आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

Course Structure

&

Syllabus

of

M.Tech.
Biotechnology

[Applicable w.e.f. Academic Session - 2022-23]

[As per CBCS guidelines given by UGC]

SCHOOL OF BIOTECHNOLOGY

IFTM UNIVERSITY, MORADABAD

आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

Website: www.iftmuniversity.ac.in

SCHOOL OF BIOTECHNOLOGY

Study and Evaluation Scheme

of

MASTER OF TECHNOLOGY

(BIOTECHNOLOGY)

[II Year PROGRAM]

Choice Based Credit System (CBCS)

[Academic Session 2022-23]

Summary

Programme:	**Master of Technology (Biotechnology)**
Programme Level:	**Degree (Post-Graduation)**
Duration:	**Two years (Four semesters) Fulltime**
Medium of Instruction:	**English**
Minimum Required Attendance:	**75%**
Maximum Credits:	**89**

IFTM University, Moradabad
Master of Technology (Biotechnology)

Preamble

The curriculum of M.Tech. in Biotechnology program at I.F.T.M. University is directed towards fundamental and practical understanding of the core biotechnology. In addition, elective courses from other disciplines provide interdisciplinary exposure to the students. The core-subjects, specialized theme areas of Biotechnology, electives from other schools, hands on laboratory training along with the Thesis project component to be undertaken in-house/ other R&D institutes/ industries will enrich students with right skills required in the current Job market both in academia and industries, on completion of the program.

School of Biotechnology, IFTM University offers **M. Tech. (Biotechnology)** with the aim to provide training to students in the areas of modern Biotechnology. The post graduates are expected to carry out both basic and applied research in the areas of Biotechnology having academic and/or industrial relevance. The students would also be trained to assist industry in developing and/or solving problems of Biotechnology. In addition, the program also aims at generating manpower capable of teaching Biotechnology at postgraduate and undergraduate level.

Considering this M.Tech. Biotechnology CBCS (2022-23) program is designed to develop the students and make them ready for the future needs of the biotechnology sector, along with exposure to practical techniques. The primary emphasis is on making the curriculum compatible with developments in the education, research, and industrial sectors. This course offers industrial training to students along with Core Courses, Generic Elective, Ability Enhancement Compulsory Course and Discipline Specific Elective.

Program Objectives: The program aims to achieve the following objectives:

- Acquire necessary knowledge and skills in the frontier areas of Biotechnology and will think critically and creatively about the use of biotechnology to address local and global problems.
- Apply the knowledge of mathematics, science, engineering fundamentals, engineering concepts like mass transfer heat, transfer and fluid flow to the solution of complex engineering problems.
- Students will be able to implement the engineering principles to biological systems for development of industrial applications, as well as entrepreneurship skills to start biotech industries.
- Apply their knowledge on Bioprocess engineering techniques like Upstream process involving medium optimization and downstream process involving product recovery and purification in fermentation industries.
- Analyze the problem related with bioreactor designing and its component parts and can conduct experiments, to analyze and interpret data.
- Independently carry out research /investigation and development work to solve practical problems, write and present a substantial technical report/document.
- Recognize the need for continuous learning and will prepare oneself to create, select, learn and apply appropriate techniques, resources, and modern instrumentation to solve complex biotechnological activities with an understanding of the limitations.

PROGRAM OUTCOMES (PO):

Following Program Outcomes will be achieved:

PO1- Engineering knowledge: To solve complicated engineering problems, use your understanding of mathematics, science, engineering fundamentals, and an engineering specialism.

PO2- Problem analysis: Identify, formulate, study research material, and analyse difficult engineering problems using first principles of mathematics, natural sciences, and engineering sciences to achieve justified findings.

PO3- Design/development of solutions: Design solutions for complex technical challenges and system components or processes that meet the given requirements while taking into account public health and safety, as well as cultural, socioeconomic, and environmental factors.

PO4- Conduct investigations of complex problems: To give valid results, use research-based knowledge and research methodologies such as experiment design, data analysis and interpretation, and information synthesis.

PO5- Modern tool usage: Create, choose, and apply relevant methodologies, resources, and current engineering and IT technologies to complex engineering processes, including prediction and modelling, while keeping in mind the restrictions.

PO6- The engineer and society: Assess societal, health, safety, legal, and cultural issues, as well as the duties associated with professional engineering activity, using reasoning informed by contextual knowledge.

PO7- Environment and sustainability: Understand the societal and environmental implications of professional engineering solutions, and demonstrate understanding of and need for sustainable development.

PO8- Ethics: Apply ethical concepts and adhere to engineering practice's professional ethics, duties, and conventions.

PO9- Individual and team work: Individually and as a member or leader in different teams and transdisciplinary situations, perform well.

PO10- Communication: Communicate effectively with the engineering community and society at large on complicated engineering operations, such as being able to read and create good reports and design documentation, give and receive clear directions.

PO11- Project management and finance: Demonstrate knowledge and comprehension of engineering and management principles and how to apply them to one's own work, as a team member and leader, to manage projects, and in interdisciplinary settings.

PO12- Life-long learning: Recognize the necessity for autonomous and life-long learning in the broader context of technological change, and have the preparation and ability to do so.

1. Eligibility

a. **Admission Criteria:** Admission to this course shall be carried out through merit.

b. **Qualifying Examination:** Undergraduate (B.Tech.) level or Master (M.Sc.)level with any discipline of life sciences.

c. Marks 55% aggregate for general, OBC and SC/ST category.

2. Curriculum: M.Tech. courses shall be based on semester system which will be of two years duration, divided into two sessions and four semesters. Each session shall be of two semesters, Session- I shall comprise of two semesters i.e., semester-I and semester-II; Session-II shall comprise of two semesters i.e., semester-III and semester-IV. The academic will follow the pattern as mentioned below:

Academic Calendar	Classes
I and III Semester	August to December
II and IV Semester	January to May
Summer Vacation	June and July

3. Cancellation of Admission: If a student at any stage is found to have concealed any information or have furnished false documents or found to be indulged in gross indiscipline/ misconduct, his/ her admission shall be cancelled and fee deposited by the student shall not be refunded in any case.

Evaluation of Performance

1. Programme: Evaluation of performance of the students in a programme shall be a continuous process based on their performance in the class test, quizzes, assignments and the end semester examinations.

a. Theory papers in semester system (Maximum Marks: 100)

The evaluation will be done through two class test and one end semester examination. This will be in addition to quizzes, assignments, attendance, etc. Each class test will carry a weightage of 10 marks, and the end semester examination will carry a weightage of 70 marks. The remaining 10 marks will be awarded on the basis of attendance and performance in quizzes and assignments.

b. Practical in semester system (Maximum Marks: 100)

In each practical, the student will be required to carry out the number of experiments as specified in the syllabus. Each practical conducted will be assessed by the teacher based on the experiment done during the lab, submission of the practical file, and understanding of the experiment done, which will carry a weightage of 30 marks. There shall be an end semester practical examination with or without an external examiner which will carry a weightage of 70 marks.

2. Project, Dissertation, Colloquium etc.: Project, Seminar, Dissertation, and other learning-oriented activities shall have associated maximum marks and credits, as stated in the syllabus.

