Syllabus for Multi-Disciplinary Minor (MDM) Degree

In

Biotechnology and Bioengineering

Under the National Education Policy (NEP 2020)

(2023-2024)



Offered by

DEPARTMENT OF BIOLOGICAL SCIENCES AND BIOTECHNOLOGY

INSTITUTE OF CHEMICAL TECHNOLOGY (University Under Section-3 of UGC Act, 1956) Elite Status and Center for Excellence Government of Maharashtra

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A. Preamble

The recent and continuing advances in biotechnology are crafting disruptive innovations in enabling advance human development. In recent years, biotechnology has offered superior outcome for improved health care, enhanced food security, better supplies of potable water, cleaner environment, advanced industrial, agricultural processes for transforming raw materials and facilitating energy securities of the world. Successful capture of biotechnology potential will further provide significant opportunities for sustainable economic, environmental and societal growth.

Applications of biotechnology, engineering research, and manufacturing techniques is critical to the future of creating products and services that improve the quality of human life. In the coming years, biotechnological knowledge will be essential for advance medicines, renewable and advance raw materials, to develop innovative ways of improving food-fuel-feed security of the world, and in nutshell for the overall sustainability. Therefore, there is a need to foster and ignite young minds and create a community driven by knowledge, curiosity, innovation, design and scientific acumen.

In tune with the above-mentioned requirements, "The Minor degree Course in Biotechnology and Bioengineering" has been designed to encompass diverse domains of biotechnology and bioengineering from fundamental to advance stage. The course content will enable the students to gain deep insight into a range of biotechnological fields, such as Cell Biology, Microbial Technology, Genetic Engineering, Bioinformatics, Environmental Biotechnology, Marine Biotechnology, Industrial Biotechnology, Bioprocess Technology, Animal and Plant Biotechnology and more. The course will provide the opportunity to explore the wide spectrum of biotechnology and understand its role in sustainable development.

According to National Education policy guidelines, the course has been designed for a total of 14 credits as per the requirements of a minor degree. The course contains five theory and one practical course as mentioned below. The details of each course are given in later sections.

Sr No	Semester	Course Credits	Name of the course
1	III	2	Introduction to Biological Science
2	IV	2	Fundamental of Applied Biotechnology
3	V	4	Lab Techniques in Biotechnology
4	VI	2	Genetic Engineering and Bioinformatics
5	VII	2	Bioprocess Technology
6	VIII	2	Industrial Biotechnology

B. Structure of the MDM course

Subject Code	Semester	Subject	Credits	Hrs	s/Wo	eek	Mar	Marks for various Exan		s Exams
				L	Т	Р	CA	MS	ES	Total
BBT1201	Ш	Introduction to Biological Science	2	2	0	0	20	30	50	100
BBT1202	IV	Fundamental of Applied Biotechnology	2	1	1	0	20	30	50	100
BBP1303	V	Lab Techniques in Biotechnology	4	8	0	0	50	-	50	100
BBT1304	VI	Genetic Engineering and Bioinformatics	2	1	1	0	20	30	50	100
BBT1405	VII	Bioprocess Technology	2	2	0	0	20	30	50	100
BBT1406	VIII	Industrial Biotechnology	2	1	1	0	20	30	50	100
		Total	14	16						600

C. Program Specific Outcomes

Programme Specific Outcomes (PSOs) for Biotechnology and Bioengineering (MDM)

PSO1	To develop Strong foundation of Biological Sciences which is directly connected to knowing different biological organisms, understanding biomolecules as well as cellular energetic to corroborate basic life processes on the planet earth and their applications for basic science and technological advancements
PSO2	To identify, review and analyse concepts and applications pertaining to biotechnology, microbiology, bioinformatics, fermentation, genetic engineering, bioprocessing and downstream processing methods.
PSO3	To develop a multi-disciplinary human workforce with the understanding of biotechnology as an independent and integration of scientific disciplines and technologies including; biochemistry, microbiology, molecular biology, immunology bioinformatics, recombinant DNA Technology, fermentation processes and bioprocess engineering
PSO4	To understand impact of Biotechnology for individual, society, industry, environment and sustainability
PSO5	To discern basic as well as emerging biotechnological knowledge to be able to correlate both and develop innovative thinking

D. Recommended batch size: Minimum 15; Maximum 35

E. Eligibility criteria:

- a. CGPA of the first two semesters.
- b. In case the results of the 2nd semester are not available, eligibility will be based on CGPA of the 1st Semester (50% weightage) and CET/JEE score (converted into percentile based on admitted students, 50% weightage).

