NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Affiliated to

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

Evaluation Scheme & Syllabus

For

Bachelor of Technology
Biotechnology

Second Year

(Effective from the Session: 2025-26)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Bachelor of Technology
Biotechnology

Evaluation Scheme
SEMESTER-III

Sl. No.	Subject Codes	Subject	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BCSCC0301	Employability Skill Development - I	Mandatory	2	0	0	60	40	100				100	2
2	BASL0301N	Technical Communications	Mandatory	2	0	0	30	20	50		50		100	2
3	BBT0303	Genetics and Molecular Biology	Mandatory	2	0	0	30	20	50		50		100	2
4	BBT0302	Microbiology	Mandatory	3	0	0	30	20	50		100		150	3
5	BBT0301N	Biochemistry	Mandatory	2	0	0	30	20	50		50		100	2
6	BBT0306	Analytical Techniques	Mandatory	3	0	0	30	20	50		100		150	3
7	BBT0353	Genetics and Molecular Biology Lab	Mandatory	0	0	4				50		50	100	2
8	BBT0352N	Microbiology and Biochemistry Lab	Mandatory	0	0	4				50		50	100	2
9	BBT0356	Analytical Techniques Lab	Mandatory	0	0	2				25		25	50	1
10	BBT0355	Bioinformatics	Mandatory	0	0	6				50		100	150	3
11	BBT0359X	Social Internship	Mandatory	0	0	2				50			50	1
12	BNC0301/ BNC0302	Artificial Intelligence and Cyber Ethics / Environmental Science	Compulsory Audit	2	0	0	30	20	50				50	NA
		*Massive Open Online Courses (For B.Tech. Hons. Degree)	*MOOCs											
		TOTAL		**16**	**0**	**18**			**350**	**225**	**350**	**225**	**1150**	**23**

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

Sr. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0055	Bioinformatics for Biologists: An Introduction to Linux, Bash Scripting, and R	Future Learn	15h	1
2	BMC0009	Probability and Statistics using Python	Infosys Wingspan (Infosys Springboard)	16h	1

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-II and will be assessedduring semester-III**
- **Compulsory Audit (CA) Courses (Non-Credit - BNC0301/BNC0302)**
  - 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, GAUTAM BUDDH NAGAR
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Bachelor of Technology
Biotechnology

Evaluation Scheme

SEMESTER-IV

Sl. No.	Subject Codes	Subject	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BASCC0401	Employability Skill Development - II	Mandatory	2	0	0	60	40	100				100	2
2	BBT0403N	Fermentation Engineering	Mandatory	3	0	0	30	20	50		100		150	3
3	BBT0402	Immunology and Immunotechnology	Mandatory	3	0	0	30	20	50		100		150	3
4	BBT0405	r-DNA Technology	Mandatory	3	0	0	30	20	50		100		150	3
5	BBT0406	Biophysics and Bioinstrumentation	Mandatory	3	1	0	30	20	50		100		150	4
6		Departmental Elective-I	Departmental Elective	3	0	0	30	20	50		100		150	3
7	BBT0453N	Fermentation Engineering Lab	Mandatory	0	0	4				50		50	100	2
8	BBT0452	Immunology and Immunotechnology Lab	Mandatory	0	0	2				25		25	50	1
9	BBT0407	Structural Bioinformatics	Mandatory	0	0	6				50		100	150	3
10	BBT0459	Mini Project	Mandatory	0	0	2				50			50	1
11	BCSCC0452	Problem Solving Approaches	Mandatory	0	0	2				50			50	1
12	BNC0402/ BNC0401	Environmental Science / Artificial Intelligence and Cyber Ethics	Compulsory Audit	2	0	0	30	20	50				50	NA
		*Massive Open Online Courses (For B.Tech. Hons. Degree)	*MOOCs											
		Applied English	VAC	1	0	0								
		TOTAL		**20**	**1**	**16**			**350**	**225**	**500**	**175**	**1250**	**26**

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

S. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0037	Financial Modelling - Biotech Company	Infosys Wingspan (Infosys Springboard)	20h 18 m	1.5
2	BMC0082	Introduction to AI & ML	Infosys Wingspan (Infosys Springboard)	64h 13m	4

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-IV and will be assessedduring Semester-V**
- **Compulsory Audit (CA) Courses (Non-Credit - BNC0401/BNC0402)**
  - 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.

List of Departmental Elective

Sl. No.	Subject Codes	Subject Name	Types of Subjects	Bucket Name	Branch	Semester
1	BBT0411	Biosimilars Technology	Program Elective	Bioprocess	BT	IV
2	BBT0413	System Biology	Program Elective	Computational	BT	IV
3	BBT0412	Environmental Biotechnology	Program Elective	Environmental	BT	IV

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A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as Coursera 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 Coursera 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

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School of Biotechnology

Course Code: BASL0301N	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

Pre-requisite: 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 Knowledge Level (KL)
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 Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2													
CO3													
CO4													
CO5													

Course Contents / Syllabus

Module 1	**Introduction to Technical Communication**	**4 hours**
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.. hours**
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. hours**
Module 3.1: Job Application & Resume	Preparing effective job applications and Resumes; writing, objectives; brief profiles	
Module 3.2: Report, Proposal & technical Paper	Writing AbstractsIntroductions & Conclusions; important parts; and formats	
Module 3.3: Ethical Writing	Copy Editing, Referencing and Plagiarism	

Module 4	**Public Speaking**	**.6. hours**
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. hours**

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 Lecture Hours	**24 hours**

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.	