3. Examination:

a. The minimum Grade required to pass in each Theory & Practical paper is 'GRADE D'.

b. A candidate, in order to pass, minimum CGPA of 4.50 is required in a particular academic year inclusive of both semesters of that academic. And maximum number of Carryover paper permissible for promotion to next academic year are 06 theory/ practical / project papers.

c. There shall be no minimum Grade required to pass in General Proficiency (GP). However, Grade obtained in General Proficiency (GP) shall be included in SGPA.

d. In case of audit paper, the minimum Grade required to pass is Grade D. However, the Grade obtained in audit paper shall not be included in SGPA.

Groups of CBCS:

05 Groups of courses have been identified to provide student comprehensive exposure to a large number of areas, leading to the holistic development of an individual. These groups / clusters are as follows:

1. Elementary / Fundamental Science courses (FSC)
2. Engineering Core Courses (ECC)
3. Engineering Laboratory Courses (ELC)
4. Engineering Departmental Elective (EDE)
5. Project/Dissertation/Colloquium (PDT)

1. Elementary / Fundamental Science courses (FSC):

These courses include science courses from the disciplines of Physics, Chemistry and Mathematics department, crafted for engineering students. These courses are of 4 credits each

2. Engineering Core courses (ECC):

Core courses of M.Tech. Program will provide a holistic approach to engineering education, giving students an overview of the field, a basis to build and specialize upon. These core courses are the strong foundation to establish technical knowledge and provide broad multi-disciplined knowledge which can be studied further in depth during the elective phase.

The core courses will provide more practical-based knowledge, case-based lessons and collaborative learning models. It will train the students to analyze, decide, and lead-rather than merely know-while creating a common student experience that can foster deep understanding, develop decision-making ability and contribute to the society at large.

A wide range of core courses provides groundwork in the field of Bioprocess, Microbiological engineering, Enzyme & Protein engineering etc.

We offer core courses in semester I, II and III during the M.Tech. Biotechnology program. There will be 4 credits for each core course offered in the program.

3. Engineering Laboratory Courses (ELC):

These courses includes various laboratories of Engineering designed to provide the student solid foundation to the domain of engineering. These courses are of 1 credit each.

4. Engineering Departmental Elective (EDE):

The departmental elective course is chosen to make students specialist or having specialized knowledge of a specific domain like Recombinant DNA Technology, Advanced Bioseparation Engineering, Bioinformatics etc. The student will have to choose any one out of the given list of specialization offered. These courses are of 4 credits each.

5. Project/Dissertation/Colloquium (PDT):

i. Project with a department faculty.

ii. The students, who take up experiential projects in companies, where senior executives with a stake in teaching guide them, drive the learning. All students are encouraged to do some live project other than their regular classes.

Summary of Credits

M.Tech. Biotechnology: Two-Year (4-Semester) CBCS Programme			
Basic Structure: Distribution of Courses			
S.No.	**Type of Course**	**Credit**	**Total Credits**
1.	**Elementary / Fundamental Science courses (FSC)**	02 Courses of 4 Credits each (Total Credit 02X4)	08
2.	**Engineering Core courses (ECC)**	10 Courses of 4 Credits each (Total Credit 12X4)	40
3.	**Engineering Laboratory Courses (ELC)**	08 Courses of 1 Credits each (Total Credit 08X1)	08
4.	**Engineering Departmental Elective (EDE)**	03 Courses of 4 Credits each (Total Credit 3X4)	12
5.	**Project/Dissertation/ Colloquium (PDT)**	01 Course of 1 Credit (Total Credit 01X1) 01 Course of 20 Credits (Total credit 01x20)	21
Total Credits			**89**

SCHOOL OF BIOTECHNOLOGY

IFTM UNIVERSITY

(Established under UPGovt.ActNo.24 of 2010 and approved under section 22 of UGC Act 1956)

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SCHOOL OF BIOTECHNOLOGY

PROGRAMME: MASTER OF TECHNOLOGY (BIOTECHNOLGY)

CHOICE BASED CREDIT SYSTEM

Effective from Session 2022-23

Course Code	CBCS BASKET	Credits			
Elementary/Fundamental Science Courses (FSC)		**L**	**T**	**P**	**C**
MTB104T	Biochemistry, Biophysics & Molecular Dynamics	3	1	0	4
MTB204T	Biophysical & Biochemical Techniques	3	1	0	4
Engineering/Discipline/Professional Core Courses (ECC)		**L**	**T**	**P**	**C**
MTB101T	Advanced Bioprocess Engineering	3	1	0	4
MTB102T	Advanced Bioseparation Engineering	3	1	0	4
MTB103T	Bioinformatics	3	1	0	4
MTB201T	Microbiological Technology	3	1	0	4
MTB202T	Enzyme & Protein Engineering	3	1	0	4
MTB203T	Recombinant DNA Technology	3	1	0	4
MTB301T	Immunotechnology & Immunoinformatics	3	1	0	4
MTB302T	Bioreactor Analysis & Design	3	1	0	4
MTB303T	Solid Waste Management	3	1	0	4
MTB304T	Pharmaceutical Biotechnology	3	1	0	4
Engineering Lab Courses (ELC)		**L**	**T**	**P**	**C**
MTB101P	Advanced Bioprocess Engineering Lab	0	0	2	1
MTB102P	Advanced Bioseparation Engineering Lab	0	0	2	1
MTB103P	Bioinformatics Lab	0	0	2	1
MTB201P	Microbiological Technology Lab	0	0	2	1
MTB202P	Enzyme & Protein Engineering Lab	0	0	2	1
MTB203P	Recombinant DNA Technology Lab	0	0	2	1
MTB301P	Immunotechnology & Immunoinformatics Lab	0	0	2	1
MTB303P	Solid Waste Management Lab	0	0	2	1
Engineering Departmental Elective (EDE)		**L**	**T**	**P**	**C**
ELECTIVE-I	MTB105T Advanced Biochemical Engineering MTB106T Food Biotechnology MTB107T Cell & Tissue Culture Technology	3	1	0	4

ELECTIVE-II	MTB205T MTB206T MTB207T	Waste Water Engineering Computer Aided Drug Design Metabolic Engineering	3	1	0	4
ELECTIVE-III	MTB305T MTB306T MTB307T	Biomedical Instrumentation & Measurements IPR, Bioethics & Biosafety Medical Biotechnology	3	1	0	4
Project/Dissertation/Colloquium (PDT)			**L**	**T**	**P**	**C**
	MTB353P	Colloquium	0	0	2	1
	MTB481P	Dissertation	0	0	20	20

SCHOOL OF BIOTECHNOLOGY
IFTM UNIVERSITY, MORADABAD

MASTER OF TECHNOLOGY (BIOTECHNOLOGY)
STUDY AND EVALUATION SCHEME

YEAR I, SEMESTER- I

S. No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	MTB101T	Advanced Bioprocess Engineering	3	1	0	20	10	30	70	100	4
2.	ECC	MTB102T	Advanced Bioseparation Engineering	3	1	0	20	10	30	70	100	4
3.	ECC	MTB103T	Bioinformatics	3	1	0	20	10	30	70	100	4
4.	FSC	MTB104T	Biochemistry, Biophysics & Molecular Dynamics	3	1	0	20	10	30	70	100	4
5.	EDE	Engineering Departmental Elective-I*	*Only 01 paper is to be chosen from the basket of the departmental electives having 03 papers, provided by the school	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
6.	ELC	MTB101P	Advanced Bioprocess Engineering Lab	0	0	2	-	-	30	70	100	1
7.	ELC	MTB102P	Advanced Bioseparation Engineering Lab	0	0	2	-	-	30	70	100	1
8.	ELC	MTB103P	Bioinformatics Lab	0	0	2	-	-	30	70	100	1
TOTAL				**15**	**05**	**06**	**-**	**-**	**240**	**560**	**800**	**23**