F. Prerequisites: None

G. Pedagogy/Teaching method

- a. Lecture/Discussions: These sessions will discuss the subject matters of the course.
- b. Experiential Learning: The sessions will involve hands-on training.
- c. Blended learning/Hybrid learning: The sessions will involve combined traditional and online learning in a flexible and engaging way.
- d. Tutorials: Problem solving / case studies / relevant real-life applications / student presentations / home assignments / individual or group projects

H. List of Faculty members who will be engaged in teaching MDM course

Prof Samir Kulkarni (SK)	Dr Hitesh Pawar (HP)
Dr Ratnesh Jain (RJ)	Dr Mayur Ladole (ML)
Dr Gunjan Prakash (GP)	Dr Chandrakant Holkar (CH)
Dr Manju Sharma (MS)	Dr Anand Jadhav (AJ)
Dr Shamlan Reshamwala (SR)	Dr Rohit Sathe (RS)

I. Faculty members associated with each subject (Tentative)

Sr No	Semester	Course Credits	Name of the course	Faculty
1	III	2	Introduction to Biological Science	SK&AJ
2	IV	2	Fundamental of Applied Biotechnology	GP&MS
3	V	4	Lab Techniques in Biotechnology	ML&CH
4	VI	2	Genetic Engineering and Bioinformatics	SR&RS
5	VII	2	Bioprocess Technology	RJ&HP
6	VIII	2	Industrial Biotechnology	GP&SK

J. Evaluation

• Theory Courses (BBT1201, BBT 1202, BBT 1304, BBT1405, BBT1406)

Continuous Assessment Test (CAT): Total 20 Flexible (Instructor specific); including but not limiting to Assignments, Quiz, problem statement, written test, presentation, short project, end of the class problem. Mid semester: Total 30 Marks (Theory paper) End semester: Total 50 Marks (Theory paper)

• Practical Courses (BBP1303)

Continuous Assessment: 50 Marks (Theory + Lab)

Performing given experiments as per the instructions, submission of lab journal on time, viva voce, group/personal discussions, and quizzes can be part of continuous

assessment. The course instructor will discuss the composition of marks for these at the beginning of the course.

• End Semester: 50 Marks (Lab experiment performance followed by viva-voce examination).

K. Detailed syllabus

	Course Codes DDT1201	Course Titles Introduction to Diclosical Sciences	Cred	its :	= 2
	Course Code: BB11201	Course Title: Introduction to Biological Sciences	L	T	Р
	Semester: III	Total contact hours: 30	2	0	0
	List of	Courses where this course will be Prerequisite			
	1. Fundamental and Applied	d Biotechnology (BBT1202)			
	2. Genetic Engineering and	Bioinformatics (BBT1304)			
	3. Bioprocess Technology	/ (BBT1405)			
	4. Industrial Biotechnology	(BBT1406)			
	5. Lab Techniques in Biotec	chnology (BBP1303)			
	Cou	rse Contents (Topics and subtopics)	Reqd hour	l. s	
1	Introduction to cells			6	
	• Eukaryotes and prokaryo	tes, Cell architecture and organelles			
	• Asexual and sexual m	nodes of reproduction example Binary fission, budding,			
	fragmentation, formation	of spores, bacterial conjugation, mitosis, and meiosis.			
2	Chemistry of life			6	
	• Carbohydrates: Functio	n, Monosaccharides and Disaccharides, Polysaccharides;			
	Glycoproteins, and Glyco	olipids; Proteins: Amino acids, Peptides and Proteins, Structure			
	of amino acids and protei	ns.			
	• Nucleic acids: Function,	Structure, chemistry, DNA, RNA and Chromosomes			
	• Lipids: Structure, Func	tion, Structural Lipids in Membranes, Lipids as Signals,			
	Cofactors				
3	Enzymology			6	
	Nomenclature & classific	cation of Enzymes			
	• Enzyme structure and pro	operties.			
	• Mechanism of enzyme ac	ction, factors affecting enzyme action.			
	Activation energy; active	site; activators and inhibitors.			
4	Cellular Energetics			6	
	• Energetics and Metabolis	sm			
	• Energy Production: aerob	bic and anaerobic respiration, and photosynthesis.			
_	• Free energy and biologica	al reactions, Redox potentials in biological systems			
5	Introduction to Metabolic Pat	hways and their regulation		3	
6	Transition of Biological Scien	nces to Biotechnology		3	
1		List of Textbooks			
1	Prescott's Microbiology; Au	thors: Joanne M. Willey, Kathleen M. Sandman (Author),			
2	Nalson DL and Cay MM	Lanshig M. Flescott, Elevenul edition.			
2	W H Freeman New Vork 1	(2017) Lemmiger Finciples of Biochemistry. 7th Edition,			
	List of Addi	526. itional Reading Material / Reference Books			
	As suggested by the concerne	ed faculty		_	
	Со	urse Outcomes (students will be able to)			
CO	Learn structural and fur	ictional aspects of cell; the basic unit of life, and its different		K1	
	organelles and working	ot a cell as a factory. Classify different microorganism as well			
	as differentiate based on	a prokaryotic and eukaryotic cell	──	17.0	
	2 Understand structure an	a runctional aspects of macromolecules of cells		$\frac{K2}{K2}$	
CO:	5 Understand the important	nce of enzymes in the biological systems		<u>K2</u>	