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://onlinecourses.nptel.ac.in/noc24_ge37/preview
Module 2	https://archive.nptel.ac.in/courses/109/106/109106094/
Module 3	https://www.youtube.com/watch?v=kOJlwMJxEG0&t=8s
Module 4	https://www.youtube.com/watch?v=Sg7Q_dC_fWU&list=PLPuC5CMHiqmuzq_KQ4aw0V9Q7xJY6aezb
Module 5	https://www.youtube.com/watch?v=ymLFJDpjgCk&list=PLPuC5CMHiqmuzq_KQ4aw0V9Q7xJY6aezb&index=6

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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School of Biotechnology

Course Code: BBT0303	Course Name: Genetics and Molecular Biology	L	T	P	C
Course Offered in: Department of Biotechnology		2	0	0	2

Pre-requisite: Basics of Biology, Biochemistry.

Course Objectives: To provide students the knowledge about fundamentals of genetics, including mutations, repair mechanisms, evaluate genetic and allelic frequencies, and get insight the chemistry of nucleic acids, and genetic materials, process and mechanism of replication, transcription, translation, molecular basis of gene regulations, and modern technologies with an emphasis on their applications in diagnostics and research.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of qualitative and quantitative genetics, including inheritance patterns, gene interactions, linkage, gene mapping, and population genetics principles like Hardy-Weinberg equilibrium.	K2
CO2	Understand the structure and function of chromosomes, types of mutations, chromosomal analysis techniques, and comprehend modern approaches for detection of mutation.	K2
CO3	Get insight into the structure and function of genetic materials, and the processes of replication, transcription, and translation in prokaryotes and eukaryotes, and apply PCR techniques in diagnostic and research contexts.	K2, K3
CO4	Evaluate the mechanisms of gene expression and regulation in detail and assess the role of methylation assays in disease diagnostics.	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	2	3	3	2	1	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

Module 1	Qualitative and Quantitative Genetics	**8 hours**

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.

Module 2	Chromosomes and Mutations	**8 hours**

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.

Module 3	Genetic material, DNA Replication, Transcription and Translation	**8 hours**

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.

Module 4	Gene Expression and Gene regulation	**8 hours**

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 Lecture Hours	**32 hours**

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.

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=7S4WMwesMts
Module 2	https://www.youtube.com/watch?v=0mURpZD-mmU
Module 3	https://www.youtube.com/watch?v=xvWdIi6_fGg&t=118s
Module 4	https://www.youtube.com/watch?v=6gUY5NoX1Lk

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Course Code: BBT0302	Course Name: Microbiology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Basics of Biology, Biochemistry.

Course Objectives: The course provides the students with both conceptual and experimental background in the broad discipline of microbiology. The students will have fundamental understanding of the microbial world, basic structure and functions of microbes, metabolism, nutrition, their diversity, physiology and relationship to environment and human health. To impart practical skills of isolation and manipulate conditions for their propagation.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Define the science of microbiology, its development and importance in human welfare.	K1
CO2	Describe some of the general methods used in the study of microorganisms.	K1
CO3	Understand the nutritional and physical importance of autotrophs, heterotrophs and chemotrophs	K2
CO4	Recognize and compare structure and function of microbes and factors affecting microbial growth.	K1, K2
CO5	Explain the role of microorganisms in the Environment, Industry and Healthcare	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	-	-	-	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

Module 1	History and scope of microbiology	**8 hours**

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

Module 2	Morphology and fine structure of microorganisms:	**8 hours**

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.

Module 3	Microbial requirements	**8 hours**

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.

Module 4	Microbial Growth and Microbial Control	**8 hours**

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.

Module 5	Environmental, industrial and medical microorganisms	**7 hours**

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 Lecture Hours	**39 hours**

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)
NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=IiqpUJ4j_bs	
Module 2	https://www.youtube.com/watch?v=FZyDZ3PLZ-4	
Module 3	https://www.youtube.com/watch?v=U_7vjo5pJXQ	
Module 4	https://www.youtube.com/watch?v=L5_6kAQBN5E	
Module 5	https://www.youtube.com/watch?v=t2cQXfnwLQ0	

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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School of Biotechnology

Course Code: BBT0301N	Course Name: Biochemistry	L	T	P	C
Course Offered in: Department of Biotechnology		2	0	0	2

Pre-requisite: Basics of Biology and chemistry

Course Objective: This course provides a comprehensive understanding of essential biomolecules and their roles in biological systems. It explores the significance of water, pH, and buffers in maintaining cellular function and stability. Students will study major metabolic pathways and how they are regulated. The course also introduces key biochemical techniques and tools used in research and diagnostics. Emphasis is placed on applying biochemical knowledge to understand health, disease mechanisms, and advancements in biomedical research.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain and associate the chemistry with carbohydrates, their function and metabolism in the body, and apply the earned knowledge to understand the biochemical basis of metabolic diseases.	K1, 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.	K1, K2
CO3	Learn the basics of amino acids and protein structure and metabolism; and apply the acquired knowledge in understanding and working with associated techniques in research and industrial level.	K1, K3
CO4	Identify and explain the structure and metabolism of nucleic acids and solve associated research problems with the help of acquired learning.	K2, 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	2	2	2	-	2	3	3	2
CO2	3	2	3	2	3	2	2	2	2	-	2	3	3	3
CO3	3	3	2	2	2	2	2	2	2	-	2	3	3	3
CO4	3	3	3	2	2	2	2	3	3	-	3	3	3	2

Course Contents / Syllabus

Module 1	Buffer system and Carbohydrates	**9 hours**

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.