Engineering Departmental Elective – I

List of Engineering Departmental Electives*		
Sr. no.	**Course Code**	**Course Name**
1.	MTB105T / MTB106T / MTB107T	Advanced Biochemical Engineering /Food Biotechnology /Cell & Tissue Culture Technology

SCHOOL OF BIOTECHNOLOGY
IFTM UNIVERSITY, MORADABAD

MASTER OF TECHNOLOGY (BIOTECHNOLOGY)
STUDY AND EVALUATION SCHEME

YEAR I, SEMESTER- II

S. No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	MTB201T	Microbiological Technology	3	1	0	20	10	30	70	100	4
2.	ECC	MTB202T	Enzyme & Protein Engineering	3	1	0	20	10	30	70	100	4
3.	ECC	MTB203T	Recombinant DNA Technology	3	1	0	20	10	30	70	100	4
4.	FSC	MTB204T	Biophysical & Biochemical Techniques	3	1	0	20	10	30	70	100	4
5.	EDE	Engineering Departmental Elective-II*	*Only 01 paper is to be chosen from the basket of the departmental electives having 03 papers, provided by the school	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
6.	ELC	MTB201P	Microbiological Technology Lab	0	0	2	-	-	30	70	100	1
7.	ELC	MTB202P	Enzyme & Protein Engineering Lab	0	0	2	-	-	30	70	100	1
8.	ELC	MTB203P	Recombinant DNA Technology Lab	0	0	2	-	-	30	70	100	1
TOTAL				**15**	**05**	**06**	**-**	**-**	**240**	**560**	**800**	**23**

Engineering Departmental Elective – II

List of Engineering Departmental Electives*		
Sr. no.	**Course Code**	**Course Name**
1.	MTB205T / MTB206T / MTB207T	Waste Water Engineering /Computer Aided Drug Design /Metabolic Engineering

SCHOOL OF BIOTECHNOLOGY
IFTM UNIVERSITY, MORADABAD

MASTER OF TECHNOLOGY (BIOTECHNOLOGY)
STUDY AND EVALUATION SCHEME

YEAR II, SEMESTER-III

S. No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	MTB301T	Immunotechnology & Immunoinformatics	3	1	0	20	10	30	70	100	4
2.	ECC	MTB302T	Bioreactor Analysis & Design	3	1	0	20	10	30	70	100	4
3.	ECC	MTB303T	Solid Waste Management	3	1	0	20	10	30	70	100	4
4.	ECC	MTB304T	Pharmaceutical Biotechnology	3	1	0	20	10	30	70	100	4
5.	EDE	Engineering Departmental Elective-III*	*Only 01 paper is to be chosen from the basket of the departmental electives having 03 papers, provided by the school	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
6.	ELC	MTB301P	Immunotechnology & Immunoinformatics Lab	0	0	2	-	-	30	70	100	1
7.	ELC	MTB303P	Solid Waste Management Lab	0	0	2	-	-	30	70	100	1
8.	PDT	MTB353P	Colloquium	0	0	2	-	-	30	70	100	1
TOTAL				**15**	**05**	**06**	**-**	**-**	**240**	**560**	**800**	**23**

Engineering Departmental Elective – III

List of Engineering Departmental Electives*		
Sr. no.	**Course Code**	**Course Name**
1.	MTB305T / MTB306T / MTB307T	Biomedical Instrumentation & Measurements /IPR, Bioethics & Biosafety /Medical Biotechnology

SCHOOL OF BIOTECHNOLOGY
IFTM UNIVERSITY, MORADABAD

MASTER OF TECHNOLOGY (BIOTECHNOLOGY)
STUDY AND EVALUATION SCHEME

YEAR II, SEMESTER-IV

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	PDT	MTB481P	Dissertation	0	0	20	-	-	150	250	400	20
TOTAL				**0**	**0**	**20**	**-**	**-**	**150**	**250**	**400**	**20**

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB101T ADVANCED BIOPROCESS ENGINEERING

Objective(s): The objectives of the course:

- Is to introduce the concept of bioprocess engineering, design and optimization method of media, importance of medium preparation its kinetic behavior, perform material and energy balances for any biochemical process decide upon control strategies for process control.
- To apply engineering principles to address issues in bioprocesses, analyze and identify limiting factors in a bioprocess scale-up and propose solutions to address biological and engineering problems.

UNIT I: **(8 Sessions)**

Methods of inoculation: Medium preparation, Media design-Plackett Burman and Response Surface Method, Sterilization of medium & fermenter, Kinetics of thermal death of microorganisms, Batch sterilization, Continuous sterilization of air: Methods, filters and deign of depth filters.

UNIT II: **(8 Sessions)**

Microbial growth kinetics: In closed, semi-open and open cultivation systems. Kinetics of substrate uptake in cell culture, kinetics of product formation, Maintenance energy and yield concepts, analysis of growth data and estimation of biomass.

UNIT III: **(8 Sessions)**

Steady state and unsteady state: Material and energy balance, Growth stoichiometry-element and electron balance, Product stoichiometry, molecular diffusion-liquid-solid, liquid-liquid and gas-liquid mass transfer, measurement of K_La-sulphite oxidation method, oxygen transfer method, Dynamic method, oxygen transfer in bioreactor.

UNIT IV: **(8 Sessions)**

Bioreactor: Types of Bioreactors for animal, plant and microbial system, Design and operation of various bioreactors, viz Batch, CSTR, fed batch systems, air-lift bioreactors, fluidized bed bioreactors & plug flow reactor, Scale up of bioreactor-mixing, aeration, mass transfer.

UNIT V: **(8 Sessions)**

Monitoring and control of bioreactor: Temperature, pressure, mixing and foam control, measurement and control of dissolve oxygen, inlet and exit gas analysis, manual and advance controlled system-Fuzzy logic, ANN and PID control.

Course Outcomes:

At the end of the course students will be able to:

CO1: Capable to design and optimization methods of media preparations, sterilization procedures for the growth of micro-organisms for industrial applications. Analyze and apply new and recent techniques used for sterilization with their principle and mode of operation for skill development, employability and entrepreneurship development.

CO2: Understand proper knowledge about microbial growth kinetics as well various factors that affect microbial growth for skill development, employability and entrepreneurship development.

CO3: Able to apply mass and energy balances to calculate the concentration of different gases in the fermenter off-gas, amount of reactant used, amount of oxygen etc. for skill development, employability and entrepreneurship development.

CO4: Understand the Criteria for scale-up and selection of bioreactors, design and functioning of various types of reactors viz Batch, Fed-batch CSTR, Airlift, Fluidized bed and PFR for skill development and employability.