CO4	Understand different types of cell metabolism, their regulation and correlate with	K2
	cellular energetics	

Mapping of Course Outcomes (COs) with Programme Specific							
Outcomes (PSOs)							
	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	3	2	2	3	2		
CO2	3	2	2	2	2		
CO3	3	2	2	2	2		
CO4	3	2	2	2	2		

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0– No Contribution K, knowledge level from cognitive domain

Semester: IV Total contact hours: 30 I <thi< th=""> I <thi< th=""> <</thi<></thi<>
Prerequisite courses 1. Introduction to Biological Sciences 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 7. Introduction to Biotechnology 8. Lab Techniques in Biotechnology 9. Course Contents (Topics and subtopics) 9. Reqd. hours 1 11. Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 2 9. Microbiology 1 1 1 1 1 1 1 1 1 1 1 1 1 2 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Prerequisite courses 1. Introduction to Biological Sciences List of Courses where this course will be prerequisite 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 4. Lab Techniques in Biotechnology, Reqd. hours 1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 2 Microbiology 6 • Types and forms of microbes, 6 • Selective methods for isolation of pure cultures, 6 • Growth, maintenance, and preservation of pure culture, 9 • Quantitative measurement of growth, 8 • Microbiology 3 3 Introduction to Animal Cell culture 3 • History, development of cell lines, Origin of animal cell line and maintenance. Primary culture, Secondary culture, Animal culture media and growth conditions. 3 • Biotechnological application of animal cells 4 Introduction to Agriculture Biotechnology 4 4 • Introduction to Agriculture Biotechnology
1. Introduction to Biological Sciences List of Courses where this course will be prerequisite 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 6 7 8 1 1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 2 Microbiology 6 • Types and forms of microbes, • Selective methods for isolation of pure cultures, • Growth, maintenance, and preservation of pure culture, • Quantitative measurement of growth, • Microbiology 3 Introduction to Animal Cell culture • Application of microbes in biotechnology 3 Introduction to Animal Cell culture, Animal culture media and growth conditions. • Biotechnological application of animal cells 4 Introduction to Agriculture, Biotechnology 4 Introduction of food to meet the demand of an increasing population, sustainable means of agriculture, Biofertilizers, Biopesticides, Secondary agriculture. • Plant Cell & Tissue cultu
List of Courses where this course will be prerequisite 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 4. Lab Techniques in Biotechnology 4. Lab Techniques in Biotechnology 8. Reqd. hours 1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 8. Reqd. hours 2 Microbiology 6 6 • Types and forms of microbes, 6 • Selective methods for isolation of pure cultures, 6 • Growth, maintenance, and preservation of pure culture, 9 • Quantitative measurement of growth, 8 • Microscopy as a tool to study microbes. 9 • Application of microbes in biotechnology 3 3 Introduction to Animal Cell culture 3 • History, development of cell lines, Origin of animal cell line and maintenance. Primary culture, Secondary culture, Animal culture media and growth conditions. 8 8 Biotechnological application of animal cells 4 4 Introduction to Agriculture Biotechnology 4
1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 4. Lab Techniques in Biotechnology 6. Course Contents (Topics and subtopics) 1
1 Bioprocess Technology 2. Bioprocess Technology 3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 2 Microbiology 2 Microbiology 6 6 • Types and forms of microbes, • Selective methods for isolation of pure cultures, • Growth, maintenance, and preservation of pure culture, • Quantitative measurement of growth, • Microscopy as a tool to study microbes. • Application of microbes in biotechnology 3 Introduction to Animal Cell culture • History, development of cell lines, Origin of animal cell line and maintenance. • Primary culture, Secondary culture, Animal culture media and growth conditions. • Biotechnological application of food to meet the demand of an increasing population, sustainable means of agriculture, Biofertilizers, Biopesticides, Secondary agriculture. • Plant Cell & Tissue culture technology and its application. • Genetic modification of Plants 5 Marine Biotechnology 3