Module 2	Fatty acids and lipids	**9 hours**

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.

Module 3	Amino acids and peptides	**9 hours**

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.

Module 4	Nucleic acids	**9 hours**

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 Lecture Hours	**36 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Principles of BiochemistryMcMillan 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
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
NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=WhLrKCXxp08	
Module 2	https://www.youtube.com/watch?v=OOc3zEgLLtk	
Module 3	https://nptel.ac.in/courses/102/105/102105034/	
Module 4	https://nptel.ac.in/courses/104/103/104103121/	

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

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School of Biotechnology

Course Code: BBT0306	**Course Name: Analytical Techniques**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

Pre-requisite: Students should know about the different analytical techniques.

Course Objectives: 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 Knowledge Level (KL)
CO1	Describe the principles and various components of different microscopes to analyze and characterize biomolecules.	K1
CO2	Describe the general principle of chromatographic separations and apply these techniques to the separation of a hypothetical protein sample.	K1, K3
CO3	Understand the regions of electromagnetic spectrum and relate them to spectroscopic methods	K2
CO4	Outline and understand the concept 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 Mapping	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

Module 1	**Microscopy and its types**	**6 hours**

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

Module 2	**Chromatography**	**7 hours**

Principle and Operations of Chromatography, Thin layer chromatography, Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Affinity Chromatography

Module 3	**Spectroscopy**	**8 hours**

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.

Module 4	**Electrophoresis**	**6 hours**

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.

Module 5	**Centrifugation and Biosensors**	**8 hours**

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 Lecture Hours	**35 hours**

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

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

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=7S4WMwesMts
Module 2	https://www.youtube.com/watch?v=0mURpZD-mmU
Module 3	https://www.youtube.com/watch?v=xvWdIi6_fGg&t=118s
Module 4	https://www.youtube.com/watch?v=6gUY5NoX1Lk

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

LAB Course Code: BBT0353	**LAB Course Name: Genetics and Molecular Biology Lab**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**0**	**0**	**4**	**2**

Pre-requisite:

Course Objectives: 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 Knowledge Level (KL)
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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
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)

1. To understand and calculate the genotypic and allelic frequencies in a given population using the Hardy-Weinberg equilibrium principle.
2. Study on linkage, crossing over, and gene mapping in *Drosophila melanogaster*.
3. Study of polytene chromosome from insect salivary gland.
4. Study and Observation of mutants in Drosophila.
5. Extraction of genomic DNA from Drosophila/ animal cell.
6. To understand the principles and applications of Polymerase Chain Reaction (PCR) amplification and gel electrophoresis in molecular biology.
7. Estimation of size in bp of DNA using agarose gel electrophoresis
8. Polyacrylamide gel electrophoresis and estimation of MW of proteins.
9. Demonstration of gene expression, regulation of gene expression by using a digital platform.
10. Demonstration of gene expression using DNA microarray by using a digital platform.

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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School of Biotechnology

LAB Course Code: BBT0352N	LAB Course Name: Microbiology and Biochemistry Lab	L	T	P	C
Course Offered in: Department of Biotechnology		0	0	4	2

Pre-requisite:

Course Objectives: 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 Knowledge Level (KL)
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 and sugars in samples	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	3	1	3	2	2	2	2	2	-	3	3	2
CO2	3	2	2	1	3	3	3	3	3	2	-	3	3	2
CO3	3	2	2	2	3	2	2	2	2	2	-	3	3	3
CO4	3	2	2	2	3	2	2	2	3	2	-	3	3	3

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

1. Good microbial lab practices and biosafety.
2. Preparation of nutrient agar plate, slant nutrient broth and their sterilization. (Heating oven, autoclave, laminar air hood)
3. Inoculation of agar slant, plate and nutrient broth. (Incubator, laminar air hood)
4. Culture of microorganisms using various techniques. (Spread-plate method, pore-plate method, streaking method)
5. Identification of microbial colony based on microbial morphology.
6. Isolation and identification (based on colony morphology) of microorganisms from soil sample.
7. To identify given microorganisms based on gram staining.
8. To study the anti-microbial efficacy of plant extract.
9. To study the microbial Growth Curve Determination
10. Identification of the microbes based on biochemical tests.
11. Estimation of carbohydrates in the given sample.
12. Estimation of protein in the given sample.