CO5: Control of physical, chemical and biological environment of the bioreactor for skill development and employability.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	3	3	2	2	2	2	2	2	2
CO2	3	3	2	3	3	2	2	2	1	2	2	1
CO3	1	1	3	3	2	1	1	3	1	2	1	2
CO4	2	2	3	3	2	1	1	1	1	2	1	2
CO5	`1	1	2	3	2	1	1	1	2	2	1	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	1	3
CO2	3	2	2
CO3	3	3	2
CO4	3	2	1
CO5	3	1	2

Suggested Readings:

1. Michael L. Shuler, Fikret Kargi, Bioprocess Engineering – Basic Concepts, 2nd Ed., Pearson Education India, 2015.
2. James Bailey, David Ollis, Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Education, 2017.
3. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, 2nd Ed., Oxford University Press, 2003.
4. Pauline M. Doran, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2012**.**
5. Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Elsevier, 2013.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.masterclass.com

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB102T ADVANCED BIOSEPARATION ENGINEERING

Objective: The main objective of this course:

Is designed to introduce the principles of bioseparation engineering that makes the student able to quantitatively and systematically design an integrated bioseparation process for the recovery and purification of biosynthetic products like pharmaceuticals, secondary metabolites form fermentation broth and the recycling of salvageable components and the proper treatment and disposal of waste.

UNIT I: **(8 Sessions)**

An introduction to Bioseparation: Role of Downstream Processing in Biotechnology, Different sectors in biotechnology, Recovery in modern versus classical biotechnology, Characteristics of fermentation broth.

UNIT II: **(8 Sessions)**

Cell disruption methods: (Physical, chemical and Enzymatic) & Kinetics for release of intracellular product. Scale up of bead mill and homogenizer. Solid Liquid separation techniques including flocculation, Sedimentation - Mechanism and importance; Centrifugation types- Mechanism; Selection and Filtration theory, Types and Pretreatment.

UNIT III: **(8 Sessions)**

Methods of concentration of Product: Extraction Processes and its fundamental relation between distribution coefficient and separation factors, kremser equation, Extraction of high molecular weight compounds. Precipitation methods of separation, Aqueous two-phase extraction- Phase Diagram, Principles Membrane based separation basic principle and types of membrane processes characteristics of different modes of operations.

UNIT IV: **(8 Sessions)**

Sorption mechanism: Materials and fundamentals of adsorption and chromatography principles with special reference to gel permeation chromatography, Different electrophoresis technique.

UNIT V: **(8 Sessions)**

Product polishing: Crystallization & Drying theory and equipments, importance of formulation of baker's yeast and enzymes, Downstream processing steps for citric acid, antibiotic extracellular enzymes, Intracellular enzymes.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the role of bioseparation in obtaining and formulating various biological products for skill development, employability and entrepreneurship development.
CO2: Understand the difference between the downstream processing steps of intracellular and extracellular products and also about the various separation techniques involved in downstream processing for skill development and employability.
CO3: Apply the principles of major unit operations used in downstream processing for product isolation and recovery for skill development, employability and entrepreneurship development.
CO4: Understand various techniques used in the purification of biological products for skill development, employability and entrepreneurship development.
CO5: Know about the recovery of various products through case studies for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	2	3	1	2	3	2	3	2
CO2	3	3	2	2	2	3	2	3	3	2	2	2
CO3	2	3	2	3	2	2	3	3	2	2	2	2
CO4	3	3	2	2	3	2	2	3	2	2	2	2
CO5	1	3	2	1	2	1	3	3	2	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	3	3
CO2	2	2	2
CO3	1	2	2
CO4	3	2	3
CO5	2	1	2

Suggested Readings:

1. Comprehensive Biotechnology- Murray Moo- Young, Vol II latest ed., Pergan Publishers, 2nd edition, 2011.
2. H.J. Rehm and G. Reed, Biotechnology- Volume 3,4,5, Verlag Publishers, 1985.
3. Stanbury and Whitakker, Principles of Fermentation Technology, Pergamon Press, 2013.
4. A Biologist's guide to principles & techniques of practical biochemistry- Wilson and Walker, 6th edition, 2010.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB103T BIOINFORMATICS

Objective(s): The objectives of this course:

- Offers advanced level training on gene expression and gene therapy by covering topics such as genome mapping, proteomic techniques and new targets for drug discovery.
- To deal with sequence alignment algorithm and matrices are introduced to solve the complex biological problems.

UNIT I: **(8 Sessions)**

Introduction and applications of Bioinformatics: Biological databases in Bioinformatics, Classification of biological databases, biological database retrieval system. Sequence and molecular file formats

UNIT II: **(8 Sessions)**

Sequence Alignment: Dot matrix analysis, dynamic programming algorithm (Needleman-Wunsch algorithm and Smith Waterman algorithm), heuristic methods (BLAST, FASTA).Iterative methods of multiple sequence alignment (Genetic Algorithm, HMM).

UNIT III: **(8 Sessions)**

Protein structure prediction: Protein identification and characterization, primary structure analysis and prediction, secondary structure analysis and prediction. Microarray Data Analysis.

UNIT IV: **(8 Sessions)**

Protein modeling: Methods of protein modeling, homology modeling, fold recognition,*Ab-initio* modeling. Protein classification and protein structure visualization: Protein structure database, Protein structure visualization databases and tools, Protein classification approaches.

UNIT V: **(8 Sessions)**

Introduction to drug discovery: Target discovery strategies, Target validation, Computer aided Drug Designing: Introduction, drug-design approaches, ADME- Tox property prediction. Introduction to QSAR.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand bioinformatics databases, data bank, data format, and data retrieval from online sources for skill development, employability and entrepreneurship development.
CO2: Apply algorithms and matrices to solve the biological problem for skill development, employability and entrepreneurship development.
CO3: Understand the knowledge of protein structure visualization software, tools related to secondary and tertiary structure prediction for skill development, employability and entrepreneurship development.

CO4: Apply molecular modelling technique for protein modelling for skill development, employability and entrepreneurship development.
CO5: Understand the drug stereochemistry, drug designing, and molecular modelling of new drug molecules for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	1	2	2	3	2	2	2
CO2	2	2	2	2	3	2	2	3	3	3	3	2
CO3	1	2	2	3	2	3	2	2	2	3	2	3
CO4	2	2	2	2	2	3	1	2	2	3	3	2
CO5	3	2	1	3	1	3	1	3	3	2	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	3
CO2	2	3	2
CO3	1	2	1
CO4	2	2	2
CO5	3	1	2

Suggested Readings:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount.
2. Bioinformatics and Functional Genomics by Jonathan Pevsner.
3. Developing Bioinformatics Computer skills by Gibas and Jambeck.
4. Bioinformatics: Principles and Applications by ZhumurGhosh and Mallick.
5. Bioinformatics: Genomics, Proteomics and drug discovery by S.C. Rastogi.
6. A text book of Bioinformatics by Singhal and Singhal

Websites Sources:

Error! Hyperlink reference not valid.

- http://www.bic.nus.edu.sg/
- http://bioinfo.ernet.in/
- http://www.bioinform.com/index

IFTM University, Moradabad
Master of Technology (M.Tech.), Program
M.Tech. Biotechnology I Year (I Semester)

MTB104T BIOCHEMISTRY, BIOPHYSICS & MOLECULAR DYNAMICS

Objective(s): The objectives of this course:

- Provides a degree path centered on the chemistry and physics of life processes with training that integrates the principles of chemistry, physics, mathematics, biochemistry, molecular genetics, and computer science.
- Explore the chemical structure of living matter and the chemical reactions occurring in living cells.
- To use the methods of physical science to study the structure and functions of macromolecules and solve problems at the intersection of biological and physical sciences.