3. Industrial Biotechnology 4. Lab Techniques in Biotechnology 4. Lab Techniques in Biotechnology Reqd. hours 1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 3 2 Microbiology 6 2 Microbiology 6 4 Types and forms of microbes, 6 5 Microbiology as a tool to study microbes. 7 6 Application of microbes in biotechnology 3 7 Introduction to Animal Cell culture 3 8 Application of microbes in biotechnology 3 9 Introduction to Animal Cell culture 3 9 History, development of cell lines, Origin of animal cell line and maintenance. Primary culture, Secondary culture, Animal culture media and growth conditions. 8 9 Biotechnological application of food to meet the demand of an increasing population, sustainable means of agriculture, Biofertilizers, Biopesticides, Secondary agriculture. 4 9 Increased production of Plants 3 5 Marine Biotechnology 3
4. Lab Techniques in Biotechnology Reqd. hours 1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 3 2 Microbiology 6 • Types and forms of microbes, • 6 • Types and forms of microbes, • 6 • Selective methods for isolation of pure cultures, • 6 • Growth, maintenance, and preservation of pure culture, • 2 • Quantitative measurement of growth, • 6 • Microscopy as a tool to study microbes. • 7 • Application of microbes in biotechnology 3 3 Introduction to Animal Cell culture • 7 • History, development of cell lines, Origin of animal cell line and maintenance. • 7 • History, development of cell lines, Origin of animal cells 4 4 Introduction to Agriculture Biotechnology 4 • Increased production of food to meet the demand of an increasing population, sustainable means of agriculture, Biofertilizers, Biopesticides, Secondary agriculture. • 9 • Plant Cell & Tissue culture technology and its application. • 3 • Diversity of marine microbes and the
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1 Introduction to Biotechnology, The colours of Biotechnology, Applications of Biotechnology 3 2 Microbiology 6 2 Microbiology 6 • Types and forms of microbes, 6 • Selective methods for isolation of pure cultures, 6 • Growth, maintenance, and preservation of pure culture, 6 • Quantitative measurement of growth, 7 • Microscopy as a tool to study microbes. 7 • Application of microbes in biotechnology 3 3 Introduction to Animal Cell culture 3 • History, development of cell lines, Origin of animal cell line and maintenance. Primary culture, Secondary culture, Animal culture media and growth conditions. 8 • Biotechnological application of animal cells 4 4 Introduction to Agriculture Biotechnology 4 • Increased production of food to meet the demand of an increasing population, sustainable means of agriculture, Biofertilizers, Biopesticides, Secondary agriculture. 9 • Plant Cell & Tissue culture technology and its application. 5 • Genetic modification of Plants 3 • Div
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Genetic modification of Plants Marine Biotechnology Diversity of marine microbes and their nutrition
5 Marine Biotechnology 3 • Diversity of marine microbes and their nutrition 3
Diversity of marine microbes and their nutrition
Applications of Marine Biotechnology
6 Environmental Biotechnology 4
• Biodegradation, bioremediation, Bioleaching, nitrification, denitrification, enhanced
phosphorus removal, Anaerobic digestion
• Inermophiles, Psychrophiles, Halophiles, Acidophiles, Actinomycetes, and their applications in modern histochnology.
Environmental Biotechnology and sustainability
7 Pharmaceutical Biotechnology and sustainability 4
• Introduction and application of Pharmaceutical Biotechnology in the healthcare and
diagnostics
• Basic principle of recombinant DNA technology and application in the production of
vaccines, hormones, interferon, monoclonal antibodies etc
List of Textbooks
1 Prescott's microbiology; Authors: Joanne M. Willey, Kathleen M. Sandman (Author),
Dorothy H. Wood (Author), Lansing M. Prescott; Edition: Eleventh edition.
Kuby, Janis Title(s): Kuby immunology/ Judith A. Owen, Jenni Punt, Sharon A. Strenford, with contributions by Detricic D. Janes, Edition, 7th 14
Stramoru, with contributions by Patricia P. Jones. Edition: /th ed.
J France Tissue Culture. Theory and Practice. Dy S.S. Dhojwalli, M.K. Kazdall.

