SANDIP UNIVERSITY

School of Engineering and Technology

Department of Biotechnology

This is to certify that the Course Structure and Syllabus for the B.Tech. Biotechnology program has been reviewed and endorsed by the Board of Studies. The syllabus has been thoroughly examined and is in full compliance with the academic and professional standards established by the University and the relevant regulatory authorities.

It is hereby recommended for implementation, effective from the academic year 2025-26. This certificate serves as formal approval of the contents of the syllabus and authorizes its distribution to students and faculty.

4/07/25

Dr.Varsha Rani
Chairperson, BoS,
Dept. of Biotechnology,
SoET, SUN

4/7/25.

Prof.(Dr.) P.G.Burade
Associate Dean Engineering
SoET,SUN

04/07/25

Prof.(Dr.) M.S.Endait
Associate Dean Academics
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SANDIP UNIVERSITY MAHIRAVANI NASHIK

SANDIP UNIVERSITY

School of Engineering and Technology

Department of Biotechnology

Course Structure-B.Tech Biotechnology
Semester – III

Sr. No.	Core	Course Code	Course Name	Teaching Scheme (Hrs./Week)				Examination Scheme				Total Marks
				L	T	P	C	Formative Assessment CIA		Summative Assessment ESE		
								Course	Lab	Course	Lab	
1	PCC	NYBT301	Microbial Biotechnology	3	0	0	3	50	-	100	-	100
2	PCC	NYBT302	Cell and Molecular Biology	3	0	0	3	50	-	100	-	100
3	PCC	NYBT303	Genetics	2	0	0	2	50	-	100	-	100
4	OE	-	Open Elective-I	3	0	0	3	50	-	100	-	100
5	MDM	-	Minor course 1	2	0	0	2	50	-	100	-	100
6	PCC	NYBT311	Microbial Biotechnology Laboratory	0	0	2	1	-	50	-	50*	100
7	PCC	NYBT312	Cell and Molecular Biology Laboratory	0	0	2	1	-	50	-	50*	100
8	VEC	NLWV01	The Constitution & Human Rights	2	0	0	2	50	-	100	-	100
9	VSEC	NYBT313	Genetics Laboratory	0	0	4	2	-	50	-	50*	100
10	AEC	NHSA11	Key Competencies for Career Growth	0	0	4	2	-	50	-	50*	100
11	CEP/FP	NYBT314	Community Engagement Project*/Field Project*	--	--	4	2		50		50*	100
TOTAL				**15**	**00**	**16**	**23**	**300**	**250**	**600**	**250**	**1100**
Value Added Course												
12	VAC		Emerging Technologies in Biotechnology	-	-	2	-	-	-	-	-	-

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		Formative Assessment		
CIA: Continuous Internal Assessment **L:** Theory Lecture **T:** Tutorial **P:** Practical **ESE:** End Semester Exam	*: Oral Examination **PCC:** Program Core course **PEC:** Programme elective Core **OE:**Open Elective **VAC:** Value Added Courses **AEC :**AbilityEnhancement curses **CEP/FP:**Communityencougement project/Field project **VSEC:** Vocational and Skill Enhancement Course **MDM:** Multidisciplinary minor course	**CIA**	**Weightage**	**Description**
		CIA 1	10%	Home Assignment
		CIA 2	20%	Written Exam
		CIA 3	10%	Seminar Presentation
		CIA 4	10%	• Behavioural Attitude + General Discipline (5%) • Theory + practical attendance 5%)
		TOTAL	**50%**	

Date **27/6/2025**

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School of Engineering and Technology

Department of Biotechnology

Course Structure- B.Tech Biotechnology
Semester – IV

Sr. No.	Core	Course Code	Course Name	Teaching Scheme (Hrs./Week)				Examination Scheme				Total Marks
				L	T	P	C	Formative Assessment CIA		Summative Assessment ESE		
								Course	Lab	Course	Lab	
1	PCC	NYBT401	Bioprocess Engineering	3	0	0	3	50	-	100	-	100
2	PCC	NYBT402	Techniques and Instrumentation	3	0	0	3	50	-	100	-	100
3	PCC	NYBT403	Recombinant DNA Technology	3	0	0	3	50	-	100	-	100
4	PCC	NYBT404	Trends in bioengineering	3	0	0	3	50	-	100	-	100
5	OE	-	Open Elective-II	3	-	-	3	50	-	100	-	100
6	VSEC	NYBT411	Recombinant DNA Technology Laboratory	-	-	2	1	-	50	-	50*	100
7	MDM	-	Minor course 2	2	0	0	2	50	-	100	-	100
8	PCC	NYBT412	Bioprocess Engineering Laboratory	-	-	2	1	-	50	-	50*	100
9	VSEC	NYBT413	Techniques and Instrumentation in Biotechnology Laboratory	-	-	2	1	-	50	-	50*	100
10	VEC	NHSA12	Strategic Communication for professionals	0	0	4	2	-	50	-	50*	100
TOTAL				**17**	**00**	**10**	**22**	**250**	**250**	**500**	**250**	**1000**
Value Added Course												
11	VAC		Computational Tools and Structural Biology for Modern	-	-	2	-	-	-	-	-	-

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		Formative Assessment		
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		CIA 1	10%	Home Assignment
		CIA 2	20%	Written Exam
		CIA 3	10%	Seminar Presentation
		CIA 4	10%	• Behavioural Attitude + General Discipline (5%) • Theory + practical attendance 5%)
		TOTAL	**50%**	

Date **27/6/2025**

Exit option:

- Award of UG Certificate in the First Year programme after securing minimum 40 credits will be awarded UG Certificate in the Department of Biotechnology provided they secure 8 credits in work-based vocational courses or internship / Apprenticeship offered during summer vacation in addition to 4 credit from skill based courses earn during first and second semester.

Refre Annure 1

- Award of UG Diploma in the second Year programme after securing minimum 80 credits will be awarded UG Diploma in the Department of Biotechnology provided they secure 8 credits in work-based vocational courses or internship / Apprenticeship offered during summer vacation in addition to 4 credit from skill based courses earn during first and second semester.

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SANDIP UNIVERSITY

School of Engineering and Technology

Department of Biotechnology

Course Structure- B.Tech Biotechnology
Semester – V

Sr. No.	Core	Course Code	Course Name	Teaching Scheme (Hrs./Week)				Examination Scheme				Total Marks
				L	T	P	C	Formative Assessment CIA		Summative Assessment ESE		
								Course	Lab	Course	Lab	
1	PCC	NYBT501	Enzyme Engineering Technology	3	-	-	3	50	-	100	-	100
2	PCC	NYBT502	Plant Biotechnology	3	-	-	3	50	-	100	-	100
3	PCC	NYBT503	Immunology & Immunotechnology	3	-	-	3	50	-	100	-	100
4	PCC	NYBT504	Bioinformatics	2	-	-	2	50	-	100	-	100
5	PEC	NYBTE--	Program Elective 1	3	-	-	3	50	-	100	-	100
6	OE	-	Open Elective-III	2	-	-	2	50	-	100	-	100
7	MDM	-	Minor course 3	4	0	0	4	50	-	100	-	100
8	VSEC	NYBT511	Plant Biotechnology Laboratory	0	0	2	1	-	50	-	50*	100
9	PCC	NYBT512	Enzyme Technology Laboratory	-	-	2	1	-	50	-	50*	100
11	AEC	NHSA13	Essential Aptitude Skills	0	0	4	2	-	50	-	50*	100
Total				**20**	**00**	**08**	**24**	**350**	**150**	**700**	**150**	**1000**
Value Added Course												
12	VAC		Applied Agriculture, Industrial and Medical Biotechnology	-	-	2	-	-	-	-	-	-

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Department of Biotechnology

		Formative Assessment		
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		CIA 1	10%	Home Assignment
		CIA 2	20%	Written Exam
		CIA 3	10%	Seminar Presentation
		CIA 4	10%	• Behavioural Attitude + General Discipline (5%) • Theory + practical attendance 5%)
		TOTAL	**50%**	

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School of Engineering and Technology

