
CO4	Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment	**K2**

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO MAPPING	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	-	3	3	2	2	-	2	2	2
CO2	3	3	2	2	-	3	3	2	2	-	2	2	2
CO3	3	3	2	2	-	3	3	2	2	-	2	2	2
CO4	3	3	2	2	-	3	3	3	2	-	2	2	2

Course Contents / Syllabus

UNIT 1 **Basic Principle of Ecology and Biodiversity** **5 HOURS**

Definition, Scope and basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem. Food chains and food. Webs. Ecological pyramids, Energy flow in ecological systems, Characteristics of different ecosystems. Biogeochemical Cycles: Importance, gaseous and sedimentary cycles. Carbon, Nitrogen, Phosphorus and Sulphur Cycles. Biodiversity and their importance, Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book. Strategies for biodiversity conservation, principles of biodiversity conservation in-situ and ex-situ conservation strategies Mega diversity zones and Hot spots, concepts, distribution and importance.

UNIT 2 **Natural Resources and Ecological succession** **5 HOURS**

Natural resources and associated problems. Forest resources: Use and over- exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and over- grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, and salinity. Land resources: Land as a resource, land degradation, man induced landslides. Equitable use of resources for sustainable lifestyles. Non-Renewable Energy Resources: Fossil fuels and their reserves, Nuclear energy, types, uses and effects, Renewable Energy Resources: hydropower, Solar energy, geothermal, tidal and wind energy, Biomass energy, biogas and its advantages. Ecological succession-Types, stages, examples of ecological succession

UNIT 3 **Pollution and Waste Management** **5 HOURS**

Air pollution: sources of air pollution, Primary and secondary air pollutants. Origin and effects of SOX, NOX, Cox, CFC, Hydrocarbon, control of air pollution. Water pollution: sources and types of water pollution, Effects of water pollution, Eutrophication, Soil pollution: Causes of soil pollution, Effects of soil pollution, Major sources of and effects of noise pollution on health, Radioactive and thermal pollution sources and their effects on surrounding environment. Solid waste disposal and its effects on surrounding environment, Introduction to E- Waste, Types and classification of E- Waste, Impacts of E- Waste on environment and human health,E-Waste management and recycling., Climate change, global warming, acid rain, ozone layer depletion.

UNIT 4 **Environmental Assessment and Legislation** **5 HOURS**

Women education, Role of NGOs regarding environmental protection, Bio indicators and their role, Natural disasters and disasters management, Aims and objectives of Environmental Impact Assessment (EIA). Salient features of following Acts:

Environmental Protection Act, 1986, Wildlife (Protection) Act, 1972.Water (Prevention and control of pollution) Act, 1974. Forest (Conserving) Act, 1980. Definition and concept of sustainability, impacted areas of sustainable development, Global initiative, and issues on sustainable development UN SDGs, System Thinking and Sustainability.		
	Total Lecture Hours	**20 HOURS**
Textbook:		
S.No	**Book Title with publication agency & year**	**Author**
1	Brady, N.C. 1990. The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York	Brady, N.C
2	Sodhi G.S. 2005, Fundamentals of Environmental Chemistry: Narosa Publishing House, New Delhi.	Sodhi G.S
3	Dash, M.C. (1994), Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.	Dash, M.C
Reference Books:		
1	Rao M.N. and H.V.N. Rao, 1989 : Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi	Rao M.N. and H.V.N. Rao
2	A Text Book of environmental Science By Shashi Chawla	Shashi Chawla
Self-Study Content Links:		
MOOC'S		
VIDEO LECTURES	https://www.youtube.com/watch?v=T21OO0sBBfc https://www.youtube.com/watch?v=qt8AMjKKPDo https://www.youtube.com/watch?v=brF0RWJyx9w https://www.youtube.com/watch?v=GK_vRtHJZu4	**7 min 42 sec** **15 min** **3 min 25 sec** **4 min 25 sec**
WEB REFERENCES	https://www.youtube.com/watch?v=yqev1G2iy20, https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2g0	**28 min** **31 min 35 sec** **11 min**

Course Code: CBT0402	Course Name: Fermentation Engineering	L	T	P	C
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

Prerequisite: The students should know the basics of microbiology, and biochemistry

Course Objective: To understand the fundamentals of fermentation technology, microbial processes, and media optimization.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain different fermentation types and microbial culture optimization.	K1
CO2	Design and control fermentation processes using advanced techniques and tools.	K2
CO3	Describe metabolic regulation mechanisms in microbial fermentation.	K2
CO4	Apply knowledge of fermentation processes in food and beverage production.	K3
CO5	Analyze bioprocesses for industrial applications, emphasizing sustainability	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	-	2	-	-	1	2	1	3	3	2
CO2	3	3	2	1	2	2	-	-	1	2	2	3	3	2
CO3	3	3	2	2	2	2	-	1	1	1	1	3	3	2
CO4	3	2	2	2	1	2	-	1	2	2	2	3	3	3
CO5	3	3	3	2	2	2	1	1	2	2	3	3	3	3

Course Contents / Syllabus

Unit 1	Fermentation Fundamentals and Requirements	10 Hrs

Interaction between Biochemical engineering, Microbiology and Biochemistry. History and development of fermentation industry: Microbial culture selection for fermentation processes, Strain development; Preservation and improvement of industrially important microorganisms. The range of fermentation processes – Microbial biomass, microbial enzymes, microbial metabolites, recombinant products, transformation processes. Chronological development of the fermentation industry. components of fermentation process