	As suggested by the concerned faculty	
	Course Outcomes (students will be able to)	
CO1	Comprehend different types of biotechnology and appreciate the importance and scope of biotechnology in everyday life.	K2
CO2	Acquire basic and applied understanding of microbiology, animal culture technology, Agriculture Biotechnology, Environmental Biotechnology, Marine Biotechnology, Immunology	К2
CO3	Analyze impact of biotechnology on environmental sustainability	K3

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)						
	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	3	2	
CO2	3	3	2	3	2	
CO3	3	2	2	3	2	

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0– No Contribution K, knowledge level from cognitive domain

Semester: V Total contact hours: 120 I P Prerequisite course Introduction to Biological Sciences 2. Fundamentals of Applied Biotechnology Ust of courses where this course will be prerequisite I. 1. Genetic Engineering and Bioinformatics Bioprocess Technology Image: Course Contents (Topics and subtopics) Reqd. hours Basic Microbiology Course Contents (Topics and subtopics) Reqd. hours Nours Basic Microbiology Microbial Isolation and quantitative measurements 1 Microbial Growth Kinetics Image: Course Contents (Topics and subtopics) Reqd. hours Microbial Growth Kinetics Microbial Growth Kinetics Image: Course Contents (Topics and subtopics) Image: Course Contents (Topics and subtopics) Reqd. hours 9 Microbial Growth Kinetics Image: Course Contents (Topics and subtopics) Reqd. hours 9 Microbial Growth Kinetics Image: Course Contents (Topics and subtopics) Reqd. hours 9 Microbial Growth Kinetics Image: Course Contents (Topics and subtopics) Image: Course Contents (Topics and subtopics) 9 To prepare Tra-HCI Buffer with a specific pH (eg. pH 8.8) Image: Course Conten		Course Code: BBP1303	Course Title: Lab Techniques in Biotechnology	Cree	dits = 4	
Semester: Total contact nours: 120 0 q Prerequisite course I. Introduction to Biological Sciences 2. Fundamentals of Applied Biotechnology List of courses where this course will be prerequisite 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology Reqd. Basic Microbiology Course Contents (Topics and subtopics) Reqd. Microbial Isolation and quantitative measurements 1 Microbial Growth Kinetics Augest and Antibiotic restiance assays Microbial Growth Kinetics Microbial Growth Kinetics 30 <th></th> <th></th> <th></th> <th></th> <th>ΓP</th>					ΓP	
Prerequisite course Introduction to Biological Sciences List of courses where this course will be prerequisite List of courses where this course will be prerequisite Industrial Biotechnology 3. Industrial Biotechnology Reqd. Basic Microbiology Microbial Isolation and quantitative measurements Nicrobial Isolation and quantitative measurements Nicrobial Isolation and quantitative measurements Nicrobial prophytic preparation, morphology-based identification, A Microbial Growth Knetics Nicrobial growth curve preparation, Optical density measurement, A Optical density measurement,		Semester: V	Total contact hours: 120	υι	4	
1. Introduction to Biological Sciences 2. Fundamentals of Applied Biotechnology List of courses where this course will be prerequisite 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology Read: Course Contents (Topics and subtopics) Read: Microbial Isolation and quantitative measurements 1. Microscopy, Sample preparation, morphology-based identification, Dilution & Plating/spectrophotometric cell growth estimation 2. Microbial growth curve preparation, Dilution & Plating/spectrophotometric cell growth estimation 3. Microbial Growth Kinetics Microbial Growth curve preparation, Optical density measurement, Production of Bakers yeast by fermentation, Growth and substrate analysis and correlation Biochemistry and Molecular Biology • Tota Lipid extraction and gravimetric analysis • Separation of Amino acids by Paper Chromatography and Thin Layer Chromatography • determination of the unknown concentration of protein concentration by plotting a standard curve of BSA using Bradford reagent • Ammonium sulphate precipitation and dialysis for a protein • Primer designing • Analysis of Protein purity and determination of molecular weight of pure protein by SDS PACE and Coomassie Brilliant blue staining of proteins on SDS gel • Quantitative DNA estimation (Demo) <t< td=""><td></td><td></td><td>Proroquisite course</td><td></td><td></td></t<>			Proroquisite course			
2. Fundamentals of Applied Biotechnology 2. Fundamentals of Applied Biotechnology 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology 3. Industrial Biotechnology Basic Microbiology Reqd. Microscopy, Sample preparation, morphology-based identification, 2. Bioprocess Technology Microscopy, Sample preparation, morphology-based identification, 2. Assays: ViB12 and Antibiotic resistance assays Microbial Growth Kinetics • Microbial growth curve preparation, 2. Optical density measurement, 30 Biochemistry and Molecular Biology • To prepare Tris-HCI Buffer with a specific PH (eg. PH 8.8) • quantitative estimation of carbohydrates • Total Lipid extraction and gravimetric analysis • Separation of Amino acids by Paper Chromatography and Thin Layer Chromatography • Ammonium subphate precipitation of protein concentration by plotting a standard curve of BSA using Bradford reagent • Analysis of Protein purity and determination of molecular weight of pure protein by SDS PAGE and Commasie Brilliant blue staining of proteins on SDS gel • Quantitative DNA estimation (Demo) Enzymology • Isolation and assay of enzyme from natural source • Primary scree	1	Introduction to Biological Sc	iences			
List of courses where this course will be prerequisite 1. Genetic Engineering and Bioinformatics 2. Bioprocess Technology Regd. 3. Industrial Biotechnology Course Contents (Topics and subtopics) Regd. Basic Microbiology Microbial Isolation and quantitative measurements Production & Plating/spectrophotometric cell growth estimation 24 1 Microbial Growth Kinetics Microbial Growth Kinetics 30 2 Optical density measurement, and unbitotic resistance assays 30 2 Optical density measurement, and unbitotic resistance assays 30 3 Optical density measurement, and unbitotic resistance assays 30 4 Production of Bakers yeast by fermentation, and quantitative estimation of carbohydrates 30 5 Forepration, and gravimetric analysis 30 6 Growth and substrate analysis and correlation 30 7 Total Lipid extraction and gravimetric analysis Separation of Amino acids by Paper Chromatography and Thin Layer Chromatography 3 determination of the unknown concentration of protein concentration by plotting a standard curve of BSA using Bradford reagent 30 4 Isolation and dasay of enzyme from natura	2.	Fundamentals of Applied Bio	otechnology			
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CO1Develop basic understanding of microbes, their monitoring and quantificationK3		Cours	e Outcomes (students will be able to)			
	C01	Develop basic understanding	g of microbes, their monitoring and quantification	K	3	