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

LAB Course Code: BBT0356	**LAB Course Name: Analytical techniques Lab**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**0**	**0**	**2**	**1**

Pre-requisite:

Course Objectives: 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 Knowledge Level (KL)
CO1	Prepare students to gain practical knowledge about the instruments for analytical techniques used in laboratory.	K2
CO2	Develop among students hand-on experience of separation of biomolecules on electrophoresis	K2, K3
CO3	Provide students with handing of UV spectrophotometer and its understanding.	K2
CO4	To make students understand the application of analytical techniques in research laboratories.	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	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

1. Demonstration of basic concept of precision and accuracy using appropriate experimental data.
2. To study principle and working of laboratory microscope.
3. To analyse the isolated plant pigments using paper chromatography
4. Separation of amino acids using thin layer chromatography
5. Separation of a mixture of polar and non-polar compounds using column chromatographic technique
6. Study of Beer-Lambert's law-using UV-Visible spectrophotometer
7. To study and analysis of DNA sample by agarose gel electrophoresis
8. To study and analysis of protein sample by SDS- PAGE.
9. To study the separation of compounds using liquid-liquid extraction experiments.
10. To study the separation of biological compounds using various membrane separation.

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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School of Biotechnology

LAB Course Code: BBT0355	LAB Course Name: Bioinformatics (Workshop mode)	L	T	P	C
Course Offered in: Department of Biotechnology		0	0	6	3

Pre-requisite: Basics of biology, molecular biology, Biochemistry

Course Objectives:

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 Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	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

Module 1	General Introduction	16 hours

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

Module 2	Database Searching	16 hours

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)

Module 3	**Scoring Matrics**	**16 hours**

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.

Module 4	**Phylogenetic analysis**	**16 hours**

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

Module 5	**Applications of Bioinformatics**	**16 hours**

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 Lecture Hours:	**80 hours**

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:

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

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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School of Biotechnology

Course Code: BNC0302	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: This course aims to equip students with a basic understanding of the interrelationship between humans and the environment, fostering awareness of environmental issues and promoting a positive attitude toward sustainability. It also seeks to develop the necessary skills and capabilities to address and solve environmental problems through social, political, cultural, and educational approaches.

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 environment. Ecosystem: Basic concepts, components of ecosystem, food chains and foodwebs. Ecological pyramids	K1,K2
CO2	Understand the different types of natural recourses like food, forest, Minerals and energy and their conservation	K1,K2
CO3	Understand the importance of biodiversity, Threats of biodiversity and different methods of biodiversity conservation.	K1,K2
CO4	Understand the different types of pollution, pollutants, their sources, effects and their control methods.	K1,K2
CO5	Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment	K1,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	3	2	2	1	3	3	2	-	2	2	3	2	2
CO2	3	3	2	2	1	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	1	3	3	2	2	2	2	2	2	2
CO4	3	3	2	2	-	3	3	3	2	2	2	2	2	2
CO5	3	3	2	2	-	3	3	2	2	**2**	**2**	**2**	**2**	**2**

Course Contents / Syllabus

Module 1	**Basic Principle of Ecology**	**4 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. Basic concepts of sustainable development, SDGs, Ecosystem services, UN Decade for Eco restoration ,

Module 2	**Natural Resources and Associated Problems**	**4 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, 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.

Module 3	**Biodiversity Succession and Non-Renewable Energy Resources**	**4 hours**

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. Succession: Concepts of succession, Types of Succession. Trends in succession. Climax and stability.

Module 4	**Pollution and Solid Waste Management**	**4 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, Climate change, global warming, acid rain, ozone layer depletion.

Module 5	**Role of CommModuley and Environmental Protection Acts**	**4 hours**

Role of community, women and NGOs in environmental protection, Bio indicators and their role, Natural hazards, Chemical accidents and disasters risk management, Environmental Impact Assessment (EIA), Salient features, of following Acts: a. Environmental Protection Act, 1986, Wildlife (Protection) Act, 1972.b. Water (Prevention and control of pollution) Act, 1974.c. Air (Prevention and control of pollution) Act, 1981. Forest (Conservation) Act, 1980. Wetlands (Conservation and Management) Rules, 2017; Chemical safety and Disaster Management law. District Environmental Action Plan. Climate action plans.

	Total Lecture Hours	**20 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York. 1990.	Brady, N.C.

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi 1989	Rao M.N. and H.V.N. Rao
2	A Text Book of environmental Science	Shashi Chawla
3	Environmental studies- Oxford Publication	R, Rajagopalan
4	**Environmental Science: Toward a Sustainable Future"**	Richard T. Wright and Dorothy F. Boorse
5	**"Living in the Environment"**	G. Tyler Miller and Scott Spoolman

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=T21OO0sBBfc https://www.youtube.com/watch?v=qt8AMjKKPDohttps:// https://www.youtube.com/watch?v=brF0RWJyx9w https://www.youtube.com/watch?v=GK_vRtHJZu4, https://www.youtube.com/watch?v=b6Ua_zWDH6U, https://www.youtube.com/watch?v=7tgNamjTRkk, https://www.youtube.com/watch?v=ErATB1aMiS
Module 2	https://www.youtube.com/watch?v=mOwyPENHhbc, https://www.youtube.com/watch?v=yqev1G2iy20, https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2g0

Module 3	https://www.youtube.com/watch?v=GK_vRtHJZu4,
Module 4	https://www.youtube.com/watch?v=b6Ua_zWDH6U, https://www.youtube.com/watch?v=7tgNamjTRkk,
Module 5	https://www.youtube.com/watch?v=ErATB1aMiS

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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(An Autonomous Institute)
School of Biotechnology

Course Code: BBT0403N	Course Name: Fermentation Engineering	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: The students should know the basics of microbiology, genetics and molecular biology and biochemistry.