UNIT I: **(8 Sessions)**

Carbohydrates, Proteins and Lipids: Classification and Structure of Carbohydrate; Mechanism of major metabolic pathways: Glycolysis, TCA Cycle, Gluconeogenesis, Galactose Metabolism, HMP Pathway. Classification and structure of Protein; Biochemical mechanism of protein synthesis and degradation. Classification and Structure of Lipid; Catabolism of Lipids; Fatty acid synthesis.

UNIT II: **(8 Sessions)**

Coenzymes and Enzymes: Introduction; Vitamins: Types, structures and functions; Coenzymes; Classification of Enzymes; Distinction between coenzymes and cofactors; Factors affecting rate of enzyme reaction; Kinetics of normal enzymatic reaction; Enzyme inhibition and activation, Isozymes and their Biochemical and clinical significance.

UNIT III: **(8 Sessions)**

Nucleic acids: Introduction; General Structure and function of purines; pyrimidines, nucleic acids and nucleotides; Hydrolysis of Nucleic acids; Biosynthesis of purines, pyrimidines, Nucleosides and Nucleotides; Degradation of nucleic acids and nucleosides; Mechanism of Salvage Pathway.

UNIT IV: **(8 Sessions)**

X-Ray and NMR: Crystals and symmetries, crystal systems point groups and space groups, growth of crystals of biological molecules, X-ray diffraction, X-ray data collection, structure solutions, refinement of structure. Basic principle, NMR theory, classical description of NMR, NMR parameters, the Nuclear Oberhausen effect.

UNIT V: **(8 Sessions)**

Biomechanics: Striated muscles and contractile proteins, mechanical properties of muscles, biomechanics of cardiovascular system. Electrical activity during the heartbeats.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the basic concepts, biosynthetic pathways, and metabolism of carbohydrates, protein and lipids for skill development and employability.
CO2: Understand how enzymes work, their kinetics and function, and the metabolism of vitamins for skill development, employability and entrepreneurship development.
CO3: Understand DNA and its metabolism for skill development and employability.
CO4: Learn the techniques like NMR and X-ray with their theories and function in detections for skill development, employability and entrepreneurship development.
CO5: Learn how human anatomy works especially in the context of muscular movement and cardiac activities for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	2	2	2	3	2	1	2	3
CO2	3	2	1	2	2	3	3	2	2	1	2	2
CO3	3	2	2	2	1	1	3	2	1	2	3	2
CO4	2	2	3	2	2	2	2	2	2	2	2	2
CO5	2	2	3	2	1	2	1	2	2	1	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	3
CO2	2	3	3
CO3	1	3	2
CO4	3	3	2
CO5	2	2	3

Suggested Readings:

1. Lehninger principles of Biochemistry-Fourth edition, Published by W.H. Freeman 2004.
2. Fundamentals of Biochemistry: Life at the molecular level- By Donald Voet, Judith G. Voet and Charlotte W. Pratt, 2012.
3. Nicholls & Ferguson, Bioenergetics, 4th Edition. Elsevier publication.

Website Sources:

- https://www.britannica.com/science/biochemistry
- https://www.sanfoundry.com/1000-biochemistry-questions-answers/
- https://science.rpi.edu/biology/programs/undergrad/bs-biochem-biophysics
- http://www.cryst.bbk.ac.uk/pps97/assignments/projects/ambrus/html.htm
- https://www.sanfoundry.com/analytical-instrumentation-questions-answers-instrumentation-xray-spectroscopy/

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB105T ADVANCED BIOCHEMICAL ENGINEERING

Objective(s): The objectives of the course:

- To introduce the role and application of engineering in biotechnology, aspects of chemical reaction engineering is described to study the transport phenomenon in biological system.
- Chemical reaction and kinetics are explained to study the homogeneous and heterogeneous reactions. Reactor data analysis and enzyme kinetics is also explained.

UNIT I: **(8 Sessions)**

Concept of ideal reactors: Based on flow characteristics, design of ideal reactors using material and energy balance equations, Single reactors with ideal flow condition, comparison of volumes of plug flow reactor and chemostat. Multiple reactors- methods to show how total volume is affected in multiple reactors.

UNIT II: **(8 Sessions)**

Searching for mechanism: Arrhenius equation, Batch reactor analysis for kinetics (synchronous growth and its application in product production), Growth Kinetics: Batch growth quantifying cell concentration, growth profiles and kinetics in batch culture, fed batch growth, continuous growth and their growth kinetic quantification, chemostat growth, semi-continuous / exponential feeding strategy.

UNIT III: **(8 Sessions)**

Maximizing the yield of intermediate product in series reactions: Design principles–Non isothermal reactions and pressure effects, non-ideal flow in bioreactors-reasons for non-ideality, concept of RTD studies, characterization of non-ideality using RTD studies, various distribution functions, conversions using tracer studies.

UNIT IV: **(8 Sessions)**

Diagnosing the ills of non-ideal bioreactors: Various models of non-ideal flow, Design and analysis of bioreactors-stability and analysis of bioreactors, biomass production and effect of dilution rate, Design and operation of various bioreactors, *viz* CSTF, fed batch systems, air-lift bioreactors, fluidized bed bioreactors.

UNIT V: **(8 Sessions)**

Mass transfer in biological reactors: Scale up of bioreactors, Instrumentation and control, Criteria for selection of bioreactors.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the functioning of ideal reactors and designing of single and multiple reactor systems for skill development and employability.
CO2: Derive the kinetic parameters of microbial growth in a batch system for skill development, employability and entrepreneurship development.
CO3: Find out the non-ideal conditions of reactor operation and can optimize the intermediate products for skill development, employability and entrepreneurship development.
CO4: Design the various operations of bioreactors *viz* CSTR, Airlift, and Fluidized bed for skill development, employability and entrepreneurship development.
CO5: Understand the instrumental control and Scale-Up for skill development and employability.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	3	1	1	2	2	2	3	2	2
CO2	1	2	2	2	2	1	2	2	2	3	3	2
CO3	2	1	3	3	3	2	2	3	2	3	3	2
CO4	2	2	2	2	3	3	2	1	2	2	2	1
CO5	3	3	3	2	2	2	2	1	1	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	2
CO2	3	3	3
CO3	2	3	3
CO4	2	2	3
CO5	1	2	2

Suggested Readings:

1. M.L. Shuler and F.Kargi: Bioprocess Engineering: Basic Concepts, Prentice Hall, 2001.
2. P M Doran: Bioprocess Engineering Principles, Academic Press 2005.
3. Octave Levenspiel: Chemical Reaction Engineering, John Wiley & Sons, 1999.
4. J.E. Bailey and D.F. Ollis:Biochemical Engineering Fundamentals, McGraw Hill Higher Education, 2nd edition, 1986.

Website Sources:

- https://www.youtube.com/watch?v=OGWwdT6UGVM&feature=emb_logo

- http://www.ric.edu/faculty/ptiskus/reactions/
- https://www.khanacademy.org/science/biology/chemistry--of-life/chemical-bonds-and-reactions/a/chemical-reactions-article

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (II Semester)

MTB106T FOOD BIOTECHNOLOGY

Objective(s): The objectives of this course:

- To make students learn fundamentals of food processing and the relationships between scientific principles and preparation techniques.
- It also provides an insight of manufacturing industries that transforms animal, plant, marine resources finished value-added food products.