Unit 2	Advanced Fermentation Technologies	10 Hrs
Introduction, Criteria for transfer of inoculum, development of inoculum for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications and examples.		
Unit 3	**Metabolic Regulation in Fermentation**	**8 Hrs**
Media ingredients, medium formulation, Oxygen requirements, antifoams, medium optimization, Media sterilization, Batch Process (thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries, filter sterilization of air and media. Advanced microbial metabolic regulation; Global metabolic control analysis; Induction and repression mechanisms (lac and trp operons, detailed studies); Catabolite repression; Crabtree and Pasteur effects; Metabolic flux analysis; Feedback and allosteric regulation.		
Unit 4	**Fermentation in Food Industry**	**8 Hrs**
Quality and pretreatment of raw materials; Innovations in alcoholic beverages; Industrial mushroom cultivation (Oyster, Button, Shiitake); Probiotics and functional fermented foods; Oriental fermented foods (Soy products, fermented dairy); Traditional foods (Kimchi, Kombucha); Safety and regulatory aspects.		
Unit 5	**Industrial Fermentation Applications and Bioprocess Engineering**	**8 Hrs**
Antibiotic production (Penicillin, Cephalosporin); Bio-solvents and bioethanol; Amino acids and organic acids biotechnology; Industrial enzyme engineering; Recombinant enzyme technology; Biopharmaceuticals (insulin, monoclonal antibodies, vaccines); Scale-up considerations; Bioprocess economics; Sustainability in fermentation.		
	Total Hrs	**45 Hrs**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Principles of Fermentation Technology. Butterworth-Heinemann.	Stanbury, P. F., Whitaker, A., and Hall, S. J. (2016).

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Bioprocess Engineering Principles (3rd ed.). Academic Press (Elsevier). (2024).	Doran, P. M.
2	Bioprocess Engineering: Basic Concepts (3rd ed.). Pearson Education.	Shuler, M. L., Kargi, F., and DeLisa, M. (2021).

Self-Study Content Links:	Duration (in Hrs)

MOOCs	https://nptel.ac.in/courses/102103672 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013842456514215936148 65_shared/overview https://onlinecourses.nptel.ac.in/e-learning/preview/noc19_bt18	36-40 hours 7 hours 42 mins 24-26 hours
Video Lectures		
Web References		

Course Code: CBT0403	Course Name: Immunology and Immunotechnology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Prerequisite: Students should know the basics of cell biology and human physiology

Course Objective: To develop a strong understanding of immunological principles, immune responses, and immunological techniques, while enabling students to analyze research and explore applications of immunotherapy, vaccines, and antibody-based therapies in disease treatment.

Course Outcome: After completion of the course, the student will be able to		Bloom's Level
CO1	Identify and explain in detail the basic components and functionalities of the immune system.	K2
CO2	Identify and explain antigen and antibody structure and function,	K2
CO3	Understand the technical aspect of immunological reactions and their application	K3
CO4	Describe various ways of regulation of immune response and critically evaluate the regulatory mechanisms and their importance in human health.	K4
CO5	Associate the immunological mechanisms with various kinds of human diseases and health conditions.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	1	1	-	-	-	2	3	-	-
CO2	3	2	-	-	-	1	1	2	1	2	2	3	-	-
CO3	3	2	2	2	2	-	-	-	-	1	2	3	2	3
CO4	3	2	-	-	-	-	-	1	1	2	2	3	-	-
CO5	3	3	-	2	2	2	2	1	2	2	3	3	2	2

Course Contents / Syllabus

Unit 1	Overview of the Immune System	10 Hrs

Introduction to immunity and immune system, Cells and Molecules of the immune system, Haematopoiesis, Characteristics and players of innate and adaptive immunity, Humoral and Cell mediated immune response, Primary and Secondary lymphoid organs, Structure, function and application of cytokines, Inflammation-features and Inflammatory response, Pro-inflammatory and anti-inflammatory cytokines, T and B cell maturation, activation and differentiation.

Unit 2	Antigen and Antibody Structure	10 Hrs
Antigens: Characteristics and types of Antigens, Factors affecting immunogenicity, Haptens and adjuvants, Epitopes, Characteristics of T and B cell epitopes. **Antibodies**: Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins, Generation of antibody diversity, Somatic hyper-mutation, Monoclonal and polyclonal antibodies and their commercial preparation		
Unit 3	**Immuno- Techniques and Immunization**	**8 Hrs**
Antigen and antibody interactions cross reactivity, precipitation reactions, and Immunological techniques: serological techniques, Immuno-diffusion assay, ELISA, RIA, Western blotting. ELISPOT assay, Immuno-Histochemistry, Flow Cytometry, FACS sorting, Immuno-precipitation, Active immunization, passive immunization, Antibodies in diagnostics, Vaccines and their types.		
Unit 4	**MHC and regulation of immune response**	**9 Hrs**
Structure and Function of MHC molecules, Antigen presenting cells, Exogenous and Endogenous pathways of antigen processing and presentation, Germinal centre, Plasma Cells, BCR signalling, Complement system and pathways, immune tolerance negative/positive selection, TCR rearrangement, co-stimulatory molecules. T cell subtypes: Th1, Th2, Th17, Tregs etc. Memory Band T cell responses, Immune checkpoints: PD1, CTLA4, TIM3 etc. CD4 and CD8 receptors.		
Unit 5	**Immunity and Diseases**	**8 Hrs**
Immunity without infection: autoimmunity, hypersensitivity, Transplantation immunology host vs graft reaction Design of recombinant antibodies, Immuno-therapy in cancer, check point therapy. Immunity against infectious diseases (virus, bacteria and protozoan), AIDS, Immune response in plants- an Overview		
Total ours		**45 Hrs**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Immunology and Immunotechnology Oxford University Press	Ashim K. Chakravarty