Course Objectives: This course provides an understanding of fermentation processes, emphasizing microbial selection, medium optimization, and advanced technologies. It explores metabolic regulations, highlights fermentation applications in the food industry, and addresses bioprocess engineering with a focus on sustainability.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
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 Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
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

Module 1	Fermentation Fundamentals and Requirements	8 hours

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 The chronological development of the fermentation industry The component parts of a fermentation process

Module 2	Advanced Fermentation Technologies	8 hours

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.

Module 3	Metabolic Regulation in Fermentation	8 hours

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.

Module 4	Fermentation in Food Industry	8 hours

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.

Module 5	**Industrial Fermentation Applications and Bioprocess Engineering**	**8 hours**

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 Lecture Hours	**40 hours**

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).

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://youtu.be/MkW0eLxKNeI2
Module 2	https://youtu.be/LsWHqyjaD003
Module 3	https://youtu.be/AYv7tvgtmBk4
Module 4	https://youtu.be/C3J2jN-Gi9w5
Module 5	https://youtu.be/dC2mPnVbSc8

Course Code: BBT0402	Course Name: Immunology and Immunotechnology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Students should know the basics of cell biology and human physiology

Course Objectives: The course will foster an understanding of immunological principles, including antigen-antibody interactions, immune cell activation and regulation, and the development of immunological memory. Students will learn to critically analyze scientific literature, design experiments, and interpret research findings. They will also explore the application of immunological methods in areas such as immunotherapy, including the use of monoclonal antibodies, immune checkpoint inhibitors, vaccines, and adoptive cell therapies for treating various diseases.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Identify and explain in detail the basic components and functionalities of the immune system.	K1
CO2	Identify and explain antigen and antibody structure and function, thus will be able to understand the associated scientific and industrial research and technologies.	K1,K2
CO3	Understand the technical aspect of immunological reactions and their application in scientific research.	K2,K3
CO4	Describe various ways of regulation of immune response; and thus, will be able to critically evaluate the regulatory mechanisms and their importance in human health.	K2,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 Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
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

Module 1	**Overview of the Immune System**	**8 hours**

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 andB cell maturation, activation and differentiation.

Module 2	**Antigen and Antibody Structure**	**8 hours**

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

Module 3	**Immuno- Techniques and Immunization**	**8 hours**

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.

Module 4	**MHC and regulation of immune response**	**8 hours**

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.

Module 5	**Immunity and Diseases**	**8 hours**

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 Lecture Hours	**40 hours**

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.

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://youtu.be/lXfEK8G8CUI?si=31lzqyT4DZQlk0QI
Module 2	https://youtu.be/BSypUV6QUNw?si=uEY07sJyezf19TRy
Module 3	https://youtu.be/LmpuerlbJu0?si=TWVNfGAnMNsTbU4w
Module 4	https://youtu.be/UZTf3OXJDWA?si=PJpxMyHieof48RIE
Module 5	https://youtu.be/23O8rRHgluA?si=by_Yb1Qgpy5cMWfH

Course Code: BBT0405	Course Name: r-DNA Technology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Basic understanding of nucleic acids and molecular biology

Course Objectives: This course provides fundamental knowledge of molecular biology and recombinant DNA technology, focusing on gene cloning mechanisms and techniques. It introduces recent advancements in rDNA technology and familiarizes students with virtual labs and in silico cloning tools. The course also trains students in screening and selection methods for identifying recombinants.

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

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	PS03
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

Module 1	**Basic Principles of rDNA Technology**	**8 hours**

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

Module 2	**Vectors**	**8 hours**

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, Vectoer Selection and Screening,Application of vectors.

Module 3	**Polymerase Chain Reaction (PCR)**	**8 hours**

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

Module 4	Techniques in r-DNA technology	**8 hours**

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

Module 5	Screening and Selection of Recombinants	**10 hours**

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 Lecture Hours	**42 hours**

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.,

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=Yh9w_fyvpUk
Module 2	https://www.youtube.com/watch?v=VXkw_U6mJpc
Module 3	https://www.youtube.com/watch?v=
Module 4	https://www.youtube.com/watch?v=CgXtJ4ooaUU https://www.youtube.com/watch?v=OK7_ReXhVaQ
Module 5	https://www.youtube.com/watch?v=YnF1b_Kqf88 https://www.youtube.com/watch?v=BIIWlZqWxKg

Course Code: BBT0406	Biophysics and Bioinstrumentation	L	T	P	C
Course Offered in: Department of Biotechnology		3	1	0	4

Pre-requisite: Students should know about the basics of biology.

Course Objectives: 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 Knowledge Level (KL)
CO1	Learn about the phenomena of water transport across cellular membranes.	K1
CO2	Understand the concept of electrical phenomena in excitable cells.	K1, K2
CO3	Explore the general principles of signal transduction pathways involved in a wide range of physiological processes.	K1, K2, K3
CO4	Understand the thermodynamics and kinetics of macromolecules	K1, K2
CO5	Explore the application of electrophysiological methods in cellular physiology	K1, K2, K3

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	PS03
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

Module 1	**Water transport across cell membranes**	**8 hours**

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

Module 2	**Electrical Phenomena**	**8 hours**

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.