Unit I: **(8 Sessions)**

Food Chemistry and Nutrition: Carbohydrates: starch, cellulose, pectic substances and dietary fibre; Proteins: Classification and structure of proteins in food; Lipids: Rancidity of fats, Polymerization and polymorphism; Pigments: Carotenoids, chlorophylls, anthocyanins, tannins.

Unit II: **(8 Sessions)**

Food flavours: Terpenes, esters, ketones and quinones; Enzymatic and non-enzymatic browning; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutrition deficiency diseases.

Unit III: **(8 Sessions)**

Food Microbiology: Characteristics of microorganisms; Microbial growth in food: Intrinsic and extrinsic factors, Growth and death kinetics, serial dilution method for quantification; Food spoilage: Contributing factors, Spoilage bacteria, Microbial spoilage of milk and milk products, meat and meat products; Foodborne disease.

Unit IV: **(8 Sessions)**

Food Products Technology: Processing principles: Canning, chilling, freezing, dehydration, control of water activity, CA and MA storage, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging and food laws.; Extraction, clarification concentration and packaging of fruit juice, Production of jam, jelly, marmalade, squash, candies, and pickles; Milk and milk products processing: Pasteurized and sterilized milk, cream, butter, ghee, ice-cream, cheese and milk powder; Animal products processing: Drying and canning of fish, post mortem changes, tenderization and freezing of meat, egg powder.

Unit V: **(8 Sessions)**

Food Preservation: Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food Preservation. Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the nature and chemistry of biomolecules and their role in food nutrition for skill development, employability and entrepreneurship development.

CO2: Identify the desirable and objectionable flavor constituents in food; biochemical pathways and important chemical reactions for skill development, employability and entrepreneurship development.

CO3: Understand the importance and growth factors of microorganisms and their role in the production, deterioration, and safety of foods, from both ecological and physiological perspectives for skill development, employability and entrepreneurship development.

CO4: Understand the concepts of common principles of food product technologies for skill development and employability.

CO5: Grasp the fundamentals of food processing and preservation for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	3	3	3	3	2	3	2	2	2
CO2	2	2	2	2	2	2	2	1	3	1	2	2
CO3	3	1	2	2	2	2	2	1	2	2	2	1
CO4	2	2	2	1	2	2	2	2	2	2	1	1
CO5	2	3	2	2	2	2	1	2	2	2	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	2
CO2	3	3	3
CO3	2	2	3
CO4	1	2	2
CO5	2	2	1

Suggested Readings:

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
2. Owen R. Fennema. Principles of food science.NewYork ; Basel : Dekker, 1975.

3. Potter, Norman N., Hotchkiss, Joseph H.FoodScience.Fifth Edition, 2007.
4. V Kyzlink. Principles of food preservation. Amsterdam : Elsevier, 1990.
5. Mann &Trusswell , 2007. Essentials of Human Nutrition. 3rd edition. Oxford University Press

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/
- ecoursesonline.iasri.res.in

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (II Semester)

MTB107T CELL & TISSUE CULTURE TECHNOLOGY

Objective: The main objective of the course:

- To make learner introduce with basic principles of cell interactions, tissue engineering, quantitative analysis of receptor-ligand binding. To understand Hormone and Growth Factor Signaling and Stem Cell Research and their use.

Unit I: **(8 Sessions)**

Introduction to tissue engineering: Basic definition and scope of development; Structure and organization of tissues: epithelial, connective; vascularity, lymph, Basic developmental biology.

Unit II: **(8 Sessions)**

Transport Properties of Tissues: General aspects of cells in culture; transport limits on 3D cultures. Invitro testing of drugs and therapeutics

Unit III: **(8 Sessions)**

Cell and Tissue Interaction: Cell-Matrix and Cell-Cell Interactions, Cells in culture on different kinds of matrix - different cell types, staining, etc., Differential cell adhesion.

Unit IV: **(8 Sessions)**

Growth Regulation: Hormone and Growth Factor, Growth factor delivery in tissue engineering Quantitative analysis of receptor-ligand binding. Applications of growth factors: VEGF/angiogenesis.

Unit V: **(8 Sessions)**

Stem Cell Research and other applications: Stem Cells Introduction, Hematopoiesis Stem Cells ES cells, Cell surface markers, FACS analysis, repopulation experiments, Introduction to liver pathophysiology, Scaffolds & tissue engineering – Basic concept of transplantation immunology. Cell transplantation for liver tissue engineering. In vitro organogenesis.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the basic developmental biology and also structure and organization of tissues, and concept of therapeutics and *in vitro* testing for skill development, employability and entrepreneurship development.

CO2: Understand the mechanism of mass transfer for skill development, employability and entrepreneurship development.

CO3: Understand the mechanism of cell – cell interaction and communications for skill development and employability.
CO4: Learn about growth regulators and its role of in tissue engineering for skill development, employability and entrepreneurship development.
CO5: Learn about stem cell research and its applications. Also understand the basic concept of organ transplantation and transplantation immunology for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	3	3	2	2	3	2	1
CO2	2	2	2	2	2	2	2	2	2	2	3	2
CO3	2	1	1	1	2	2	2	3	3	2	2	2
CO4	2	2	2	2	2	2	2	3	1	1	3	3
CO5	1	1	1	1	1	2	1	3	2	1	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	1	2
CO2	2	2	2
CO3	1	3	3
CO4	2	2	3
CO5	3	2	1

Suggested Readings:

1. Saltzman, W.M. Tissue Engineering, Principle for the design of replacement organs and tissues. Oxford University Press
2. Blitterswijk et al. Tissue Engineering. Academic Press.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB101P ADVANCED BIOPROCESS ENGINEERING LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	To plot Microbial growth curve for shake flask culturing using turbidity method.	Experiment 1
6.	To prepare a standard curve of reducing sugar by 3, 5-Dinitrosalicylic acid method.	Experiment 2
7.	To Estimate the Monod Parameters for microbial growth kinetics.	Experiment 3
8.	Demonstration of lab scale fermenter (bench top fermenter).	Experiment 4
9.	Preparation of standard curve of Ethanol.	Experiment 5
10.	To demonstrate the effect of osmotic pressure on microbial growth.	Experiment 6
11.	To demonstrate the effect of osmotic pressure on microbial growth.	Experiment 7
12.	To understand the effect of agitation on the growth of bacterial cultures.	Experiment 8

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB102P ADVANCED BIOSEPARATION ENGINEERING LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	To estimate the amount of protein in the given sample by Lowry's method	Experiment 1
6.	To achieve cell lysis using chemical methods.	Experiment 2
7.	To filter the given slurry and to determine specific cake resistance αand medium resistance Rm.	Experiment 3
8.	To study the effect of increasing centrifugal times on the settling of yeast cell particles.	Experiment 4
9.	Disruption of yeast cells by mechanical method.	Experiment 5
10.	To study the effect of Increasing speeds of centrifugation on the settling of the yeast cell particles.	Experiment 6
11.	To estimate citric acid from fermentation broth by calorimetric method.	Experiment 7
12.	To identify the unknown pigments by comparing its R_f value with R_f value of the standards.	Experiment 8

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (I Semester)

MTB103P BIOINFORMATICS LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	To learn how to retrieve structural data of a protein using PDB database.	Experiment 1
6.	To compute the various physical and chemical parameters of a protein.	Experiment 2
7.	To predict the secondary structure of a protein using SOPMA.	Experiment 3
8.	Identifying fold of Proteins: Use of Threading Servers-Phyre2.	Experiment 4
9.	To identify the 10-homologues sequences of P68871 of various origins. Find the conserved region existing between them comment on the same.	Experiment 5
10.	Comment on the evolutionary relationship between the sequences.	Experiment 6
11.	To model a protein using SWISS-MODEL	Experiment 7
12.	To retrieve more information about the drug molecules, drug targets, enzymes and pathways related to drugs.	Experiment 8

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (II Semester)

MTB201T MICROBIOLOGICAL TECHNOLOGY

Objective(s): The objectives of the course:

- Is to introduce the concept of biochemical engineering and its application in bioprocess.
- Substrate required for the microbial growth and product yield calculation are explained by stoichiometry equation.
- Importance of medium components and sterilization techniques are also described.