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Immunology by. 8th edition	Kuby, Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby
2	Introduction to Medical Immunology 7th edition	Gabriel Virella.
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://nptel.ac.in/courses/102105083 https://nptel.ac.in/courses/109106198	36-48 Hrs 36-48 Hrs

Video Lectures		
Web References		

Course Code: CBT0404	Course Name: r-DNA Technology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Prerequisite: Basic understanding of nucleic acids and molecular biology

Course Objective: To provide a strong foundation in molecular biology and recombinant DNA technology by developing knowledge of gene cloning, recombinant screening techniques, recent advancements, and in silico cloning tools.

Course Outcome: After completion of the course, the student will be able to		Bloom's Level
CO1	Understand gene cloning procedures and the roles of enzymes and vectors	K1
CO2	Gain theoretical knowledge of various vectors and their applications	K2
CO3	Learn PCR techniques and their diverse applications	K3
CO4	Acquire detailed knowledge on gene library construction and screening methods	K2
CO5	Understand selection techniques in genetic engineering	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	2	1	1	2	2	1	2	3	3
CO2	3	3	2	2	2	2	1	1	2	2	1	2	3	3
CO3	3	3	3	2	2	2	1	1	2	2	1	2	3	3
CO4	3	3	2	2	2	2	1	1	3	2	1	2	3	3
CO5	3	3	2	3	2	2	1	1	2	2	1	2	3	3

Course Contents / Syllabus

Unit 1	Basic Principles of rDNA Technology	9 Hrs

Introduction to recombinant DNA technology and its applications, Restriction enzymes: Classes I, II, III; nomenclature, isoschizomers, heterotypic enzymes, Modules and activity of restriction enzymes; restriction digestion (partial and complete), star activity, Homopolymer tailing, synthetic linkers, adaptors, Role of enzymes in cloning: DNA ligase, T4 DNA polymerase, alkaline phosphatase, reverse transcriptase

Unit 2	Vectors	8 Hrs

Cloning, expression, and promoter-less vectors, Plasmids and bacteriophages; phage lambda and M13 vectors;

PUC19, Bluescript vectors, Phagemids, cosmids, artificial chromosome vectors (YACs, BACs), Animal virus-derived vectors; expression vectors (e.g., Baculovirus, Pichia), Plant-based vectors (e.g., Ti and Ri plasmids), yeast and shuttle vectors, Vector components and their functions, Vector Selection and Screening, Application of vectors.		
Unit 3	**Polymerase Chain Reaction (PCR)**	**9 Hrs**
DNA amplification using PCR,PCR types and applications: RT-PCR, inverse PCR, nested PCR, multiplex PCR, anchored PCR, RACE, DD-RTPCR, degenerate PCRTA cloning and real-time PCR, Primer design and enzyme fidelity, Primer design, Optimization of PCR condition, PCR product analysis, Applications of PCR in biotechnology, Limitations and troubleshooting in PCR		
Unit 4	**Techniques in r-DNA technology**	**9 Hrs**
Isolation and purification of genetic materials, Restriction digestion, Gel electrophoresis, Ligation techniques, Transformation and transfection, Gene/genomic library and cDNA library construction, Screening and selection methods: functional and nutritional complementation, colony/plaque hybridization, blotting techniques, plus-minus screening, immunological screening, HART, HAT		
Unit 5	**Screening and Selection of Recombinants**	**10 Hrs**
Selectable markers, Screening techniques, Functional assays, Preparation of competent bacterial cells; transformation of recombinant DNA Screening techniques: colony PCR, DNA/RNA sequencing (Sanger, Maxam-Gilbert, automated, pyrosequencing) Genomic analysis: high-throughput sequencing, shotgun and clone contig cloning, microarray, Purification and spectroscopic characterization of recombinant proteins		
	Total ours	**45 Hrs**

Textbook:

S.No	Book Title with publication agency & year	Author
1	From Genes to Clones: Introduction to Gene Technology, VCH Publishers. (1987)	Ernst L. Winnacker
2	Genetic Engineering, Oxford University Press.	Smita Rastogi and Neelak Pathak
3	Genetic Engineering: Principles and Practice, McGraw Hill Education	Sandhya Mitra
Reference Books:		
S.No	**Book Title with publication agency & year**	**Author**
1	Principles of Gene Manipulation and Genomics.	Primrose and Twyman
2	Molecular Biology of the Cell, 4th Edition, Garland Science.	Alberts et al.,
3	Modern Genetic Analysis, W.H. Freeman	Griffiths et al.,

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://nptel.ac.in/courses/102103013	48 **Hrs**
Video Lectures		
Web References	https://www.youtube.com/watch?v=Yh9w_fyvpUk https://www.youtube.com/watch?v=VXkw_U6mJpc https://www.youtube.com/watch?v= https://www.youtube.com/watch?v=CgXtJ4ooaUU https://www.youtube.com/watch?v=OK7_ReXhVaQ https://www.youtube.com/watch?v=YnF1b_Kqf88 https://www.youtube.com/watch?v=BIIWlZqWxKg	

Course Code: CBT0401	Course Name: Biophysics and Bioinstrumentation	L	T	P	C
Course Offered in: Department of Biotechnology		**3**	**1**	**0**	**4**

Prerequisite: Students should know about the basics of biology.