CO2	Perform the quantitative analysis of biomolecules, Enzyme Kinetics	K3
CO3	Perform and analyze quantitative estimation for biomolecules	K4
CO4	Know different bioreactor parts and their function	K2

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)								
	PSO1 PSO2 PSO3 PSO4 PSO5							
CO1	3	3	2	3	2			
CO2	3	2	2	2	2			
CO3	3	2	2	2	2			
CO4	2	2	2	2	2			

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0– No Contribution K, knowledge level from cognitive domain

C	C. J., DDT1204	Course Title: Genetic Engineering and	Cre	dits	= 2	
Course	Code: BB11304	Bioinformatics	L	Т	P	
Semest	er: VI	Total contact hours: 30	1	1	0	
		Prerequisite course				
1.	Introduction to Biological Sc	iences				
2.	Fundamentals of Applied Bio	technology				
	List of Co	urses where this course will be Prerequisite				
1.	Bioprocess Technology					
2.	Industrial Biotechnology					
	Course Co	ntents (Topics and subtopics)	Req	uire	d	
a 4			hou	rs		
Genetic	c Engineering		1			
	Coding of Genetic Informati	on				
1	• DNA replication and tra	nscription		3		
	• Protein biosynthesis					
• Gene regulation and gene expression						
	Gene Cloning					
	Cloning vectors					
2	• Expression vectors					
	Prokaryotic host cells					
	Restriction endonuclease	es				
Polymerase chain reaction						
	Transformation of Cells					
	• Prokaryotes			-		
3	• Yeast			3		
	• Plant cells					
	Animal cells					
4	Genome Modification and In	ntegration Strategies, including CRISPR		2		
	Synthetic Biology					
5	Standardization of DNA	parts		2		
	Assembly of standard pa	arts				
Bioinfo	rmatics		1			
	Introduction to Bioinformati	cs				
6	• History, development of	of the field, interdisciplinary contribution to the field,		1		
	important concepts in	the field, current research scenario in bioinformatics,				
	artificial intelligence, etc	2.				
7	Databases			2		
	• NCBI, PDB, DDBJ, Put	oMed, GenBank, EMBL, PubChem, BioMed Central, etc.				
0	File Formats	l'annual familie (CAM DAM CDAM). Challes ha		1		
8	• FASTA, FASTQ, PDB	, alignment formats (SAM, BAM, CRAM), Stockholm		I		
	Iormats (VCF), GFF, G	IF, JSON, PHYLIP, PIR, etc.				
	Nucleotide Sequence Alight	liennant. Clobal alienmant, logal alienmant, naimuisa				
9	• Concept of sequence a	augument, Giobal augument, local augument, pairwise		1		
	alignment EACTA DI	AST EMBLERI CLUSTALW				
	Protein Sequence Alignment	t				
10	Algorithms of alignment	t Clustal Omega UniDrot SIM ExDASy		1		
11	Three_dimensional Molecule	ar Structures		r		
1 11	TIMEC-unicusional workedua		1	4		