Department of Biotechnology

Course Structure- B.Tech Biotechnology
Semester – VI

Sr. No.	Core	Course Code	Course Name	Teaching Scheme (Hrs./Week)				Examination Scheme				Total Marks
				L	T	P	C	Formative Assessment CIA		Summative Assessment ESE		
								Course	Lab	Course	Lab	
1	PCC	NYBT601	Animal Biotechnology	3	-	-	3	50	-	100	-	100
2	PCC	NYBT602	Food Science and Technology	3	-	-	3	50	-	100	-	100
4	PCC	NYBT603	Protein Engineering	3	-	-	3	50	-	100	-	100
5	PEC	NYBTE--	Program Elective 2	3	-	-	3	50	-	100	-	100
6	PEC	NYBTE--	Program Elective- 3	3	-	-	3	50	-	100	-	100
7	MDM	-	Minor course 4	2	0	0	2	50	-	100	-	100
8	PCC	NYBT611	Animal Biotechnology Laboratory	-	-	2	1	-	50	-	50*	100
9	PCC	NYBT612	Protein Engineering Laboratory	-	-	2	1	-	50	-	50*	100
10	PCC	NYBT613	Food Science and Technology Laboratory	-	-	2	1	-	50	-	50*	100
11	VSEC	NYBT614	Omics Technology Laboratory	-	-	4	2		50	-	50*	100
12	AEC	NHSA14	Employability Skills and Career Advancement	0	0	4	2	-	50	-	50	100
TOTAL				**16**	**00**	**14**	**24**	**250**	**300**	**500**	**300**	**1100**
Value Added Course												
13	VAC		Laboratory and Analytical Skill Development	-	-	2	-	-	50	-	-	50

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		CIA 1	10%	Home Assignment
		CIA 2	20%	Written Exam
		CIA 3	10%	Seminar Presentation
		CIA 4	10%	• Behavioural Attitude + General Discipline (5%) • Theory + practical attendance 5%)
		TOTAL	**50%**	

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School of Engineering and Technology

Department of Biotechnology

Course Structure- B.Tech Biotechnology
Semester – VII

Sr. No.	Core	Course Code	Course Name	Teaching Scheme (Hrs./Week)				Examination Scheme				Total Marks
				L	T	P	C	Formative Assessment CIA		Summative Assessment ESE		
								Course	Lab	Course	Lab	
1	PCC	NYBT701	Downstream Processing Technology	3	0	-	2	50	-	100	-	100
2	PCC	NYBT702	Metabolic Engineering	2	-	-	2	50	-	100	-	100
3	PEC	NYBTE--	Program Elective 4	3	-	-	3	50	-	100	-	100
4	MDM	-	Minor course 5	2	0	0	2	50	-	100	-	100
5	PCC	NYBT711	Downstream Processing Technology Laboratory	-	-	2	1	-	50	-	50*	100
6	INT/OJT	NYBT712	Internship/OJT#	-	-	-	12	-	50	-	50*	100
7	AEC	NHSA15	Corporate Readiness and Entrepreneurial Excellence	0	0	4	2	-	50	-	50*	100
			TOTAL	**10**	**00**	**6**	**24**	**150**	**200**	**300**	**200**	**700**
Value Added Course												
8	VAC		Multidisciplinary and Global Aspects of Biotechnology & Technical Writing	-	-	2	-	-	-	-	-	-

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Department of Biotechnology

		Formative Assessment		
CIA: Continuous Internal Assessment **L:** Theory Lecture **T:** Tutorial **P:** Practical **ESE:** End Semester Exam	#- Internship for 45 Days *: Oral Examination **PC:** Program Core course **PEC:** Programme elective Core **OE:**Open Elective **VAC:** Value Added Courses **AEC :**AbilityEnhancement curses **CEP/FP:**Communityencougement project/Field project **VSEC:** Vocational and Skill Enhancement Course **MDM:** Multidisciplinary minor course	**CIA**	**Weightage**	**Description**
		CIA 1	10%	Home Assignment
		CIA 2	20%	Written Exam
		CIA 3	10%	Seminar Presentation
		CIA 4	10%	• Behavioural Attitude + General Discipline (5%) • Theory + practical attendance 5%)
		TOTAL	**50%**	

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SANDIP UNIVERSITY MAHIRAVANI NASHIK

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School of Engineering and Technology

Department of Biotechnology

Course Structure- B.Tech Biotechnology
Semester – VIII

Sr. No.	Core	Course Code	Course Name	Teaching Scheme (Hrs./Week)				Examination Scheme				Total Marks
				L	T	P	C	Formative Assessment CIA		Summative Assessment ESE		
								Course	Lab	Course	Lab	
1	PCC	NYBT801	Bionanotechnology	2	-	-	2	50	-	100	-	100
2	PCC	NYBT802	Bioseparation Technology	2	-	-	2	50	-	100	-	100
3	PEC	NYBTE--	Program Elective-5	4	-	-	4	50	-	100	-	100
4	ELC		Research Methodology	4	-	-	4	-	50	-	50	100
5	PEC	NYBTE--	Program Elective-6	4	-	-	4	50	-	100	-	100
6	MDM	-	Minor course 6	2	0	0	2	50	-	100	-	100
7	CEP/FP	NYBT811	Project	-	-	8	4	-	50	-	100*	100
TOTAL				**18**	**-**	**8**	**22**	**200**	**150**	**400**	**200**	**700**
Value Added Course												
8	VAC		Smart Biotechnology: Integrating AI and Computational Approaches	-	-	2	-	-	-	-	-	-

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Department of Biotechnology

		Formative Assessment		
CIA: Continuous Internal Assessment **L:** Theory Lecture **T:** Tutorial **P:** Practical **ESE:** End Semester Exam	***:** Oral Examination **PC:** Program Core course **PEC:** Programme elective Core **OE:**Open Elective **VAC:** Value Added Courses **AEC :**AbilityEnhancement curses **CEP/FP:**Communityencougement project/Field project **VSEC:** Vocational and Skill Enhancement Course **MDM:** Multidisciplinary minor course	**CIA**	**Weightage**	**Description**
		CIA 1	10%	Home Assignment
		CIA 2	20%	Written Exam
		CIA 3	10%	Seminar Presentation
		CIA 4	10%	• Behavioural Attitude + General Discipline (5%) • Theory + practical attendance 5%)
		TOTAL	**50%**	

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Department of Biotechnology

Programme Elective Core Basket

Sr No	Course Code	PEC-I
1	NYBTE01	Omics in Biotechnology
2	NYBTE02	Cheminformatics & Medicinal Chemistry
3	NYBTE03	Pharmaceutical Biotechnology
4	NYBTE04	Biodiversity and Conservation
5	NYBTE05	Medical Biotechnology

Sr No	Course Code	PEC-II
1	NYBTE06	Tissue Engineering
2	NYBTE07	Cancer Biology and Therapeutics
3	NYBTE08	Industrial Nanotechnology
4	NYBTE09	Biosensors Technology
5	NYBTE10	Structural Biology

Sr No	Course Code	PEC-III
1	NYBTE11	Stem cells in Health care
2	NYBTE12	Agrobiotechnology
3	NYBTE13	Microbe, Health and Vaccine Development
4	NYBTE14	Physiology of stress and its management
5	NYBTE15	Computational molecualr biology

Sr No	Course Code	PEC-IV
1	NYBTE16	Marine Biotechnology
2	NYBTE17	Vaccine Biotechnology
3	NYBTE18	Molecular basis of drug action
4	NYBTE19	Plant Hormones and Signaling
5	NYBTE20	Epigenetics In Plants

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Sr No	Course Code	PEC-V
1	NYBTE21	Pathogenesis Related Proteins in Plants
2	NYBTE22	Food Science and Nutrition
3	NYBTE23	Therapeutic Compounds from Plants
4	NYBTE24	Food Safety and Quality Management
5	NYBTE25	Membrane Separation Technology

Sr No	Course Code	PEC-VI
1	NYBTE26	Industrial Fermentation Engineering
2	NYBTE27	Bioreactor Design
3	NYBTE28	Bioprocess Modelling and Simulation
4	NYBTE29	Bioprocess Plant Design
5	NYBTE30	Industrial Waste Management