Course Objective: The course provides the students with a comprehensive understanding of the principles and techniques used in the study of biological systems at molecular and cellular levels.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Learn about the phenomena of water transport across cellular membranes.	K1
CO2	Understand the concept of electrical phenomena in excitable cells.	K2
CO3	Apply the general principles of signal transduction pathways involved in a wide range of physiological processes.	K3
CO4	Understand the thermodynamics and kinetics of macromolecules	K2
CO5	Apply electrophysiological methods in cellular physiology	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	2	2	2	2	2	-	2	3	3	2
CO2	3	2	2	2	3	2	2	2	2	-	2	3	3	2
CO3	3	2	3	2	3	2	2	2	2	-	2	3	3	3
CO4	3	3	2	2	2	2	2	2	2	-	2	3	3	3
CO5	3	3	3	2	2	2	2	3	3	-	3	3	3	2

Course Contents / Syllabus

Unit 1	**Water transport across cell membranes**	**10 Hrs**

Overview of biophysics as an interdisciplinary field, Structure, function and proteins of biological membranes, Membrane transport mechanisms (diffusion, facilitated diffusion, Osmosis, active transport, tonicity, hydrostatic pressure, dialysis), Aquaporins: Structure, function and clinical significance, Water transport in artificial membranes and biomimetic systems

Unit 2	**Electrical Phenomena**	**11 Hrs**

Electrically Excitable Cells and their functions, Concept of Electrical Phenomena in Excitable Cells, Membrane Potential, The Ionic Hypothesis and Rules of Ionic Electricity (Nernst Equation and Goldmann-Hodgkin-Katz

Equation), Generation of Action Potential, Transmission of Nerve Impulses (Electrical Synapse and Chemical Synapse), Conduction disorders.		
Unit 3	**Ion Channels and Transporters**	**9 Hrs**
Ligands and Receptors, General Principles of signal transduction, Intracellular Receptors, Cell Surface receptors (Ion channel linked receptors, G-protein coupled receptors and Enzyme linked receptors), Ion pumping (Sodium Potassium Pump), Transport ATPase, Glucose transporter, Rhodopsin and their function in vision.		
Unit 4	**Proteins and Nucleic acids**	**10 Hrs**
Hierarchical Structure of Proteins, Structure of Nucleotides, Sugar Pucker, Torsional angles in proteins and nucleic acids, Ramachandran Plot, Protein stability and folding: thermodynamics and kinetics, A B and Z DNA, The Biophysics of RNA, Functional Design of Proteins, Molecular Chaperons (Heat Shock Proteins), Characterization of secondary structure using CD spectroscopy and X-ray crystallography.		
Unit 5	**Cell Dynamics and Electrophysiological Methods**	**10 Hrs**
Molecular Motors: Actin, Myosin, Kinesin, Dynein, Intracellular movement, Cell migration: Types and mechanism, Mechanobiology and its importance in human health, Biophysics of Medical Imaging (computed tomography (CT), magnetic resonance imaging (MRI), Positron Emission Tomography (PET), Single neuron recording, patch-clamp recording, ECG, Brain activity recording		
	Total ours	**60 Hrs**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Introduction to Biophysics S. Chand Publishing, 2008	Pranab Kumar Banerjee

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Principles of Biochemistry 8th edition, Nelson and Cox, McMillan Worth Publishers.	A.L. Lehninger
2	Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 8th edition., et al., editors. Philadelphia:Lippincott-Raven; 1999.	Siegel GJ, Agranoff BW, Albers RW
3	Molecular Biology of the Cell. 7th edition. New York: Garland Science; 2002.	Alberts B, Johnson A, Lewis J, et al.
4	Molecular Cell Biology. 9th edition.New York: W. H. Freeman; 2000.	Lodish H, Berk A, Zipursky SL, et al
5	Neuroscience. 7th edition. Purves, editors. Sunderland (MA): Sinauer Associates; 2001.	D, Augustine GJ, Fitzpatrick D, et al.

Self-Study Content Links:	Duration (in Hrs)

MOOCs	https://nptel.ac.in/courses/104102009 https://www.coursera.org/learn/medical-neuroscience#modules	36-48 Hrs 70 Hrs
Video Lectures		
Web References		

Course Code: CBT0411	Course Name: Biosimilars Technology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Prerequisite: Fundamentals of Molecular Biology.

Course Objective: This course covers the significance of biosimilars, their development and quality control, biosimilarity assessments, regulatory and ethical aspects, and commercialization with a focus on market access and sustainability.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain the concept of biosimilars and their differences from generic drugs and reference biologics.	K2
CO2	Describe the analytical and preclinical approaches used in biosimilar development and characterization.	K3
CO3	Illustrate manufacturing, formulation, and quality control processes for biosimilars	K3
CO4	Analyze regulatory guidelines, global approval pathways, and comparability	K4
CO5	Examine challenges in safety, efficacy, interchangeability, and pharmacovigilance of biosimilars.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	2	1	-	-	2	2	3	-	-
CO2	3	2	2	2	2	-	1	-	-	1	2	3	2	2
CO3	3	3	3	2	3	1	1	-	-	-	2	2	3	1
CO4	2	3	2	3	2	2	2	1	1	2	3	2	2	2
CO5	2	3	2	3	-	3	3	2	2	2	3	1	2	2

Course Contents / Syllabus

Unit 1	**Introduction to Biosimilars**	**10 Hrs**

Definition and classification: biosimilars vs. generics vs. biologics, Key characteristics of biological drugs, Historical development and market overview of biosimilars. Importance and rationale for biosimilar development, Comparison with small molecule generics