UNIT I: **(8 Sessions)**

Introduction to biotechnology and biochemical engineering: bioprocess techniques, biotechnology products. Raw materials used for Industrial fermentation and its processing. Chemical, physical and physiochemical treatment.

UNIT II: **(8 Sessions)**

Microbial growth: Aerobic and anaerobic growth phenomena; Synchronous culture; Mathematical modeling of microbial growth; product synthesis kinetics: Batch, fed-batch and continuous culture cultivation techniques; Growth and non-growth associated product formation.

UNIT III: **(8 Sessions)**

Medium optimization and Sterilization: principles and mechanism of media sterilization using thermal and membrane filtration; Medium optimization techniques with special emphasize on statistical techniques, Placket-Burman design. Sterilization: Batch and continuous sterilization of media; Air sterilization – Principle and design; Media sterilization: kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, coupling of Arrhenius equation and cell death kinetics, Radiation and chemical sterilization.

UNIT IV: **(8 Sessions)**

Stoichiometry of bioreaction and energetic of microbial growth: ATP and redox potential balance, Yield coefficients, Growth stoichiometry and elemental balances, electron balances, productivity and their correlation with the stoichiometry. The limitation of Monod model Kinetics based on molecular mechanism.

UNIT V: **(8 Sessions)**

Engineering and social considerations: For the production of r-DNA products; Safety, Good Laboratory and manufacturing practices. Parameter estimation, Model validation and bioprocess optimization.

Course Outcomes:

At the end of the course students will able to:
CO1: Understand the basics of biotechnology, biochemical engineering and raw material pretreatments for skill development, employability and entrepreneurship development.
CO2: Know about microbial growth, product formation, and growth kinetics for skill development and employability.
CO3: Capable to design and optimize methods of media preparation and various sterilization procedures for skill development and employability.
CO4: Utilize the element balance method to design the stoichiometry of growth and product formation for skill development, employability and entrepreneurship development.
CO5: Estimate parameters, validate model, and understand GLP and GMP for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	2	2	2	1	2	2	3	2
CO2	1	2	3	3	2	2	2	3	3	3	2	2
CO3	2	2	3	3	2	2	1	3	3	3	2	2
CO4	2	2	3	2	1	2	2	2	3	3	2	1
CO5	2	2	2	2	2	1	1	2	2	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	2
CO2	2	2	3
CO3	3	1	2
CO4	2	2	3
CO5	1	1	2

Suggested Readings:

1. Bailey JE, Ollis DF; Biochemical Engineering Fundamentals, McGraw-Hill Education, 1986.
2. Blanch HW and Clark DS: Biochemical Engineering, Marcel Decker, 1987.
3. D G Rao: Introduction to Biochemical Engineering, Tata, McGrawHill,New Delhi 2005.

4. Wiseman, A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood1999.
5. Moser, A; Bioprocess technology, kinetics and reactors, Springer Verlag1988.
6. Syed Tanveer Ahmed Inamdar:Biochemical Engineering Principles and functions, PHI Learning Private Ltd., 2012.

Website Sources:

- https://en.wikipedia.org/wiki/Biochemical_engineering
- https://chem.libretexts.org/
- http://umich.edu/~elements/5e/asyLearn/bits/batch/index.html

IFTM University, Moradabad
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MTB202T ENZYME AND PROTEIN ENGINEERING

Objective: The objective of the course:

- To understand the kinetics and mechanisms of action of enzymes, to become familiar with the basic methods of studying enzymes, and to appreciate how individual reactions are controlled and integrated into the metabolic pathways of the cell.

UNIT I: **(8 Sessions)**

Methods of enzymes and protein engineering: Through genetic engineering, protein engineering, chemical modification, intra-molecular cross-linking and immobilization; Molecular structure and function of enzymes; Folding and active site formation in enzymes; Phenomena of allosterism and allosteric kinetics.

UNIT II: **(8 Sessions)**

Various techniques used for the immobilization of enzymes: Kinetics of immobilized enzymes; Types of enzyme reactors: Fed batch reactor, enzyme-catalyzed reactions in CSTR, CSTR rectors ideal plug flow tubular reactors; Heterogeneous reaction systems; Transient analysis of enzyme reactors.

UNIT III: **(8 Sessions)**

Biosynthesis of proteins, structural and conformation studies of proteins: Energy status of a protein molecule, structure; function relation of enzymes; Purification of cell signaling proteins: spectroscopic techniques and chromatography principles; Methods to estimate the concentration & purity.

UNIT IV: **(8 Sessions)**

Methods to determine 3D-Structures: X-ray crystallography and Nuclear Magnetic Resonance methods; Biological Membranes; Membrane Assembly and Protein Targeting; Signal transduction; Receptors and hormones; Antigen-antibody relationship. Protein Folding; Dynamics and Structural Evolution.

UNIT V: **(8 Sessions)**

Protein design and engineering: Strategies to alter catalytic efficiency; structure prediction and modeling proteins; Molecular graphics in protein engineering- Dynamics and mechanics; Drug-protein interactions and Design; applications of engineered proteins.

Course Outcomes:

At the end of the course students will able to:

CO1: Understand the concept of structural and functional modification of protein and enzymes as well as their regulation for skill development, employability and entrepreneurship development.
CO2: Understand the techniques of immobilization and kinetics involved in it for skill development, employability and entrepreneurship development.
CO3: Understand the techniques for protein synthesis and purification for skill development and employability.
CO4: Learn the techniques for 3D structure analysis of protein and the interaction of protein for skill development and employability.
CO5: Understand the process of drug discovery through molecular graphic techniques for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	2	3	2	3	3	2	2	3
CO2	3	1	3	3	3	2	2	3	3	2	2	3
CO3	3	2	3	2	2	1	3	3	2	1	3	3
CO4	2	3	2	2	3	1	3	3	3	1	3	1
CO5	2	2	3	1	2	1	3	3	2	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	2
CO2	2	2	3
CO3	2	1	2
CO4	2	2	2
CO5	1	1	1

Suggested Readings:

1. Nicolas Price & Lewis Stevens: Fundamentals of Enymology, 2nd edition, Oxford Univ. Press, New York, NY.
2. Trevor Palmer: Understanding Enzymes, Second Edition, J. Wiley & Sons, New York.
3. Geoffrey Zubay: Biochemistry, 3rd edition, Wm. C. Brown, Oxford, (1993).
4. Berg, Tymoczo and Stryer: Biochemistry, 7thEdition.,W.H.Freeman, 2010.

5. Practical Chemical Biochemistry Ed. H.V.Varley, A.H.Goven Lock and M. Bell William Heinnemann Medical Books Ltd. London.
6. David L. Nelson; Michael M. Cox.Lehninger Principles of Biochemistry, Fourth Edition.W. H. Freeman, 2004.