Module 3	**Ion Channels and Transporters**	**8 hours**

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.

Module 4	**Proteins and Nucleic acids**	**10 hours**

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.

Module 5	**Cell Dynamics and Electrophysiological Methods**	**10 hours**

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 Lecture Hours	**44 hours**

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.

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtu.be/eHV1s2g4s4o https://www.youtube.com/watch?v=J5pWH1r3pgU
Module 2	https://youtu.be/oxX2fq2DBBo?si=V5xVcAlJGq8IbXho https://www.youtube.com/watch?v=iWp9FVN7RIQ
Module 3	https://www.youtube.com/watch?v=Pl7nzXaVqak
Module 4	https://www.youtube.com/watch?v=Y5JOW2eApUI
Module 5	https://www.youtube.com/watch?v=wQID2zmeWTQ

Course Code: BBT0411	Biosimilars Technology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Fundamentals of Molecular Biology, Genetic Engineering, Bioprocess Technology

Course Objectives: 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 Knowledge Level (KL)
CO1	Explain the concept of biosimilars and their differences from generic drugs and reference biologics.	K1, K2
CO2	Describe the analytical and preclinical approaches used in biosimilar development and characterization.	K2, K3
CO3	Illustrate manufacturing, formulation, and quality control processes for biosimilars	K3
CO4	Analyze regulatory guidelines, global approval pathways, and comparability	K3, K4
CO5	Examine challenges in safety, efficacy, interchangeability, and pharmacovigilance of biosimilars.	K3, K4

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	PS03
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

Module 1	**Introduction to Biosimilars**	**8 hours**

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

Module 2	Development and Characterization	**8 hours**

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

Module 3	**Manufacturing and Quality Control**	**8 hours**

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

Module 4	**Regulatory Guidelines and Approval Pathways**	**8 hours**

EMA, USFDA, WHO, CDSCO guideline, Biosimilarity and interchangeability requirements, Clinical trial design for biosimilars, Risk-based comparability protocols, Patent and exclusivity issues in biosimilars

Module 5	**Market Trends, Safety, and Challenges**	**8 hours**

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 Lecture Hours	**40 hours**

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,
NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=1s7W1EKUekk	
Module 2	https://www.youtube.com/watch?v=ll0R_tvtMkI	
Module 3	https://www.youtube.com/watch?v=oyTE3xHwDnY	
Module 4	https://www.youtube.com/watch?v=W5xLU_Ihoag	
Module 5	https://www.youtube.com/watch?v=vGyU3XOEQ0M	

Course Code: BBT0412	Environmental Biotechnology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Students should know about the basic microbiology and fermentation engineering.

Course Objectives: This course aims to create awareness about environmental pollution and emphasize the necessity of advanced and biological technologies for its mitigation. It provides an overview of biotechnological approaches for pollutant conversion and environmental management. The course further explores industrial applications of biotechnology to reduce pollution, educates on bioproduct recovery from industrial wastes, and introduces novel technologies for effective environmental pollution abatement.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the biotechnological solutions for the treatment of industrial liquid and solid wastes	K2
CO2	Acquire knowledge in 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	**G**ain knowledge on the recovery of high value-added bioproducts from industrial wastes	K2, K3

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	PS03
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

Module 1	Environmental Pollutants and Biotechnological Approaches for Waste Treatment	**8 hours**

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.

Module 2	Biological Wastewater Treatment and Nutrient Removal Technologies	**8 hours**

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.

Module 3	Biodegradation of Xenobiotics and Recalcitrant Environmental Pollutants	**8 hours**

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.

Module 4	Microbial and Enzymatic Approaches for Industrial Waste Treatment	**8 hours**

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.

Module 5	Waste to Wealth: Resource Recovery and Sustainable Waste Utilization	**8 hours**

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 Lecture Hours	**40 hours**

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

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://app.jove.com/science-education/v/11112/in-vitro-plant-tissue-culture-and-genetic-modifications
Module 2	https://www.learninsta.com/applications-of-plant-tissue-culture/
Module 3	https://www.youtube.com/watch?v=8zZsJxjKjwQ
Module 4	https://www.researchgate.net/publication/387476821_The_Application_of_Transgenic_Technology/fulltext/676f9a56894c55208530acbe/The-Application-of-Transgenic-Technology.pdf
Module 5	https://www.youtube.com/watch?v=2PP4lVH8N2Q

Course Code: BBT0413	System Biology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Basic Biology and Genetics, Biochemistry, Mathematics, Computational and Data Analysis Skills.

Course Objectives: This course aims to provide a foundational understanding of systems biology by integrating molecular biology, biochemistry, and computational modeling to analyze complex biological systems. It covers gene regulation, genetic switches, biochemical kinetics, and cellular signaling, with applications in development, synthetic biology, and disease modeling. Students will gain a systems-level perspective essential for modern biological research and innovation.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
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.	K2, K3
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 examples like quorum sensing and Drosophila development	K2, 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 Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PS03
CO1	3	2	1	-	-	-	-	-	-	-	2	1	2	3
CO2	3	3	2	2	1	-	-	-	-	-	2	2	2	3
CO3	3	3	2	2	2	-	-	-	-	-	2	2	2	3
CO4	2	2	1	1	-	1	-	-	-	-	2	1	2	3
CO5	3	3	3	2	3	2	2	2	2	2	3	1	2	3

Course Contents / Syllabus

Module 1	**Systems Biology**	**8 hours**

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

Module 2	**Kinetics**	**8 hours**

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.