Unit 2	**Development and Characterization**	**8 Hrs**
Steps in biosimilar development, Reference product selection and sourcing, Analytical characterization: structural and functional assays, In vitro bioassays and immunogenicity testing, Preclinical studies and comparability studies		
Unit 3	**Manufacturing and Quality Control**	**8 Hrs**
Upstream and downstream process design, Cell line development and expression systems, Formulation development and stability testing, Quality control assays: purity, potency, safety, Good Manufacturing Practices (GMP) compliance		
Unit 4	**Regulatory Guidelines and Approval Pathways**	**10 Hrs**
EMA, USFDA, WHO, CDSCO guideline, Biosimilarity and interchangeability requirements, Clinical trial design for biosimilars, Risk-based comparability protocols, Patent and exclusivity issues in biosimilars		
Unit 5	**Market Trends, Safety, and Challenges**	**9 Hrs**
Global biosimilar market landscape and key players, Pharmacovigilance and post-market surveillance, Immunogenicity and safety concerns, Substitution and interchangeability debates, Case studies of marketed biosimilars (e.g., insulin, epoetin, infliximab)		
Total		**45 Hrs**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs (Indian Ed.). New Delhi: Wiley India (2003).	Ho, R. J. Y., and Gibaldi, M.

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Biosimilars and Interchangeable Biologics – Academic Press, 1st Edition (2021)	Ajaz Hussain
2	Biopharmaceuticals and Biosimilars – Elsevier, 1st Edition (2023)	M. N. Bawa,
3	Current Regulatory Guidance Documents (EMA, USFDA, CDSCO). The EMA's "Guideline on Similar Biological Medicinal Products"	
4	Handbook of Biogeneric Therapeutic Proteins – CRC Press	Sarfaraz K. Niazi,

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://www.coursera.org/learn/drug-commercialization https://www.coursera.org/specializations/drug-development-and-pharmacoepidemiology	10 Hrs 40 Hrs

Video Lectures		
Web References		

Course Code: CBT0412	Course Name: Environmental Biotechnology	L	T	P	C
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

Prerequisite: Students should learn about basic microbiology.

Course Objective: To develop a comprehensive understanding of environmental pollution and its mitigation through biotechnological approaches by exploring biological treatment methods, industrial pollution management, bioproduct recovery, and emerging technologies for sustainable environmental protection.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Understand the biotechnological solutions for the treatment of industrial liquid and solid wastes	K2
CO2	Understand aerobic and anaerobic biological treatment technologies	K2
CO3	Understand the importance of biotechnology in environmental pollution management	K2
CO4	Understand the bioconversion pathways for the degradation of various xenobiotic compounds	K2
CO5	Apply knowledge on the recovery of high value-added bioproducts from industrial wastes	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PS O3
CO1	3	2	2	2	2	3	3	1	1	1	–	2	3	2
CO2	3	3	2	2	3	3	2	1	2	2	–	2	3	2
CO3	3	3	3	3	3	2	2	1	2	2	1	3	3	3
CO4	3	3	3	3	3	2	1	2	2	2	2	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	2	3	3	2

Course Contents / Syllabus

Unit 1	**Environmental Pollutants and Biotechnological Approaches for Waste Treatment**	**10 Hrs**

Introduction to Environmental Biotechnology, Types and sources of liquid and solid wastes, Stages of wastewater treatment – Primary, Secondary, Tertiary, Physicochemical treatment methods: Coagulation, Flocculation, Sedimentation, Chemical precipitation – pros and cons, Filtration methods and types, Adsorption using activated carbon – applications, Ion exchange – applications, Solid waste disposal methods – effects and

types, Secured landfill, Composting – bacterial and vermicomposting, Incineration and pyrolysis, Advanced oxidation processes, Electrodialysis for copper removal.

Unit 2	**Biological Wastewater Treatment and Nutrient Removal Technologies**	**10 Hrs**

Overview of biological wastewater treatment, Aerobic and anaerobic treatment technologies, Anaerobic digestion – stages and advantages, Microorganisms in anaerobic digesters, Factors affecting digestion efficiency, Biofilms – development and use in pollution control, Comparison of biofilm systems with suspended systems, Nutrient removal and eutrophication, Advanced methods for nitrogen and phosphorus removal, EBPR – Enhanced Biological Phosphorus Removal – mechanism.

Unit 3	**Biodegradation of Xenobiotics and Recalcitrant Environmental Pollutants**	**8 Hrs**

Introduction to xenobiotics and recalcitrant compounds, Environmental effects, Biodegradation mechanisms – reductive, oxidative, hydrolytic, Degradation of aliphatic and aromatic hydrocarbons, Halogenated hydrocarbons – microbial transformation, Oil pollution – impact and microbial cleanup methods.

Unit 4	**Microbial and Enzymatic Approaches for Industrial Waste Treatment**	**9 Hrs**

Biodegradation of industrial waste – recent developments, Role of biotechnology in industrial waste management, Microbial enzymes – uses in pollution control, Free vs. immobilized enzymes/cells, Applications of immobilized systems, Types and effects of dyes, Microbial and enzyme-based dye decolourization, Textile dye degradation, Laccases in industrial bioremediation, Heavy metal toxicity and microbial removal methods, Use of biosurfactants, polysaccharides, and siderophores in metal removal.

Unit 5	**Waste to Wealth: Resource Recovery and Sustainable Waste Utilization**	**8 Hrs**

Waste to Wealth, Industrial waste as a source of enzymes and valuable metabolites, Slaughterhouse waste – enzyme and metabolite recovery, Leather industry waste – types and recovery methods, Plastic waste – environmental impact and recycling, Bioplastics and renewable energy sources, Technologies for energy recovery from waste, Using biomass residue as fertilizer.