Sr No	Course Code	PEC-VII
1	NYBTE31	Metabolic Engineering of Microorganism for Environment And Energy
2	NYBTE32	Microbial Degradation and Bioremediation Technology
3	NYBTE33	Environmental Biosensors
4	NYBTE34	Cellular and Molecular Neuroscience
5	NYBTE35	Diseases Models and Mechanism

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Open Elective Basket offered by the Department of Biotechnology

Sr No	Course Code	Open Elective offered by the Department of Biotechnology
1	NYBTO01	Biostatistics
2	NYBTO02	Environmental Biotechnology
3	NYBTO03	Bioenergy and Biofuels
4	NYBTO04	Bioenergetics and Metabolic Engineering

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School of Engineering and Technology

Department of Biotechnology

Mutidisciplinary Minor offered by Department of Biotechnology

Sr. No	Course Name	Code	Scheme	Credit	Semester
1	Big Data Biology and Biological Databases	NYBTM01	2-0-0	2	3rd
2	Sequence Alignment Algorithms	NYBTM02	2-0-0	2	4th
3	IPR, Biosefty and Bioethics	NYBTM03	4-0-0	4	5th
4	Computer aided Drug Design	NYBTM04	2-0-0	2	6th
5	Python and R for Biologists	NYBTM05	2-0-0	2	7th
6	AI and Machine Learning in Biotechnology	NYBTM06	2-0-0	2	8th
			Total	**14**	

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School of Engineering and Technology

Department of Biotechnology

Credit distribution

Course		Total Credits as per GR	Total Credits SUN B.Tech Biotechnology
Basic Science Course	BSC/ESC	14-18	16
Engineering Science Course		16-12	12
Programme Core Course (PCC)	Program Courses	44-56	60
Programme Elective Course (PEC)		20	20
Multidisciplinary Minor (MDM)	Multidisciplinary Courses	14	14
Open Elective (OE) Other than a paricular program		08	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	08	12
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	04	10
Entrepreneurship/ Economics / Management Course		04	
Indian knowledge System (IKS)		02	2
Value Education Course (VEC)		04	4
Research Methedology	Experiential Learning Courses	04	4
Comm. Engg. Project (CEP) / Field Project (FP)		02	2
Project		04	4
Internship/ OJT		12	12
Co-curricular Course (CC)	Liberal Learning Courses	04	4
Total Credits (Major)		**160-176**	**184**

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School of Engineering and Technology
Department of Biotechnology

Year: **First Year** **Semester** **II**
Course: **Essential of Biochemistry** **Course Code:** **NYBT201**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
2	0	0	2	10	20	10	10	-	50	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Acquire knowledge of biological classification system
CO2	Acquire knowledge Biomolecules
CO3	Learn about cell structure and functions
CO4	Understand signaling process in living organism
CO5	Applications of biology for engineers

Unit No	Details	Mapping with COs	Hours
1	**Nature of life:** Characteristics of living organisms, Concept and use of a classification system, brief of five Kingdoms and three domain classification system. Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals, and microorganisms	**CO1**	8
2	**Introduction to bio-molecule:** Structure and functions of Biomolecules, biological functions of carbohydrate, lipid and protein. Concept of Enzyme, nomenclature, classification, kinetics and mechanism of action	**CO2**	7
3	**Cell:** Basic structure and functions of cell, Cell Organeels structure and function, detailed study of Plasma membrane, action potential and transport process.	**CO3**	8
4	**Basic concept of gene and genome:** DNA, RNA, genetic code, structure, function and its properties	**CO4**	5
5	**Engineering in biology:** Biology and engineering needs, Bio-inspired design and bio-robotics, Biology and wellness, e.g. biosensor, bio-pesticides and nanoparticles.	**CO5**	8

Text Books

1. Stryer, Lubert (2002). Biochemistry; Fifth edition. W. H. Freeman and Company.
2. Principles of Biochemistry [5th edition], Lehninger.
3. Life Sciences Fundamentals and Practice, Vol 1 & 2, Seventh edition, Pranav Kumar and Usha Mina, Pathfinder Publication

Reference Books

4. Neill, Campbell (1996). Biology; Fourth edition.The Benjamin/Cummings Publishing Company. p. 309,310. ISBN 0-8053-1940-9.
5. W. Haupt, Fundamental of Biology, 3rd ed. McGRAW-HILL
6. https://nptel.ac.in/courses/122103039/

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Microbial Biotechnology** **Course Code:** **NYBT301**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	Basic knowledge of Microbial kingdom, understand the diversity, historical development, and scope of microbiology
CO2	Understanding the morphology, structure, and classification of microorganisms
CO3	Understanding the microbial metabolism, nutrient uptake mechanisms, and genetic processes such as transformation, conjugation, and transduction.
CO4	Understanding the basic concept of growth phases of microbes, culture, and its measurements along with the factors influencing the growth of microbes.
CO5	Decipher diverse application of microorganisms in agriculture, industry, environment, and health, and understand their interactions and pathogenic mechanisms.

Unit No	Details	Mapping with COs	Hours
1	**Introduction to the world of Microbes:** Discovery of microorganisms, theory of spontaneous generation, germ theory of diseases, major contribution, and events in the field of microbiology, scope, and relevance of microbiology. Identification of microorganisms - a general account, staining techniques. pure culture, preservation methods	**CO1**	8
2	**Microbial taxonomy:** Taxonomy: principle and its types; classical approach: numerical, chemical, serological and genetic; bacterial taxonomy: Bergey's manual of Systematic Bacteriology (eubacteria and archaebacteria), Morphology and fine structure of bacteria, characteristics of important groups of microorganisms.	**CO2**	7
3	**Microbial Metabolism, Nutrition and Genetics:** An overview of microbial metabolism, nutritional Types, uptake of nutrients by cells, simple diffusion, facilitated diffusion, group translocation, active transport, chemiosmotic theory. Microbial genetics: transformation, conjugation, transduction.	**CO3**	8
4	**Growth and Cultivation of Microorganisms**: growth curve, measurement of microbial growth, continuous growth, chemostat, turbidostat, balanced and unbalanced growth, methods of culturing microorganisms (aerobes and anaerobes), culture media, factors influencing growth, control of	**CO4**	5

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	microorganisms by physical and chemical agents, evaluation of antimicrobial chemical agents.		
5	**Application of microbes:** Applications in agriculture; environment; industry; health and disease. microbe interactions; mechanisms of pathogenicity.	**CO5**	8

Text Books

1. Prescott's Microbiology. 9 th Edition. McGraw Hill International.
2. M.J. Pelczar, E.C.S. Chan, and N.R. Krieg, Microbiology, 5th Edn., McGraw-Hill, 2007.

Reference Books

Microbiology: An Introduction. 9th edition. Pearson Education. Tortora GJ, Funke BR and Case CL. (2008).

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Microbial Biotechnology Laboratory** **Course Code:** **NYBT311**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
0	0	2	1	-	-	-	-	50	0	50	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	To learn and become familiar with handling of microscope and imaging of microbial cells.
CO2	To learn and become familiar with types staining method, culture media, preparations of culture media, isolation and maintenance process of bacterial cultures, types of equipments.
CO3	To understand the quality of water and the microbial diversity in tap water sample
CO4	To interpret microbial growth phases, its kinetics, specific growth rate
CO5	To understand the antimicrobial effect and to to identify the organisms based on its sensitivity to various antibiotics.