Module 3	**Developmental Systems Biology**	**8 hours**

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.

Module 4	**Gene expression networks**	**8 hours**

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.

Module 5	**Applications and Future Perspectives in Systems Biology**	**8 hours**

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 Lecture Hours	**40 hours**

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

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=yWPdlTV_ny0andpp=ygW7AVN5c3RlbXMgQmlvbG9neSAgRnVuZGFtZW50YWxzIE92ZXJ2aWV3IG9mIEdlbmUgQ29udHJvbCDigJNXb3JraW5nIG9mIEdlbmV0aWMgU3dpdGNoZXMg4oCTIEludHJvZHVjdG9yeSBTeXN0ZW1zIEJpb2xvZ3kgVGhlIGJpb2NoZW1pY2FsIHBhcmFkaWdtLCBnZW5ldGljIHBhcmFkaWdtIGFuZCB0aGUgc3lzdGVtcyBwYXJhZGlnbS4%3
Module 2	https://www.youtube.com/watch?v=3kLHz9u2rzEandpp=ygUea2luZXRpY3MgaW4gYmlvbG9naWNhbCBzeXN0ZW1z
Module 3	https://www.youtube.com/watch?v=gFjU_fW-dSwandpp=ygUeRGV2ZWxvcG1lbnRhbCBTeXN0ZW1zIEJpb2xvZ3kg
Module 4	https://www.youtube.com/watch?v=So6MK_FcP4Eandpp=ygUZR2VuZSBleHByZXNzaW9uIG5ldHdvcmtzIA%3D%3D
Module 5	https://www.youtube.com/watch?v=2DGcOza087Aandpp=ygU1QXBwbGljYXRpb25zICYgRnV0dXJlIFBlcnNwZWN0aXZlcyBpbiBTeXN0ZW1zIEJpb2xvZ3k%3D

LAB Course Code: BBT0453N	LAB Course Name: Fermentation Engineering Lab	L	T	P	C
Course Offered in: Department of Biotechnology		**0**	**0**	**4**	**2**

Pre-requisite:

Course Objectives: 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 Knowledge Level (KL)
CO1	Operate lab-scale fermenters and apply sterilization techniques effectively.	K1
CO2	Measure microbial growth and analyze bioprocess kinetic parameters.	K2
CO3	Perform production, recovery, and yield optimization of primary and secondary metabolites.	K1,K2
CO4	Evaluate and apply bioprocess monitoring and control strategies to enhance fermentation productivity.	K2.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	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)

1. To study the design, construction, and control systems of a fermenter
2. To prepare dhokla for the understanding of lactic acid fermentation in traditional Indian fermented food
3. To measure the quantity of lactic acid produced by *Lactobacillus* during curd fermentation.
4. To produce citric acid from whey supplemented with glucose
5. To produce wine using oranges
6. To produce ethanol from grapefruit through yeast fermentation
7. To produce microbial Amylase/Protease Enzyme by Submerged Fermentation
8. To produce biopolymers using a suitable microbial strain
9. To isolate protease-producing microorganisms from soil or food waste
10. To produce antibiotics using the principles of fermentation.

Total Hours: 48 hrs.

LAB Course Code: BBT0452N	LAB Course Name: Immunology and Immunotechnology Lab	L	T	P	C
Course Offered in: Department of Biotechnology		0	0	2	1

Pre-requisite:

Course Objectives: 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 Knowledge Level (KL)
CO1	Gain a comprehensive understanding of fundamental concepts in immunology, including the immune system's components, mechanisms, and functions.	K1
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
CO4	Apply immunological methods and techniques to investigate questions related to immune function, disease pathology, and therapeutic interventions.	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	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
CO4	3	3	3	2	3	2	1	1	2	2	3	3	2	3

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

1. To identify the blood cells/ immune cell with the help of leishman stain.
2. To determine the blood group and Rh factor of given blood
3. To perform single radial immunodiffusion
4. To perform double immunodiffusion
5. To perform counter current immune electrophoresis
6. To perform Sand-witch ELISA
7. To determination of binding affinity of antigen-antibody complex.
8. To Isolate and perform microscopic visualization of T-cells and B-cells
9. To perform western blotting.
10. Histological examination of immune organs.

Total Hours: 48 hrs.

Course Code: BBT0407	Course Name : Structural Bioinformatics (workshop mode)	L	T	P	C
Course Offered in: Biotechnology		**0**	**0**	**6**	**3**

Pre-requisite: Bioinformatics

Course Objectives: 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 Knowledge Level (KL)
CO1	Understand the various tools and techniques related to in-silico modeling of biomolecules.	K2, K3
CO2	Analyze problems related to collection and Speculate RNA Structure by different methods and its limitations	K3, 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, K4

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	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

Module 1	**Sequence Alignment**	**16 hours**

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

Module 2	**RNA Structure and Function**	**16 hours**

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

Module 3	**High Throughput Sequencing**	**16 hours**

Exercise 17: Basic concept of Databases and file formats:, Fastq, 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..