	Total	**45 Hrs**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	*Environmental Biotechnology: Principles and Applications*, McGraw Hill, 2001.	Bruce E. Rittmann and Perry L. McCarty,
2	*Environmental Biotechnology*, Oxford University Press, 2007.	Bimal C. Bhattacharyya,

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	*An Introduction to Environmental Biotechnology*, Springer, 1999.	Milton Wainwright
2	*Microbial Bioremediation*, MJP Publishers, India, 2006.	P. Rajendran, P. Gunasekaran,

3	*Advances in Biodegradation and Bioremediation of Industrial Wastes*, CRC Press, Taylor & Francis, 2015.	Ram Chandra
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://nptel.ac.in/courses/102105088	48 **Hrs**
Video Lectures		
Web References	https://app.jove.com/science-education/v/11112/in-vitro-plant-tissue-culture-and-genetic-modifications https://www.learninsta.com/applications-of-plant-tissue-culture/ https://www.youtube.com/watch?v=8zZsJxjKjwQ https://www.researchgate.net/publication/387476821_The_Application_of_Transgenic_Technology/fulltext/676f9a56894c55208530acbe/The-Application-of-Transgenic-Technology.pdf https://www.youtube.com/watch?v=2PP4lVH8N2Q	

Course Code: CBT0413	Course Name: System Biology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Prerequisite: Basic Biology and Genetics, Biochemistry, Mathematics, Computational and Data Analysis Skills.

Course Objective: The course provides a systems-level understanding of biological processes, including gene regulation, biochemical networks, computational modeling and their applications in modern biology.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Recall and explain the fundamentals of systems biology, including genetic switches, and different biological paradigms	K1
CO2	Interpret kinetic models such as equilibrium binding, cooperativity, and Michaelis-Menten kinetics relevant to gene regulation.	K4
CO3	Apply concepts of genetic switches, noise in gene expression, and oscillators to model gene regulatory mechanisms.	K3
CO4	Describe the developmental processes and mechanisms of cell communication using quorum sensing and Drosophila development	K3
CO5	Apply knowledge of gene expression networks, synthetic biology, and computational tools in analyzing biological systems and their applications in health and disease.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO2	PSO 3
CO1	3	2		2	3	3		3	1	-2	2		2	3
CO2	3	3	2	3	3	3	1	2		3	2	2	2	3
CO3	3	3	2	2	3	3	1	3	1	3-	2	2	2	3
CO4	2	2	1	3	3	3	1	3	-1	3-	2	1	2	3
CO5	3	3	3	3	3	3	2	2	2	2	3	1	2	3

Course Contents / Syllabus

Unit 1	Systems Biology	8 Hrs

Fundamentals Overview of Gene Control –Working of Genetic Switches – Introductory Systems Biology The biochemical paradigm, genetic paradigm and the systems paradigm.

Unit 2	**Kinetics**	**11 Hrs**
Equilibrium Binding and Co-operativity – Michaelis Menten Kinetics –identical and independent binding sites – Identical and interacting binding sites, noninteracting binding sites. Genetic switch in Lambda Phage -Noise-based Switches and Amplifiers for Gene Expression. Synthetic genetic switches –Ecoli chemotaxis – biological oscillators- genetic oscillators -The Origin and Consequences of Noise in Biochemical Systems.		
Unit 3	**Developmental Systems Biology**	**9 Hrs**
Building an Organism Starting from a Single Cell -Quorum Sensing – Programmed Population Control by Cell-Cell Communication and Regulated Killing Drosophila Development. Establishment of Developmental Precision and Proportions in the Early Drosophila embryo.		
Unit 4	**Gene expression networks**	**9 Hrs**
Gene regulation at a single cell level- Transcription Networks -basic concepts -coherent Feed Forward Loop (FFL) and delay gate -The incoherent FFL - Temporal order, Signaling networks and neuron circuits -Aspects of multi-stability in gene networks.		
Unit 5	**Applications and Future Perspectives in Systems Biology**	**8 Hrs**
Synthetic Biology and Gene Circuit Design, Computational Biology Tools for Systems Biology, Systems Biology in Disease Modeling and Drug Discovery, Integrative Approaches: Omics Data and Personalized Medicine		
	Total	**45 Hrs**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	*Tissue Engineering*	Bernhard O. Palsson and Sangeeta N. Bhatia

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman and Hall/CRC Press, Mathematical and Computational Biology, 2nd edition, 2006.	Uri Alon

Self-Study Content Links:		**Duration (in H)**
MOOCs	https://alison.com/course/the-basics-of-forensic-biology-and-chemistry	4-5 **Hrs**
	https://alison.com/course/mastering-genomics-unveiling-insights-through-microarray-analysis	5-6 **Hrs**
	https://alison.com/course/introduction-to-bioengineering-and-biotechnology	6-10 **Hrs**
	https://alison.com/course/fundamentals-in-biotechnology-and-	