Unit No	Details	Mapping with COs	Hours
1	Handling of Microscope and examination of microbial cell.	**CO1**	**2**
2	To perform staining procedure to compare morphological features and arrangements of bacterial cells.	**CO2**	2
3	To prepare routine laboratory media	**CO2**	2
4	To study the different techniques of isolation and maintenance of pure cultures: subculturing, streak plate method, pour plate method, spread plate method.	**CO2**	2
5	To study the estimation of coliform bacteria in water by MPN (most probable number) test.	**CO3**	2
6	To study the growth pattern of bacteria, specific growth rate calculation, different growth phases of bacteria.	**CO4**	2
7	To study the methods of sterilization	**CO4**	2
8	To determine the sensitivity of bacterial isolates to antibiotics using Kirby-Bauer method by agar disc diffusion technique.	**CO5**	2
9	To study the preservation techniques of the microbial cultures.	**CO2**	2
10	To analyse the presence of catalase, an enzyme that catalyses the release of oxygen from hydrogen peroxide (H_2O_2).	**CO5**	2

Text Books

1. Cappuccino, C. J., & Welsh, C. (1988). Microbiology A laboratory Manual (Eleventh).

Reference Books

2. Das, S., & Dash, H. R. (2014). Microbial biotechnology-A laboratory manual for bacterial systems. Springer.

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Cell and Molecular Biology** **Course Code:** **NYBT302**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome: Biology

CO1	Understand the cell theory, cellular organelles and compare and contrast the events of cell cycle and its regulation.
CO2	Understand the molecular mechanisms of cell cycle and signal transduction
CO3	Understanding of gene and genetic material; the types of repair that may occur due to DNA damage
CO4	Understand the mechanism of the central dogma of life in prokaryotes and eukaryotes
CO5	Understand how proteins are synthesized with the help of the genetic code and invoke the various regulatory elements and mechanisms that control the expression of genes

Unit No	Details	Mapping with COs	Hours
1	**Cell structure and function:** Discovery of cells, Cell theory; Cell complexity, Different classes of cells; Structure and functions of cell organelles, cell cycle , Cell division: Molecular Mechanics of Mitosis & Meiosis	**CO1**	**5**
2	**Cell signaling:** Intracellular signaling and types of signal receptors, Chemoreceptors of Bacteria (Attractants & Repellents), Signal Transduction by hormones - Steroid / Peptide hormones, Concept of Secondary messengers, cAMP, cGMP, Protein Kinases, G Proteins, Receptors & Non-receptors associated tyrosine kinases, Protein kinase receptors (calmodulin,RAS, RAF, MAPK), Cytokine receptor-JAK-STAT signaling pathway.	**CO2**	**10**
3	**DNA Structure Replication and Repair-**Nucleic acids and their structure, nucleic acid as genetic material, types of DNA, DNA replication in prokaryotes and eukaryotes, model of DNA replication, DNA repair: types and mechanism DNA repair in prokaryotes and eukaryotes	**CO3**	**8**
4	**Transcription in prokaryotes and eukaryotes:** Central dogma concept, transcription in prokaryotes: initiation, elongation and termination. Transcription in eukaryotes: RNA polymerase, transcription factors and initiation RNA synthesis, elongation and termination of RNA synthesis.	**CO4**	**8**
5	**RNA processing, Translation and Regulation of gene expression:** Ribosome- Structural features of prokaryotic and eukaryotic ribosome. Types of RNA, processing of RNA and RNA Splicing, mRNA	**CO5**	**14**

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	transport, mRNA synthesis in prokaryotes and eukaryotes. Coding of genetic information, Initiation and elongation of polypeptide, formation of peptide bond, termination of polypeptide, modification, folding and transport of released polypeptide, protein sorting or protein trafficking, protein folding, Regulation of gene expression in bacteria- operon concept, inducible and repressible operons (lac and trp).		

Text Books

1. The Cell: A Molecular Approach, Geoffrey M. Cooper and Robert E Hausman, Oxford University press, 2015, 7thEdition.
2. Molecular Biology of the Cell, Bruce Alberts, Alexander D. Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Garland Science, 2015, 6thEdition.

Reference Books

3. Cell and Molecular Biology, Karp, G., Iwasa, J., Marshall, W.Wiley press 2019, 9th Edition.
4. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). WH Freeman.

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Cell and Molecular Biology Laboratory** **Course Code:** **NYBT312**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
0	0	2	1	-	-	-	-	50	-	50	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	Microscopic detection of cell counting, staining and cell viability
CO2	To understand the cellular compartments
CO3	Separation and determining various phases of cell division in eukaryotic cell
CO4	Isolation and detection of nucleic acids using Gel electrophoresis
CO5	Design experiments and analyse data for transformation and restriction mapping

Unit No	Details	Mapping with COs	Hours
1	Cell counting using hemocytometer	CO1	2
2	Cell viability and membrane permeability	CO1	2
3	Preparation of blood smear and differential staining of blood cells	CO2	2
4	Isolation of mitochondria from yeast cell	CO2	2
5	Study of divisional stages in Mitosis	CO3	2
6	Isolation of Genomic DNA/RNA	CO4	2
7	Detection and quantification of DNA/RNA	CO4	2
8	Restriction -ligation of DNA	CO5	2
9	Isolation and detection of Plasmid by Alkali Lysis Method	CO5	2
10	Amplification of DNA by Polymerase Chain Reaction.	CO5	2

Text Books

1. Sambrook, J. & Russell, D. (2004). *Molecular cloning: A laboratory manual* (3rd ed.). CSHL Press.
2. Gerstein, A. S. (2001). *Molecular biology problem solver: A laboratory guide* (1st ed.). John Wiley & Sons

Reference Books

3. D. C. Amberg, D. J. Burke, and J. N. Strathern, *Methods in Yeast Genetics, Cold Spring Harbor Laboratory Press*, 2005.

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Genetics** **Course Code:** **NYBT303**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Tota 1
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
2	0	0	2	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	To understand the basics of genes and heredity material.
CO2	To understand the basics of genetic inheritance and Mendelian laws of inheritance.
CO3	To construct linkage maps from inheritance pattern of different genes
CO4	Analyze quantitative traits using statistical methods to determine the mean, variance, and standard deviation.
CO5	Evaluate the effects of natural selection, mutation, genetic drift, and migration on allelic frequency in populations.

Unit No	Details	Mapping with COs	Hours
1	**Genes, chromosome and heredity:** Gene-fundamental unit of heredity; Chromosome structure and function; DNA-the genetic material; Molecular organization of chromosomes. Chromosome mutations : Types of mutations; Numerical changes in chromosome: euploidy, aneuploidy; Structural changes in chromosomes: duplications, deletions, inversions, translocations	**CO1**	**6**
2	**Basic principles of heredity**: Mendelian genetics: Mendel's experiments, genetic terminology; Basic principles of Mendel's law, Mendel's laws of genetics: monohybrid crosses, dihybrid crosses; Deviations of Mendel's ratios; Genetic interactions: epistasis, pleiotropy, penetrance and expressivity, multiple alleles	**CO2**	**5**
3	**Linkage, crossing over and chromosome mapping**:, linkage intensity: calculating recombination frequency, coupling and repulsion linkages; Crossing over as physical basis of recombination; Gene mapping and recombination frequencies. Sex determination and Sex-linked characteristics: Chromosomal sex-determining systems; Genic sex-determining systems; Environmental sex-determination; Sex determination in Drosophila melanogaster; Sex determination in Humans; Sex determination in plants; Sex-linked, Sex-influenced and Sex limited traits; Dosage compensation, Y-linked characteristics.	**CO3**	**7**

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4	**Quantitative Genetics:** Quantitative traits; polygenic inheritance; Statistical methods to analyze quantitative characteristics: the mean, the variance and standard deviation, correlation, regression.	**CO4**	**8**
5	**Population Genetics:** Allelic frequency; Hardy-Weinberg Law and its applications; Natural selection; Mutation; Genetic drift; Migration	**CO5**	**5**

Text Books

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL,
3. S. T. Nicholl, An Introduction to Genetic Engineering, 3rdEdn.,Cambridge University Press, 2008.
4. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn.,Benjamin Cummings, 2007.

Reference Books

5. Brown T. A. Gene Cloning, Blackwell Science Publishers.
6. Ernst L and Winnacker. Genes to Clones, Panima Publishing House, New Delhi.

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Genetics Laboratory** **Course Code:** **NYBT313**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
0	0	4	2	-	-	-	-	50	-	50	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	Collect and classify plant samples with contrasting traits, documenting dominant and recessive traits in a field report
CO2	Dissect flowers, analyze reproductive structures, and relate them to inheritance patterns.
CO3	Document and discuss genetic variations in plants and insects.
CO4	Prepare herbaria for plants, flowers seeds and insect, labeling and analyzing trait variations.
CO5	Use NCBI BLAST and ORF Finder to compare gene sequences and predict coding regions.