	• Importance of visualizing molecules in 3D, programs for 3D visualization, creating and editing 3D structures, structural alignments, geometry optimization			
	Molecular Modeling			
12	• Protein structures and their importance, protein structure predictions, homology	2		
	modeling, different bioinformatics tools available for molecular modeling			
12	Molecular Docking	2		
13	• Introduction to protein-ligand interactions, models of protein-ligand interactions, different bioinformatics tools available for molecular docking	2		
	Industrial Applications of Bioinformatics			
14	 Applications of bioinformatics and related fields into chemical pharmaceutical 	1		
	and various other industries.	1		
	List of Textbooks			
1	Molecular Biotechnology: Principles and Applications of Recombinant DNA (6th edit	ion) by		
1	Bernard R. Glick, Cheryl L. Patten (Wiley)			
2	Molecular Biology of the Gene (7th edition) by James D. Watson (Cold Spring Harbor	r Press)		
3	Gene Cloning and DNA Analysis: An Introduction (6th edition) by T. A. Brown (Wiley)			
4	Introduction to Bioinformatics by M. Lesk (2002) Oxford University Press.			
5	Sequence Analysis in a Nutshell: A Guide to Common Tools and Databases by S. Mar	kel and D.		
5	León (2003) O'Reilly Press.			
6	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A. D. Bas	kevanis and		
	B. F. F. Ouellette (2004) Wiley-Interscience.			
/	Fundamental Concepts of Bioinformatics by D. E. Krane and M. L. Raymer (2002) Pe	arson.		
8	Developing Bioinformatics Computer Skills by C. Gibas and P. Jambeck (2001) O Rei	ny Media.		
	List of Additional Reading Material / Reference Books			
	As suggested by the concerned faculty			
CO1	Choose appropriate hosts for gene expression and protein production based on the	K3		
COI	known properties.	K5		
CO2	Understand basic and modern techniques of gene manipulation.	К3		
CO3	Apply principles of synthetic biology to construct gene circuits.	K4		
CO4	Have essential and working knowledge in bioinformatics.	K3		
CO5	Generate important supplementary data to support the research hypotheses with	K4		
	various bioinformatics tools.			

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)									
	PSO1 PSO2 PSO3 PSO4								
CO1	3	2	2	2					
CO2	3	2	2	3					
CO3	3	2	2	2					
CO4	2	2	2	2					
CO5	2	2	2	2					

3: Strong Contribution; 2: Moderate Contribution; 1: Low Contribution

	Course Code: Course Title: Bioprocess Technology		Credits = 2				
	BBT1405		L	Τ	P		
	Semester: VII	Total contact hours: 30	2	0	0		
		Prerequisite course					
1.	1. Introduction to Biological Sciences						
2.	2. Fundamentals of Applied Biotechnology						

	List of course where this course will be Prerequisite					
	1. Industrial Biotechnology					
	Course Contents (Topics and subtopics)	Reqd. hours				
1	Introduction to Bioprocess Technology	6				
	Definition and importance of bioprocess technology					
	• Applications of Bioprocessing in pharmaceutical, food, agriculture and bioenergy					
	industries					
	• Convergence of the molecular biology principles for bioprocessing: Applications					
	and dependencies					
2	Growth Kinetics	3				
	• Growth phases of microorganisms/cells					
	Determination of growth rate constants					
	• Factors influencing microbial/cell growth					
	Convergence of the growth principles for bioprocessing: Applications and dependencies					
3	Bioreactor Design and Operation	3				
	• Types of bioreactors and their applications					
	Components and functions of bioreactors					
	Mixing and aeration in bioreactors					
4	Downstream Processing	3				
	Cell harvesting methods					
	Filtration and centrifugation					
	• Purification techniques: chromatography, crystallization, etc.					
5	Bioprocess Control and Automation	3				
	Sensors and actuators in bioprocessing					
	• Feedback and feedforward control					
	Importance of process automation					
6	Environmental and Ethical Considerations	3				
	Environmental impact of bioprocessing					
	Ethical issues in biotechnology and bioprocessing					
	Sustainability in bioprocess technology	-				
7	Case Studies in Bioprocess Technology	3				
	Success stories in bioprocessing					
	• Failure analysis and lessons learned					
0	Innovations and future trends					
9	Applying Knowledge to Bioprocess Improvements	3				
	Identifying areas for bioprocess optimization					
	• Proposing strategies for process intensification: Improvement in expression,					
	continuous processing etc.					
10	Implementing sustainable practices	2				
10	Summery of key concents covered in the course	5				
	 Summary of Key concepts covered in the course Final assessment and O & A cassion 					
	I liet of Taythooks	l				
1.	Shuler M.L. and Kargi, F. (2002). Bioprocess engineering-basic concepts 2nd					
· ·	Edition, Prentice-Hall of India pyt ltd, New Delhi.					
	List of Additional Reading Material / Reference Books					
	As suggested by the concerned faculty					
	Course Outcomes (students will be able to)					
CO1	Define bioprocess technology and explain its significance in different industries.	K2				
CO2	Describe the growth kinetics of microorganisms and its importance in bioprocess design	. K2				

CO3	Evaluate different bioreactor design for designing a fermentation process	K3
CO4	Discuss downstream processing techniques and their role in product purification.	K3
	Analyse case studies of successful bioprocess applications and learn from past failures	K3
CO5	and apply fundamental knowledge to propose improvements in bioprocess designs and	
	strategies.	