Module 4	**Phylogenetic analysis**	**16 hours**

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

Module 5	**Metagenomics**	**16 hours**

Exercise 27: Introduction to Metagenomics, Microbial CommModuleies, Taxonomic classification and functional annotation

Exercise 28: Novel Gene Prediction, Different metagenomic milieu; Viral,bacterial, fungal, algal and protozoan

Exercise 29: Techniques for metagenomics study: Shotgun metagenomics, Amplicon sequencing (16S/18S rRNA, ITS)

Exercise 30: 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 Lecture Hours	**80 hours**

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

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=zvyv_snBih8andpp=ygUmR2VuZXJhbCBJbnRyb2R1Y3Rpb24gb2YgYmlvaW5mb3JtYXRpY3M%3D

Module 2	https://www.youtube.com/watch?v=rDhElW5ox6wandpp=ygUkRGF0YWJhc2UgU2VhcmNoaW5nIG9mIGJpb2luZm9ybWF0aWNz
Module 3	https://www.youtube.com/watch?v=AgIMm4B_Ticandpp=ygUeU2NvcmluZyBNYXRyaWNzIEJpb2luZm9ybWF0aWNz
Module 4	https://www.youtube.com/watch?v=Wj0OV2jf1VQandpp=ygUkUGh5bG9nZW5ldGljIGFuYWx5c2lzIEJpb2luZm9ybWF0aWNz0gcJCYsJAYcqIYzv
Module 5	https://www.youtube.com/watch?v=z2XvrbRw7y8andpp=ygUeQXBwbGljYXRpb25zIG9mIEJpb2luZm9ybWF0aWNz

Course Code: BNC0402	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: This course aims to equip students with a basic understanding of the interrelationship between humans and the environment, fostering awareness of environmental issues and promoting a positive attitude toward sustainability. It also seeks to develop the necessary skills and capabilities to address and solve environmental problems through social, political, cultural, and educational approaches.

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 environment. Ecosystem: Basic concepts, components of ecosystem, food chains and foodwebs. Ecological pyramids	K1,K2
CO2	Understand the different types of natural recourses like food, forest, Minerals and energy and their conservation	K1,K2
CO3	Understand the importance of biodiversity, Threats of biodiversity and different methods of biodiversity conservation.	K1,K2
CO4	Understand the different types of pollution, pollutants, their sources, effects and their control methods.	K1,K2
CO5	Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment	K1,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	3	2	2	1	3	3	2	-	2	2	3	2	2
CO2	3	3	2	2	1	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	1	3	3	2	2	2	2	2	2	2
CO4	3	3	2	2	-	3	3	3	2	2	2	2	2	2
CO5	3	3	2	2	-	3	3	2	2	**2**	**2**	**2**	**2**	**2**

Course Contents / Syllabus

Module 1	**Basic Principle of Ecology**	**4 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. Basic concepts of sustainable development, SDGs, Ecosystem services, UN Decade for Eco restoration ,

Module 2	**Natural Resources and Associated Problems**	**4 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, 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.

Module 3	**Biodiversity Succession and Non-Renewable Energy Resources**	**4 hours**

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. Succession: Concepts of succession, Types of Succession. Trends in succession. Climax and stability.

Module 4	**Pollution and Solid Waste Management**	**4 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, Climate change, global warming, acid rain, ozone layer depletion.

Module 5	**Role of CommModuley and Environmental Protection Acts**	**4 hours**

Role of community, women and NGOs in environmental protection, Bio indicators and their role, Natural hazards, Chemical accidents and disasters risk management, Environmental Impact Assessment (EIA), Salient features, of following Acts: a. Environmental Protection Act, 1986, Wildlife (Protection) Act, 1972.b. Water (Prevention and control of pollution) Act, 1974.c. Air (Prevention and control of pollution) Act, 1981. Forest (Conservation) Act, 1980. Wetlands (Conservation and Management) Rules, 2017; Chemical safety and Disaster Management law. District Environmental Action Plan. Climate action plans.

Total Lecture Hours	**20 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York. 1990.	Brady, N.C.

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi 1989	Rao M.N. and H.V.N. Rao
2	A Text Book of environmental Science	Shashi Chawla
3	Environmental studies- Oxford Publication	R, Rajagopalan
4	**Environmental Science: Toward a Sustainable Future"**	Richard T. Wright and Dorothy F. Boorse
5	**"Living in the Environment"**	G. Tyler Miller and Scott Spoolman

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=T21OO0sBBfc https://www.youtube.com/watch?v=qt8AMjKKPDohttps:// https://www.youtube.com/watch?v=brF0RWJyx9w https://www.youtube.com/watch?v=GK_vRtHJZu4, https://www.youtube.com/watch?v=b6Ua_zWDH6U, https://www.youtube.com/watch?v=7tgNamjTRkk, https://www.youtube.com/watch?v=ErATB1aMiS
Module 2	https://www.youtube.com/watch?v=mOwyPENHhbc, https://www.youtube.com/watch?v=yqev1G2iy20, https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2g0
Module 3	https://www.youtube.com/watch?v=GK_vRtHJZu4,
Module 4	https://www.youtube.com/watch?v=b6Ua_zWDH6U, https://www.youtube.com/watch?v=7tgNamjTRkk,
Module 5	https://www.youtube.com/watch?v=ErATB1aMiS