Unit No	Details	Mapping with COs	Hours
1	Identification and Collection of Plant Samples, Chi Square Test for Monohybrid and dihybrid crosses	**CO1**	**2**
2	Genetic Insights Through Flower Dissection: Analyzing Reproductive Structures	**CO1**	**2**
3	Field Observation of Natural Mutations or Variants	**CO3**	**2**
4	Plant Trait Herbarium Preparation	**CO4**	**2**
5	Flower Morphology Herbarium	**CO4**	**2**
6	Seed Trait Collection	**CO4**	**2**
7	Insect Morphology Documentation	**CO4**	**2**
8	Trait Comparison and Genetic Analysis	**CO4**	**2**
9	Gene Sequence Comparison Using NCBI BLAST	**CO5**	**2**
10	Gene Prediction Using ORF Finder	**CO5**	**2**

Text Books

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL,
3. S. T. Nicholl, An Introduction to Genetic Engineering, 3rdEdn.,Cambridge University Press, 2008.
4. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn.,Benjamin Cummings, 2007.

Reference Books

1. Brown T. A. Gene Cloning, Blackwell Science Publishers.
2. Ernst L and Winnacker. Genes to Clones, Panima Publishing House, New Delhi.

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Biostatistics** **Course Code:** **NYBTO01**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Mathematics

Course Outcome:

CO1	Understand the mathematical basis and organization of data
CO2	Understand the basic concept of probability and statistics
CO3	Apply statistical methods to solve biological problems
CO4	Apply the statistical principles to design the research experiments
CO5	Apply basic and modern statistical methods to analyze the big data in research field

Unit No	Details	Mapping with COs	Hours
1	**Introduction to biostatistics and organization of data:** Data type, graphical and pictorial presentation of data, measurers of central tendency and dispersion, sampling techniques, sample size, coefficient of variation, means error, relative error, precision and accuracy.	**CO1**	**8**
2	**Probability distribution:** Introduction to probability, Bayes' theorem, probability distributions, binomial distribution, Poisson distribution, normal distribution.	**CO2**	**7**
3	**Statistical Inference (Parametric and Non-parametric tests):** Testing hypothesis, types of errors, tests of significance based on normal distribution, Data characteristics and non-parametric procedures, chi square test, sign test, Wilcoxon sign rank test, Wilcoxon rank sum test, ANOVA, correlation and regression, test of significance for correlation coefficients.	**CO3**	**10**
4	**Experimental Design:** General principles of Experimental Design, Randomization, Double-blind and double-dummy techniques, completely randomized and latin square designs, factorial design, cross over and parallel designs, case studies with biological data.	**CO4**	**10**
5	**Statistics in Data Analytics:** Application of statistics in biological data analysis, Introduction to Big data analytics, data analytics lifecycle: discovery, data preparation, model planning, model building, communicate results, operationalize.	**CO5**	**10**

Text Books

1. Daniel Wayne W., Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley 2008, 9th Edition

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2. Rosner Bernard, Fundamentals of Biostatistics, Brooks/Cole, 2011, 7th Edition.
3. Motulsky H, Intuitive Biostatistics, Oxford University Press, 2009, 2nd Edition.

Reference Books

4. Data Science and BIg Data Analytics. Discovery, Analyzing, Visualizing and Presenting Data,
5. EMC Education Services, John Wiley & Sons, 2017.
6. Statistics for Biologists, https://www.nature.com/collections/qghhqm/

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Environmental Biotechnology** **Course Code:** **NYBTO02**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Understand the biological treatment techniques for wastewater
CO2	Understand the bioremediation and its types
CO3	To describe the use of biotechnological processes to protect the environment
CO4	Understand the hazardous waste management
CO5	Understand the Concepts and methodologies of environmental impact assessment

Unit No	Details	Mapping with COs	Hours
1	**Introduction:** Biological Treatment of Wastewater – Aerobic System Biological processes for domestic and industrial wastewater treatments, Anaerobic System Anaerobic biological treatment	**CO1**	**8**
2	**Bioremediation:** Introduction, constraints and priorities of Bioremediation, Biostimulation of naturally occurring microbial activities, Bioaugmentation, *in situ*, *ex-situ*, intrinsic & engineered bioremediation. Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.	**CO2**	**10**
3	**Biomining:** Introduction, Microbial leaching of ores. Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects.	**CO3**	**10**
4	**Hazardous Waste Management:** Introduction - Xenobiotic compounds. Hazardous wastes - biodegradation of Xenobiotics and Plastics. Biological detoxification - market for hazardous waste management, biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management – cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics – phenols, STP, antibiotic treatment.	**CO4**	**10**

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5	**Environmental Impact Assessment (EIA):** Evolution of eia – concepts – methodologies – screening – scoping – base line studies - mitigation – matrices – check list.	**CO5**	**8**

Text Books

1. Surajbhan Sevda, Solid Waste Management: Biological Approaches, Taylor & Francis Group, 2024, 1st Edition.
2. Paulin M. Doran, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2013, 2nd Edition.
3. Canter R.L.(1997) Environmental Impact Assessment, Mc Graw Hill International Edition.

Reference Books

4. Foster C.F., John Ware D.A, Environmental Biotechnology, Ellis Horwood Ltd., 2007
5. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 2009

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **III**
Course: **Community Engagement Project*/Field Project*** **Course Code:** **NYBT314**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination	
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab
0	0	4	2	-	-	-	-	50	-	50
Max. Time– 3 Hrs									End Semester Exam (Lab): -100	

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Communities manage waste and pollution using green biotech.
CO2	Communities embrace sustainable diets and farming practices.
CO3	Awareness improves hygiene, vaccination, and disease prevention.
CO4	Farmers adopt biotech tools to boost yield and soil health.
CO5	Promoted healthy eating and local food sustainability.

Unit No	Details	Mapping with COs
1	**Biotechnology in Agriculture:** Field visit to local farms and identify challenges like nutrient-deficient soils, pest pressure, or low crop productivity, community workshops & awareness drives by organizing interactive sessions with farmer	**CO1**
2	**Environmental Biotechnology:** Site assessments such as identify environmental issues in the area such as polluted water bodies, plastic accumulation and compostable waste, waste management by community training on converting kitchen/agro-waste into bio-compost, sustainability campaigns by collaborations with local eco-clubs or schools	**CO2**
3	**Biodiversity and Ecosystem Management for Sustainable Development:** Conduct surveys to document the diversity of plant and animal species in the region, identifying endemic and endangered species, study the role of local flora and fauna in maintaining ecosystem balance and their potential for bioremediation or sustainable agriculture.	**CO3**
4	**Biodiversity Conservation:** Engage with local communities to gather traditional knowledge about the uses of flora and fauna in farming and environmental management, collaborate with local or conservation groups to study and protect endangered species using biotechnological, techniques and practices.	**CO4**
5	**Public Health Awareness:** Awareness drives on vaccines, genetic counselling, and biotechnological solutions for common health issues, awareness programs on hygiene and disease prevention such as conduct workshops on personal hygiene, menstrual health, vaccination importance, and sanitation, promote eco-friendly mosquito control using biotechnology bio-interventions, understanding local food systems, traditional diets, and community nutrition challenges. Participants will explore sustainable agriculture practices, food security issues and promote awareness on healthy eating habits within the community.	**CO5**

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Bioprocess Engineering** **Course Code:** **NYBT401**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Understand bioreactor construction, design, and operation.
CO2	Understand the air and media sterilization principles and techniques
CO3	Understand the enzyme and cell immobilization methods.
CO4	To learn cell growth, substrate utilization, and product formation kinetics
CO5	Understand the scale up concepts for production of organic acids, amino acids, and antibiotics.