	genetics https://alison.com/course/introduction-to-precision-medicine https://alison.com/course/metabolic-network-analysis https://alison.com/course/applications-of-biotechnology	6-10 **Hrs** 3-4 **Hrs** 5-6 **Hrs** 3-4 **Hrs**
Video Lectures		
Web References	https://www.youtube.com/watch?v=yWPdlTV_ny0andpp=ygW7AVN5c3RlbXMgQmlvbG9neSAgRnVuZGFtZW50YWxzIE92ZXJ2aWV3IG9mIEdlbmUgQ29udHJvbCDigJNXb3JraW5nIG9mIEdlbmV0aWMgU3dpdGNoZXMg4oCTIEludHJvZHVjdG9yeSBTeXN0ZW1zIEJpb2xvZ3kgVGhlIGJpb2NoZW1pY2FsIHBhcmFkaWdtLCBnZW5ldGljIHBhcmFkaWdtIGFuZCB0aGUgc3lzdGVtcyBwYXJhZGlnbS4%3 https://www.youtube.com/watch?v=3kLHz9u2rzEandpp=ygUea2luZXRpY3MgaW4gYmlvbG9naWNhbCBzeXN0ZW1z https://www.youtube.com/watch?v=gFjU_fW-dSwandpp=ygUeRGV2ZWxvcG1lbnRhbCBTeXN0ZW1zIEJpb2xvZ3kg https://www.youtube.com/watch?v=So6MK_FcP4Eandpp=ygUZR2VuZSBleHByZXNzaW9uIG5ldHdvcmtzIA%3D%3D https://www.youtube.com/watch?v=2DGcOza087Aandpp=ygU1QXBwbGljYXRpb25zICYgRnV0dXJlIFBlcnNwZWN0aXZlcyBpbiBTeXN0ZW1zIEJpb2xvZ3k%3D	

Lab Course Code: CBT0452	Lab Course Name: Fermentation Engineering Lab	L	T	P	C
Course Offered in: Department of Biotechnology		**0**	**0**	**4**	**2**

Prerequisite: Basics of microbiology and biochemistry

Course Objective: This course provides hands-on experience in fermentation techniques, focusing on the operation of key equipment like fermenters and bioreactors. Students will study microbial growth kinetics, analyze product formation, and interpret critical fermentation parameters.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Operate lab-scale fermenters and apply sterilization techniques effectively.	K3
CO2	Measure microbial growth and analyze bioprocess kinetic parameters.	K4
CO3	Perform production, recovery, and yield optimization of primary and secondary metabolites.	K5
CO4	Evaluate and apply bioprocess monitoring and control strategies to enhance fermentation productivity.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	1	1	2	1	2	2	2	2
CO2	3	3	2	2	2	2	1	1	2	1	2	2	2	2
CO3	3	3	2	2	2	2	1	1	2	1	2	2	2	2
CO4	3	3	2	2	2	2	1	1	2	1	2	2	2	2

List of Practical's (Indicative & Not Limited To)	**CO**
1. To study the design, construction, and control systems of a fermenter.	CO1, CO4
2. To study microbial growth curve analysis using spectrophotometric OD measurement in batch fermentation.	CO2
3. To study the effect of temperature on yeast fermentation by measuring CO_2 production.	CO2, CO4
4. To isolate and enumerate yeast from fermented food samples using serial dilution technique.	CO2
5. To prepare dhokla for the understanding of lactic acid fermentation in traditional Indian fermented food.	CO3

6. To measure the quantity of lactic acid produced by Lactobacillus during curd fermentation.	CO2, CO3
7. To produce ethanol from grapefruit through yeast fermentation.	CO3
8. To produce wine using oranges.	CO3
9. To produce citric acid from whey supplemented with glucose.	CO2
10. To produce microbial Amylase/Protease enzyme by submerged fermentation.	CO4
11. To isolate protease-producing microorganisms from soil or food waste.	CO3
12. To produce antibiotics using the principles of fermentation.	CO2, CO3
13. To produce biopolymers using a suitable microbial strain.	CO4
14. To prepare fruit jam and study the role of sugar concentration in preservation.	CO2, CO4
Total H: 60 hrs.	

Lab Course Code: CBT0453	Lab Course Name: Immunology and Immunotechnology Lab	L	T	P	C
Course Offered in: Department of Biotechnology		**0**	**0**	**2**	**1**

Prerequisite: Basics of molecular biology and biochemistry

Course Objective: The course aims to equip students with practical skills and theoretical understanding in immunology and immunotechnology, fostering proficiency in experimental techniques and clinical applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Understand the fundamental concepts in immunology, including the immune system's components, mechanisms, and functions.	K2
CO2	Analyze, and interpret experimental data obtained from immunological experiments, including quantitative analysis of antigen-antibody interactions	K4
CO3	Develop practical skills in performing a variety of immunological assays and experiments.	K6

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	1	-	1	1	2	3	-	-
CO2	3	3	-	3	2	-	-	-	2	1	3	3	-	3
CO3	2	2	2	2	3	-	-	1	2	1	2	3	2	2

List of Practical's (Indicative & Not Limited To)		**CO**
1.	To identify the blood cells/ immune cell with the help of leishman stain.	CO1
2.	To determine the blood group and Rh factor of given blood	CO1
3.	To perform single radial immunodiffusion	CO2
4.	To perform double immunodiffusion	CO2
5.	To perform counter current immune electrophoresis	CO2
6.	To perform Sandwitch ELISA	CO3
7.	To determination of binding affinity of antigen-antibody complex.	CO2
8.	To Isolate and perform microscopic visualization of T-cells and B-cells	CO1
9.	To perform western blotting.	CO3

10.	Histological examination of immune organs.	CO3
		Total H: 30 hrs.

Course Code: CBT0455	Course Name : Structural Bioinformatics	L	T	P	C
Course Offered in: Biotechnology		0	0	6	3