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)								
	PSO1 PSO2 PSO3 PSO4 PSO5							
CO1	2	3	3	3	2			
CO2	2	3	3	2	3			
CO3	2	2	3	2	2			
CO4	2	2	3	2	2			
CO5	2	3	3	2	2			

3: Strong Contribution; 2: Moderate Contribution; 1: Low Contribution

	Course Code: BBT1406	Course Title: Industrial Biotechnology	Credi	ts =	2	
			L	Τ	P	
	Semester: VIII	Total contact hours: 30	1	1	0	
	T	List of Prerequisite Courses				
	1. Introduction to Biolog	ical Sciences				
	2. Fundamental of Applied Biotechnology					
	3. Bioprocess Technolog	у				
	Cor	rrse Contents (Topics and Subtopics)	Reqd. hours			
1	Introduction to Industr	ial Biotechnology based bioprocess		3		
	Biochemistry of ferme	ntation. Traditional and Modern Biotechnology- A brief survey				
	of organisms, processe	es, products.				
	Selection of Appropria	te microbe/cell type for industrial biotechnology				
	• Significance of wild t	ype and genetically modified organisms (GMO) in Industrial				
	Biotechnology					
	• Submerged and Soli	d-state Fermentation, relative advantages and limitations,	2	2		
	applications					
	• Strain Improvement	in Industrial Biotechnology: Conventional and advanced		3		
	Methodologies (rando	om mutagenesis, targeted mutagenesis, recombinant DNA				
	Technology)					
2	• Stoichiometry of cell	growth and product formation, elemental balances, degrees of		3		
	reduction of substrate	and biomass, available electron balances, yield coefficients of				
	biomass and product fe	ormation, productivity, maintenance coefficients				
3	Medium requirements	for Industrial fermentation processes, Types of Media, Criteria	-	5		
	of media design, Raw	material, Industrial by products as a source of fermentation				
	medium nutrients					
	Medium optimization	methods: One factor at a time, Plackett Burman and Response				
	surface method					
	Cost Economics of fer	mentation media for different product types (High Value-Low				
	Volume and Low Valu	le-High Volume)				

	• Entrepreneurship opportunities and challenges in Industrial Biotechnology	2
3	Applications-I	6
	• Microbial production of industrial enzymes (glucose isomerase, cellulase &	
	lipases)	
	Production of antibiotics, recombinant products, and amino acids	
	• Immobilization of cells and enzymes (conventional and modern methods of	
	immobilization techniques)	
4	Applications-II	6
	• Process technology to produce cell biomass and some primary metabolites, e.g.	
	ethanol, acetone-butanol, citric acid, dextran,	
	Applications of bioconversion/biotransformation.	
	• Bioenergy-fuel from biomass, production, and economics of biofuels.	
	List of Textbooks	
1	Biotechnology: A Textbook of Industrial Microbiology: T.D. Brock, Smaeur Associates,	
	1990	
2	Industrial Microbiology: L.E. Casida, Wiley Eastern Ltd., 1989	
3	Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987	
4	Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom	
	(1992), RIT, Stockholm	
5	Bioseparations-Downstream processing for Biotechnology by Paul. A. Belter,	
	E.L.Cussler and Wei-Shou Hu., John Wiley and sons	
	List of Additional Reading Material / Reference Books	
1	Bioprocess engineering principles by Pauline M. Doran, Academic Press	
2	Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Rutledge & A Sasson,	
	Cambridge Univ. Press, Cambridge	
	Course Outcomes (students will be able to)	
CO1	Select type of fermentation based on organism, product and process economics	K3
CO2	Model the nutrient requirements for a fermentation process with economic perspective	K4
CO3	Analyse case studies of different industrial biotechnology process	K3

Mapping of Course Outcomes (COs) with Programme Specific							
Outcomes (PSOs)							
PSO1 PSO2 PSO3 PSO4 PSO5							
CO1	3	3	3	2	2		
CO2	2	3	3	3	3		
CO3	2	3	3	2	2		

3: Strong Contribution; 2: Moderate Contribution; 1: Low Contribution