Unit No	Details	Mapping with COs	Hours
1	**Bioreactors and Sterilization:** Bioreactors Construction, Design & Operation Materials of Constructions, Welding, Surface treatment Components of the fermenters & their specifications. **Agitation and aeration:** Introduction, Basic Mass-Transfer Concepts, types of impellors and sparger, oxygen transfer rate, oxygen uptake rate, volumetric oxygen transfer rate (kLa), measurement of kLa, power requirement for agitation in gaseous and non gaseous systems	**CO1**	**10**
2	**Air & Media sterilization :** Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air sterilization Principles of Media Sterilization, Decimal reduction, Design of sterilization cycle using kinetics of thermal depth of microbes Equipments used in sterilization; Batch & Continuous **Batch, Fed-Batch and Continuous Processes:** Operation, industrial applications, and comparison of batch, fed-batch, and continuous processes; principles of chemostat and turbidostat.	**CO2**	**10**
3	**Enzyme & cell immobilization (industrial aspects):** Properties of enzymes to be immobilized. Adsorption, Covalent binding, Entrapment, or encapsulation. Properties of immobilized enzymes (Km, Ks, cycle time half life). Inactivation kinetics.	**CO3**	**8**
4	**Cell growth, substrate utilization and product formation kinetics:** growth media, their estimation & quantification. Design of media. Quantification of cell growth, growth patterns and kinetics in batch culture, environmental factors affecting growth kinetics, heat generation by microbial growth, unstructured/ structured, non segregated/ segregated models, models for transient behaviour,	**CO4**	**10**

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	kinetics of substrate utilization, Yield and maintenance coefficients, kinetics of product formation.		
5	**Production of Primary & Secondary Metabolites** brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, lactic acid), amino acids (glutamic acid, lysin); Antibiotics-beta-lactams (Penicillins), aminoglycosides (streptomycin)	**CO5**	**7**

Text Books

1. Principles of Fermentation Technology - Whittaker & Stan bury, Pergamon Press
2. Michael L. Shuler, Filkert Kargi(2001) *Bioprocess engineering: Basic concepts* (2 nd Ed) Prentice Hall
3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker(1995) ,*Principles of Fermentation Technology*, (2 nd Ed) Butterworth-Heinemann.
4. Bioprocess Engineering Principles. By Paulin M. Doran. Elsevier Science & Technology Books, 2008, 2nd Edition.

Reference Books

5. Biochemical Engineering Fundamentals, Second Edition, James E. Bailey, David F. Ollis. Mc Graw Hill, 2004, 2nd Edition.
6. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill Higher Education, 2nd edition, 1986

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Bioprocess Engineering Laboratory** **Course Code:** **NYBT412**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
0	0	2	1	-	-	-	-	50	-	50	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Understand sterilization techniques
CO2	Perform the kinetics of fermentation processes
CO3	Design and optimization of medium components for biomass production
CO4	Understand Enzyme Immobilization process and kinetics
CO5	Execution of small scale and pilot scale study for fermentation of biological products

Unit No	Details	Mapping with COs	Hours
1	Sterilization Of Media	CO1	2
2	Batch Growth Kinetics of Bacteria	CO2	2
3	Media Optimization by Plackett and Burman	CO3	2
4	Effect of Temperature on Enzyme Activity	CO3	2
5	Effect of pH on enzyme activity	CO3	2
6	Enzyme Immobilization Kinetics – Gel Entrapment/ Cross Linking	CO4	2
7	Production of Wine by Yeast	CO5	2
8	Production of Amino Acid	CO5	2
9	To determine Chemical oxygen demand (COD)/ Biological oxygen demand (BOD)	CO5	2
10	Measurement of Ethanol Production in a Fermenter	CO5	2

Text Books

1. J. E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn., McGraw Hill Publishers, 1986.
2. M. L. Shuler, F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.

Reference Books

3. Das, D., & Das, D. (2021). *Biochemical engineering: A laboratory manual* (1st ed.). Jenny Stanford Publishing.

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Techniques & Instrumentation in Biotechnology** **Course Code:** ***NYBT402***

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Describe the principle of the various spectroscopic techniques and microscopic techniques to analyze biological samples.
CO2	Understand the principles and applications of centrifugation for separating and analyzing substances.
CO3	To Gain proficiency in using electrophoresis for analyzing and separating biomolecules based on size and charge
CO4	To understand different types of chromatographic techniques and apply this knowledge in biological compounds.
CO5	To understand the basics of thermal methods to study the thermal properties and behavior of biomolecules.

Unit No	Details	Mapping with COs	Hours
1	**Optical Methods** (Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), UV-Vis Spectrophotometry, Atomic absorption and flame emission spectroscopy, Fluorescence spectrometry-theory, Instrumentation, and applications)	**CO1**	**10**
2	**Centrifugation:** Principle, construction, working of centrifugation and concept of RCF, types of instruments and rotors used in centrifugation, types of centrifugations- preparative, differential density gradient centrifugation and analytical ultracentrifuge.	**CO2**	**10**
3	**Electrophoresis:** Principle & working of zonal and continuous electrophoresis, types of electrophoresis- paper, cellulose acetate, gel and capillary electrophoresis, native and denaturing gels, isoelectric focusing, two-dimensional gel electrophoresis, pulse-field gel electrophoresis.	**CO3**	**8**
4	**Chromatography:** Principle, instrumentation, and biological applications of paper and thin layer (TLC) chromatography, gel permeation (GPC), ion exchange chromatography, affinity chromatography, gas liquid (GC) and high-pressure liquid chromatography.	**CO4**	**7**

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5	**Thermal Method:** Instrumentation applications of thermo gravimetric analysis (TGA), Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Thermometric titrations	**CO5**	**10**

Text Books

1. D.A. Skoog, F. J. Holler and S.R. Crouch. Principles of Instrumental Analysis. Cenage Learning, 6th Edition, 2014.

Reference Books

2. H. Willard, L. Merritt, J. Dean and F. Settle, Instrumental Methods of Analysis, 7thEdn., Wadsworth Pub. Co., 1988

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Techniques and Instrumentation in Biotechnology Laboratory** **Course Code:** **NYBT413**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
0	0	2	1	-	-	-	-	50	50	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Describe the principle of the various spectroscopic techniques and microscopic techniques to analyze biological samples.
CO2	Summarize the different types of liquid chromatographic techniques and apply this knowledge in biological compounds.
CO3	Outline the principle behind the basic biochemical and molecular biological techniques.
CO4	To understand the principle of chromatographic techniques in gaseous phase and different types of detectors used in analysing biomolecules.
CO5	To understand the basics of thermal methods to study the thermal properties and behavior of biomolecules.

Unit No	Details	Mapping with COs	Hours
1	To demonstrate the operational procedure of UV-Visible Spectrophotometry using a selected sample.	CO1	2
2	To perform two-dimensional Thin Layer Chromatography (2D-TLC) for the separation and identification of components of selected sample.	CO2	2
3	To separate and analyze compounds present in a plant sample using paper chromatography	CO2	2
4	To demonstrate the working and operational procedure of LC-MS/HPLC using a selected sample.	CO2	2
5	To perform agarose gel electrophoresis for the separation and visualization of protein samples.	CO3	2
6	To conduct SDS-PAGE to analyze protein molecular weight and purity from a given protein extract.	CO3	2
7	To demonstrate the operation and analytical capabilities of GC-MS using a chosen sample for volatile compound analysis.	CO4	2
8	To demonstrate Thermogravimetric Analysis (TGA) of a selected sample to study its thermal stability and decomposition pattern.	CO3	2
9	To demonstrate Differential Scanning Calorimetry (DSC) of a selected sample to assess thermal transitions.	CO3	2
10	To demonstrate the PCR technique and analyze a selected DNA sample for amplification and result interpretation.	CO3	2

Text Books

1. Harisha, S. (2008). *Biotechnology procedures and experiments handbook*. Laxmi Publications, Ltd.
2. Brandt, M. (2002). Chemistry 472B BIOTECHNOLOGY LABORATORY MANUAL.

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Reference Books
3. Haines, P. J. (2012). Thermal methods of analysis: principles, applications and problems. Springer Science & Business Media.
4. Carl W. Dieffenbach, Gabriela S. Dveksler (2003). A laboratory manual, 2nd ed. by Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Recombinant DNA Technology** **Course Code:** **NYBT403**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	To learn the basics of recombinant DNA technology, its tools, and the role of DNA modifying enzymes
CO2	To learn about different vectors in recombinant DNA technology
CO3	Understand genomic and cDNA library construction, PCR techniques, and real-time PCR applications for molecular analysis and research
CO4	To learn gene and genome sequencing techniques
CO5	Assess the applications of recombinant DNA technology in medicine, industry, agriculture, livestock, and environmental protection.