Prerequisite: Bioinformatics

Course Objective: To exhibit depth and breadth of knowledge by demonstrating a well-developed understanding of biological sciences and able to critically analyse and solve problems in biotechnology by gathering, synthesizing and critically evaluating information from a range of sources.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Understand the various tools and techniques related to in-silico modeling of biomolecules.	K3
CO2	Analyze problems related to collection and Speculate RNA Structure by different methods and its limitations	K4
CO3	Understand different Machine algorithms and capable to evaluate and validate by statistical significance	K2
CO4	Understand the application of molecular dynamics, molecular mechanism and its application in protein folding	K2
CO5	Apply the knowledge of molecular modeling in drug designing and development	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	2	-	-	-	-	2	3	2	-	3
CO2	2	2	-	-	3	-	-	-	2	3	2	2	-	3
CO3	3	2	-	2	2	-	-	-	-	2	3	2	-	3
CO4	3	3	-	2	2	1	-	-	-	2	2	2	-	3
CO5	3	3	2	3	3	1	1	-	2	3	3	2	1	3

Course Contents / Syllabus

Unit 1	Sequence Alignment	16 Hrs

Exercise 1: Homology identification Exercise 2: Genomic sequence annotation (Genes and ORFs identification) Exercise 3: Protein structure prediction (Secondary structure prediction) Exercise 4: Protein structure prediction (Tertiary structure prediction) Exercise 5: Protein function prediction. Exercise 6: Biological network identification Exercise 7: Next generation sequencing Exercise 8: Microarray data analysis		
Unit 2	**RNA Structure and Function**	**16 Hrs**
Exercise 9 Basics of RNA Structure prediction and its limitations. Exercise 10: Database Searching: Introduction, Evolutionary Basis of Sequence Alignment Exercise 11: Features of RNA Secondary Structure Exercise 12: RNA structure prediction methods: Based on self- complementary regions in RNA sequence Exercise 13: RNA structure prediction methods: Minimum free energy methods Exercise 14: Suboptimal structure prediction by MFOLD Exercise 15: Prediction based on finding most probable structure and Sequence co-variance method Exercise 16: Application of RNA structure modeling		
Unit 3	**High Throughput Sequencing**	**16 Hrs**
Exercise 17: Basic concept of Databases and file formats: Fasta, VCF, BED and SRA Exercise 18: - Mapping data formats: SAM, BAM- General Feature Format/General Transfer Format for Genes, DNA and RNA, and Protein sequences Exercise 19: Data preprocessing and Quality Controlling, - Whole genome sequencing, transcriptome and exome sequencing Exercise 20: Single cell RNA sequencing, ChipSeq, Personalized Medicine, Application of NGS in Human diseases: Cancer and neurodegenerative diseases.		
Unit 4	**Phylogenomics and Metabolic Pathway Reconstruction**	**16 Hrs**
Exercise 21: Genome Annotation and Core Marker Harvesting Using RAST Exercise 22: Whole-Genome Core Phylogenomic Tree Generation Exercise 23: Advanced Tree Visualization and Customization in iTOL Exercise 24: Functional Annotation and Metabolic Pathway Identification via KEGG		
Unit 5	**Metagenomics**	**16 Hrs**
Exercise 25: Introduction to Metagenomics, Microbial Comm Moduleies, Taxonomic classification and functional annotation Exercise 26: Novel Gene Prediction, Different metagenomic milieu; Viral,bacterial, fungal, algal and		

protozoan Exercise 27: Techniques for metagenomics study: Shotgun metagenomics, Amplicon sequencing (16S/18S rRNA, ITS) Exercise 28: third-generation sequencing (Nanopore, PacBio), Comparative Metagenomics, Microbiome-based disease diagnostics, Biosafety and IPR issues in metagenomics. Application of metagenomics to the study of human microbiome, Bioremediation and Industrial Bioproducts		
Total ours		**80 Hrs**
Textbook:		
S.No	**Book Title with publication agency & year**	**Author**
1	Bioinformatics: Sequence and Genome Analysis 2nd Edition	David W. Mount
2	Bioinformatics: A Practical Guide to the Analysis of Genes and Protein.	
Reference books		
S.No	**Book Title with publication agency & year**	**Author**
1	Bioinformatics for Dummies by, 2nd Edition	Jean-Michel Claverie and Cedric Notredame
Self-Study Content Links:		**Duration (in Hrs)**
MOOCs	https://www.nptel.ac.in/courses/106105152 https://nptel.ac.in/courses/106106198	36-48 Hrs 36-48 Hrs
Video Lectures		
Web References		
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=zvyv_snBih8andpp=ygUmR2VuZXJhbCBJbnRyb2R1Y3Rpb24gb2YgYmlvaW5mb3JtYXRpY3M%3D	
Unit 2	https://www.youtube.com/watch?v=rDhElW5ox6wandpp=ygUkRGF0YWJhc2UgU2VhcmNoaW5nIG9mIGJpb2luZm9ybWF0aWNz	
Unit 3	https://www.youtube.com/watch?v=AgIMm4B_Ticandpp=ygUeU2NvcmluZyBNYXRyaWNzIEJpb2luZm9ybWF0aWNz	
Unit 4	https://www.youtube.com/watch?v=Wj0OV2jf1VQandpp=ygUkUGh5bG9nZW5ldGljIGFuYWx5c2lzIEJpb2luZm9ybWF0aWNz0gcJCYsJAYcqIYzv	
Unit 5	https://www.youtube.com/watch?v=z2XvrbRw7y8andpp=ygUeQXBwbGljYXRpb25zIG9mIEJpb2luZm9ybWF0aWNz	