Unit No	Details	Mapping with COs	Hours
1	**Introduction to Recombinant DNA Technology:** Historical perspective, Concept and significance Molecular tools used in Recombinant DNA Technology, DNA modifying enzymes – Restriction enzymes, Ligases, Polymerases, Alkaline Phosphatases, Nucleases (Mode of Actions & applications) .	**CO1**	**8**
2	**Vectors used in Recombinant DNA Technology:** Plasmid Vectors, Bacteriophages: λ (Lambda)and M13, Overview of Expression vectors, Agrobacterial Vectors – Ti plasmid, Chimeric Vectors - Cosmids, Phasmids, Phagemids, Introduction of YAC& BAC	**CO2**	**10**
3	**Construction of Genomic and cDNA Library:** Genomic and cDNA library, Applications of libraries, PCR: Introduction, Steps involved in PCR, Real time PCR, Applications,	**CO3**	**10**
4	**Sequencing of Genes and Genomes:** Maxam- Gilbert Method, Sanger's enzymatic method, Automated DNA sequencing, Next Generation sequencing,	**CO4**	**8**
5	**Application of r-DNA technology:** Medicine, industry, agriculture, live stock improvement, environmental protection, Introduction to CRISPR/Cas9 as genome editing tool	**CO5**	**9**

Text Books

1. Jeremy W. Dale, Malcolm von Schantz, Nick Plant (2011) From Genes to Genomes-Concepts and Applications of DNA Technology (Illustrated) John Wiley & Sons

Reference Books

2. J.D. Watson, A.A. Caudy, R.M. Myers and J.A. Witkowski(2007), Recombinant DNA, (3rd Edition),W.H. Freeman and Company.

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Recombinant DNA Technology Laboratory** **Course Code:** **NYBT411**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
0	0	2	1	-	-	-	-	50		50	50
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Understand and apply fundamental techniques of plasmid DNA isolation, restriction digestion, and DNA fragment analysis.
CO2	Demonstrate proficiency in molecular cloning procedures, including ligation, preparation of competent cells, and bacterial transformation.
CO3	Analyze and interpret results of PCR amplification and agarose gel electrophoresis for DNA fragment validation
CO4	Utilize bioinformatics tools for primer designing, restriction mapping, and ORF prediction in DNA sequences.
CO5	Integrate wet-lab and computational approaches to plan, execute, and interpret basic recombinant DNA technology experiments..

Unit No	Details	Mapping with COs	Hours
1	To isolate plasmid DNA from bacterial cultures	CO1	2
2	To perform restriction digestion of plasmid DNA with specific restriction enzymes.	CO2	2
3	To analyze digested DNA fragments using agarose gel electrophoresis.	CO3	2
4	To ligate DNA fragments into plasmid vectors using DNA ligase.	CO2	2
5	To prepare competent cells for bacterial transformation by calcium chloride method.	CO2	2
6	To transform bacteria with recombinant plasmids and screen transformants (e.g., blue-white screening).	CO2	2
7	To amplify target genes using Polymerase Chain Reaction (PCR).	CO3	2
8	To analyze PCR products by agarose gel electrophoresis.	CO3	2
9	To perform primer designing and restriction map analysis using bioinformatics tools.	CO5	2
10	To predict open reading frames (ORFs) in a given DNA sequence using bioinformatics tools.	CO5	2

Text Books

1. Jeremy W. Dale, Malcolm von Schantz, Nick Plant (2011) From Genes to Genomes- Concepts and Applications of DNA Technology (Illustrated) John Wiley & Sons

Reference Books

2. J.D. Watson, A.A. Caudy, R.M. Myers and J.A. Witkowski(2007), Recombinant DNA, (3rd Edition),W.H. Freeman and Company.

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Trends in Bioengineering** **Course Code:** **NYBT404**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Identify various types of stem cells, their sources, and applications in therapy.
CO2	Explain the role of biopharmaceuticals in disease treatment and their development process.
CO3	Understand the principles and applications of bioprinting for tissue engineering.
CO4	Describe the use of bioimaging and artificial intelligence in disease diagnosis.
CO5	Understand microbial methods for removing heavy metals through bioremediation and biomining.

Unit No	Details	Mapping with COs	Hours
1	**Stem cell engineering:** Types & sources of stem cell with characteristics: Embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells, induced pleuripotent stem cells. Applications of stem cells.	**CO1**	**10**
2	**Disease biology and biopharmaceuticals:** Introduction of biopharmaceuticals, medical uses, product development scheme, delivery, classifications, significance, protein-based biopharmaceuticals	**CO2**	**10**
3	**Bioprinting:** Techniques and materials, 3D printing of ear, bone, and skin.	**CO3**	**8**
4	**New disease diagnosis techniques:** Bioimaging and Artificial Intelligence for disease diagnosis	**CO4**	**7**
5	**Bioremediation and Biomining:** via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).	**CO5**	**5**

Text Books

1. Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press.
2. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pearson Education India, 2016
3. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginners, Academic Press, 2017
4. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.

Reference Books

5. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha A C Udayashankar Lambert Academic Publishing, 2019.
6. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
7. Electronic Noses and Tongues in Food Science Maria Rodriguez Mende, Academic Press, 2016

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Bioenergetics & Metabolic Engineering** **Course Code:** **NYBTO04**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology

Course Outcome:

CO1	Understand the molecular concepts of entropy, free energy, redox reactions, and the role of high-energy phosphate compounds in metabolism.
CO2	Explain the roles and mechanisms of key coenzymes and cofactors in metabolic reactions with relevant examples.
CO3	Describe the pathways and regulation of carbohydrate metabolism including glycolysis, gluconeogenesis, TCA cycle, and oxidative phosphorylation.
CO4	Illustrate lipid metabolism processes including beta-oxidation, ketone body formation, fatty acid biosynthesis, and their regulation.
CO5	Understand amino acid and nucleic acid metabolism, including degradation pathways, biosynthesis, urea cycle, and related metabolic disorders.

Unit No	Details	Mapping with COs	Hours
1	**Bioenergetics:** Molecular basis of entropy, Concept of free energy and significance in metabolism, Biological oxidation-reduction reactions, redox potentials, High energy phosphate compounds, free energy of hydrolysis of ATP and sugar phosphates.	**CO1**	**10**
2	**Coenzymes and Cofactors:** Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, and metal ions with specific examples.	**CO2**	**10**
3	**Carbohydrate Metabolism:** Introduction, Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation.TCA cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Oxidative phosphorylation, & production of ATP.	**CO3**	**10**
4	**Lipid Metabolism:** Beta – oxidations of saturated & unsaturated fatty acids. Ketone bodies, production during starving and diabetes Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate, energetics, Regulation of fatty acid biosynthesis.	**CO4**	**7**
5	**Amino Acid/ Nucleic Acid Metabolism:** Biodegradation of amino acids –deamination, transamination, decarboxylation, urea cycle including its regulation. Biosynthesis of amino acids, Disorders of amino acid metabolism.	**CO5**	**8**

Text Books

1. Lehninger, Nelson and Cox, Principles of Biochemistry, 4th Edition, W.H.Freeman & Company, 2004.
2. Voet & Voet, Fundamentals of Biochemistry, Upgrade Edition, Wiley, 2002.

Reference Books

3. Lubert Stryer, Biochemistry, 4th Edition, W.H.Freeman and Company, 1995.

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School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Bioenergy and Biofuels** **Course Code:** **NYBTO03**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
3	0	0	3	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Classify different types of bioenergy, bio-based products, and identify various conventional and residual biomass feedstocks.
CO2	Explain thermochemical and biochemical bioconversion processes including combustion, pyrolysis, fermentation, and transesterification.
CO3	Compare first, second, and third generation biofuels and understand their production, composition, advantages, and economic aspects.
CO4	Describe biohydrogen production methods and discuss the role of photosynthetic organisms in the emerging hydrogen economy.
CO5	Understand the principles of bioelectricity generation using microbial fuel cells and evaluate bioenergy production processes and entrepreneurial opportunities.

Unit No	Details	Mapping with COs	Hours
1	**Introduction:** Classification of energy based on sources, bio-based energy, bioenergy types, Biopower, Bioheat, Biofuels, advanced liquid fuels, drop-in fuels, Syngas, biohydrogen, biobased products. Feedstocks: Conventional and dedicated biomass feedstock. Residual Feedstocks: Agricultural wastes, forestry wastes, farm waste, organic components of residential, commercial, institutional and industrial waste.	**CO1**	**10**
2	**Bioconversion processes:** Thermochemical processes, Direct Combustion, Pyrolysis, Gasification; Biochemical conversion-hydrolysis, enzyme and acid hydrolysis, fermentation, anaerobic digestion; other techniques: trans-esterification	**CO2**	**10**
3	**Biofuels:** First generation biofuels, Second generation biofuels, third generation biofuels; fourth generation biofuels, Pros and cons of biofuels, Algal biofuels, Cyanobacteria and producers of biofuels, biodiesel composition and production processes, Bioethanol, biomethane, biobutanol, Engineering aspects of biofuels, Economics of biofuels	**CO3**	**10**
4	**Biohydrogen:** Bioproduction of gases, Production of H2 by photosynthetic organisms, Emergence of the hydrogen economy.	**CO4**	**7**
5	**Bioelectricity:** Microbial fuel cells (MFC), fuel cell design and MFC performance, biopower production process, micro-entrepreneurial opportunities in bioenergy.	**CO5**	**8**

Text Books

1. Brown, R. C., & Brown, T. R. (2014). *Biorenewable resources: Engineering new products from agriculture* (2nd ed.). Wiley-Blackwell.

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2. Soetaert, W., & Vandamme, E. J. (2009). *Biofuels* (1st ed.). Wiley.
3. Klass, D. L. (1998). *Biomass for renewable energy, fuels and chemicals* (1st ed.). Academic press.

Reference Books

4. Nelson, V. C., & Starcher, K. L. (2016). *Introduction to bioenergy* (1st ed.). CRC Press.
5. Dahiya, A. (2015). *Bioenergy: Biomass to biofuels* (1st ed.). Academic Press.

SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year**
Course: **Big Data Biology and Biological Databases**
Semester: **IV**
Course Code: **NYBTM01**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
2	0	0	2	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Understand what big data means in the context of biology, including its key characteristics, major biological data sources like genomics and proteomics, and the challenges around data privacy and handling.
CO2	Recognize different types of biological databases, understand how they are organized, and learn how to access and interpret the data they contain.
CO3	Use tools and platforms such as BLAST, NCBI, and UniProt to retrieve biological data, analyze sequences, and explore gene or protein functions.
CO4	Get familiar with big data technologies like Hadoop and cloud platforms, and learn how workflow systems are used to process and visualize large-scale biological data.
CO5	Explore real-life case studies like the Human Genome Project or cancer genomics to see how big data is applied in modern biological research.

Unit No	Details	Mapping with COs	Hours
1	**Introduction to big data in biology:** Concept and Big data characteristics, Big data revolution, Industrialization of big data biology, Big data privacy and security, Sources of big biological data: Genomics, transcriptomics, proteomics, metabolomics, phenomics, Challenges in big data analytics	**CO1**	**6**
2	**Biological database and Types of biological databases**: Primary, secondary, and specialized databases, Nucleotide databases: GenBank, EMBL, DDBJ, Protein databases: UniProt, PDB, PIR, Genomic databases: Ensembl, UCSC Genome Browser, Functional databases: GO, KEGG, Reactome, Structure databases: SCOP, CATH, Disease and drug databases: OMIM, DrugBank, PharmGKB, Database formats and accession numbers, Database querying and cross-referencing	**CO2**	**6**
3	**Database Tools and Data Retrieval:** Sequence retrieval using NCBI Entrez, EBI, and UniProt interfaces, BLAST and FASTA searches, Tools for genome browsing and annotation, Data mining and integration using BioMart, InterPro, STRING	**CO3**	**6**
4	**Big Data Technologies in Biology:** Introduction to Hadoop, Spark, and cloud computing for biological data, Data storage formats: FASTQ, SAM/BAM, VCF, GFF/GTF, Workflow management	**CO4**	**6**

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	systems: Galaxy, Nextflow, Snakemake, Data visualization and dashboards for biological datasets		
5	**Applications and Case Studies:** Case studies: Human Genome Project, Cancer Genomics, Single-cell data analysis, Metagenomics, Systems biology and multi-omics integration	**CO5**	**6**

Reference Books

1. Bioinformatics for Omics Data (Methods and Protocols), Editors: Mayer, Bernd (Ed.) (Springer) (2011)
2. Big Data Analysis for Bioinformatics and Biomedical
3. Discoveries. ISBN 9780367240226 Chapman and Hall/CRC Shui Qing Ye (Ed.) (2019)
4. Big Data Analytics in Bioinformatics and Healthcare (IGI
5. Global) by Baoying Wang, Ruowang Li and William Perrizo. ISBN: 9781466666115 (2014).

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SANDIP UNIVERSITY

School of Engineering and Technology
Department of Biotechnology

Year : **Second Year** **Semester:** **IV**
Course: **Sequence Alignment Algorithms** **Course Code:** **NYBTM02**

Teaching Scheme (Hrs. /Week)				Continuous Internal Assessment (CIA)					End Semester Examination		Total
L	T	P	C	CIA-1	CIA-2	CIA-3	CIA-4	Lab	Theory	Lab	
2	0	0	2	10	20	10	10	-	100	-	100
Max. Time, End Semester Exam (Theory) – 3 Hrs									End Semester Exam (Lab): -		

Prerequisites: Biology and Chemistry

Course Outcome:

CO1	Understand why sequence alignment is important in biology and explain the different types, like global vs. local and pairwise vs. multiple alignment.
CO2	Learn how to use dynamic programming techniques, such as the Needleman-Wunsch and Smith-Waterman algorithms, to align DNA or protein sequences accurately.
CO3	Use fast and popular tools like BLAST and FASTA to find sequence similarities and analyze biological data efficiently.
CO4	Perform multiple sequence alignments using tools like Clustal Omega or MUSCLE and interpret the biological meaning of the aligned sequences.
CO5	Explore more advanced methods, like profile alignments and Hidden Markov Models, and apply them in real-world problems like gene prediction, evolutionary analysis, and protein structure comparison.

Unit No	Details	Mapping with COs	Hours
1	**Introduction to Sequence Alignment:** Biological motivation for sequence alignment, Types of sequence alignment: Pairwise vs. multiple, Global vs. local, Scoring systems: Match/mismatch, gap penalties, substitution matrices (PAM, BLOSUM), Biological applications of sequence alignment	CO1	6
2	**Pairwise Sequence Alignment Algorithms:** Global alignment – Needleman-Wunsch algorithm, Local alignment – Smith-Waterman algorithm, Affine gap penalties, Space and time complexity analysis, Dynamic programming principles in sequence alignment	CO2	6
3	**Heuristic and Fast Algorithms:** Limitations of exact algorithms, Heuristic methods: BLAST (Basic Local Alignment Search Tool), FASTA algorithm, Indexing and k-mer based approaches, Overview of optimization strategies	CO3	6
4	**Multiple Sequence Alignment (MSA):** Biological relevance of MSA, Progressive alignment: ClustalW/Clustal Omega, Iterative methods: MUSCLE, MAFFT, Consistency-based methods: T-Coffee, Scoring and evaluation of MSA quality, Challenges and limitations	CO4	6
5	**Advanced Topics and Applications:** Profile alignments and HMMs, Structural alignment (e.g., DALI, TM-align), Phylogenetic tree construction from aligned sequences, Applications in motif discovery, gene prediction, and comparative genomics	CO5	6

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Reference Books

1. David W Mount, Bioinformatics sequence and genome analysis, CBS publishers & Distributors 2nd Ed. (2004) ISBN 978-087969712-9
2. Multiple Sequence Alignment Methods; David J Russell, (Ed.) 1st Ed. 2014 ISBN 978-1-62703-646-7

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