Website Sources:

- https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
- http://www.gbu.ac.in/coursestructure/biotech/MSc_Biotech_17July2019.pdf
- https://en.wikipedia.org/wiki/Protein_engineering
- https://www.researchgate.net/publication/221925539_Protein_Engineering_Methods_and_Applications
- http://www.sau.int/ISA/protein%20engg.pdf
- https://academic.oup.com/peds

IFTM University, Moradabad
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M. Tech. Biotechnology I Year (II Semester)

MTB203T RECOMBINANT DNA TECHNOLOGY

Objective(s): The objectives of this course:

- Recombinant DNA technology which came into existence in the middle of the twentieth century, allow for genetic manipulation of organisms by which incorporating DNA sequences from different sources into a single recombinant molecules.
- Is to technology has unfastened several applications in animal and plant genomics; basic, applied and clinical research.

UNIT I: **(8 Sessions)**

Tools of Genetic Engineering: Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors.

UNIT II: **(8 Sessions)**

Molecular probes and Gene Transfer: Agrobacterium mediated gene transfer, Transformation, transduction, Particle gun, Electroporation, microinjection, Preparation and application of molecular probes: DNA probes, RNA probes, Radioactive labeling, Non radioactive labeling, use of molecular probes, DNA fingerprinting.

UNIT III: **(8 Sessions)**

Polymerase Chain reaction (PCR): Basic principles, modifications, applications. Modifying Genes: Site-directed mutagenesis, Insertion & Deletion Mutagenesis.

UNIT IV: **(8 Sessions)**

Analysis and expression of cloned gene in host cells: Expression vectors, Restriction enzyme mapping, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins.

UNIT V: **(8 Sessions)**

Different methods of gene isolation: Gene libraries- cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries.

Course Outcomes:

At the end of the course students will able to:

CO1: Know about different enzymes used in genetic engineering and vehicles for gene transfer for skill development and employability.
CO2: Understand the physical and chemical methods of gene transfer for skill development, employability and entrepreneurship development.
CO3: Understand the technique of PCR and mutagenesis for skill development and employability.
CO4: Understand various blotting techniques and vectors used for expression of gene for skill development, employability and entrepreneurship development.
CO5: Understand the application of Genetic engineering and construction of genetic libraries for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	3	2	2	2	3	3	3	3
CO2	2	1	2	3	2	2	2	3	2	2	2	2
CO3	3	2	2	3	2	2	2	2	2	2	2	2
CO4	2	1	3	2	3	1	1	3	2	2	2	1
CO5	2	2	2	2	2	1	2	2	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	1	3
CO2	3	2	3
CO3	2	2	3
CO4	1	2	3
CO5	2	2	2

Suggested Readings:

1. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th Edition.ASM Press; 4 edition (2009).
2. S. B. Primrose and R. M. Twyman, John Wiley & Sons. Principles of Gene Manipulation and 3. Genomics 7th Edn. Oxford Publisher USA (2009).
3. Julia Lodge, Pete Lund and Steve Minchin, Gene Cloning Taylor and Francis, NY (2006).
4. T. A. Brown, Gene Cloning and DNA Analysis. An Introduction, 7th Edn (2016).

5. Blackwell Scientific Publications. India.
6. Sambrook, J., Russell, D.W., Molecular cloning: A Laboratory Manual 3th Edn. Cold Spring Harbor, New York (2001).

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books/NBK21988/

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (II Semester)

MTB204T BIOPHYSICAL & BIOCHEMICAL TECHNIQUES

Objective(s): The objectives of this course:

- Is to impart knowledge to students about the concepts related to the biophysical properties of biomolecules.
- Students will learn the techniques and tools employed in the various qualitative and quantitative analyses of molecules.

UNIT I: **(8 Sessions)**

Colloids Of Biopolymers and Their Properties: Colloidal solutions of biopolymers and their electrochemical properties. Hydrodynamic properties: Viscosity, diffusion etc of biopolymers; Molecular weight determination, osmotic pressure, reverse osmosis, and Donnan effect. Structure of Bio membranes and their electrochemical properties, membrane potential, action potential and propagation of impulses.

UNIT II: **(8 Sessions)**

Microscopy: Introduction to principles and working of light & Electron Microscope, Scanning Tunneling Microcopy, SEM, TEM, AIM, Sample preparation for Electron Microscopy.

UNIT III: **(8 Sessions)**

Electrophoresis & Advanced Immuno techniques: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds. Peptide mapping and combination of electro focusing and SDS-PAGE, Comet assay, Karyotyping, FISH, Rocket Immuno electrophoresis, ELISA, RIA, western blot.

UNIT IV: **(8 Sessions)**

Spectrophotometry And Radio Activity: Introduction to principles and applications of (a) spectroscopic methods (UV, Vis, IR, Fluorescence, ORD, CD & PAS) (b) NMR, ESR & Mass spectrometry. Use of radioactive and stable isotopes and their detection in biological systems.

UNIT V: **(8 Sessions)**

Separation And Sequencing Techniques: Automatic analyzer for amino acids, protein sequenator, peptide synthesizer & nucleic acid synthesizer. Cell sorters and their applications. Theory of lyophilization and its applications to biological systems.

Course Outcomes:

At the end of the course students will able to:

CO1: Understand the colloids of biopolymer and their properties for skill development, employability and entrepreneurship development.

CO2: Describe the theory and types of light and electron microscope for skill development, employability and entrepreneurship development.

CO3: Describe the principle and working of electrophoresis and immuno-techniques for skill development, employability and entrepreneurship development.

CO4: Describe the principle and application of spectroscopic methods and radioactive isotopes for skill development and employability.

CO5: Explain the amino acid separation and sequencing techniques. Learn the theory of lyophilization and application to biological system for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	2	2	2	3	2	2	2
CO2	2	2	2	3	2	1	2	2	3	3	1	2
CO3	2	2	2	2	3	2	2	3	2	2	2	2
CO4	1	1	1	1	3	2	1	3	2	2	2	1
CO5	2	2	1	2	1	1	2	2	2	2	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	3
CO2	2	2	2
CO3	2	2	2
CO4	1	2	2
CO5	3	2	2

Suggested Readings:

1. Introduction to Biophysics by Pranab Kumar Banerjee, S Chand and company, 2008.
2. Instrumental methods of chemical analysis by G. R Chatwal and S. K Anand, Himalaya publishing house, 2008.

3. Biotechnology Procedures and Experiments handbook by S. Harisha, Infinity Science, Press LIC, 2008.

Website Sources:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5695667/
- https://www.biophysics.org/education-careers/education-resources/selected-topics-in-biophysics/biophysical-techniques
- https://www.omicsonline.org/scholarly/biophysical-techniques
- http://nsdl.niscair.res.in/jspui/bitstream/123456789/104/1/Spectroscopic_techniques.pdf
- https://www.biophysics.org/education-careers/education-resources/selected-topics-in-biophysics/biophysical-techniques

IFTM University, Moradabad
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MTB205T WASTE WATER ENGINEERING

Objective(s): The objectives of this course:

- Is to describe wastewater treatment technologies predominantly in use today.
- Ultimately, the technology selected as appropriate for one application may not be the optimal for another.
- Selection will be based on site-specific factors, such as resources available, climate, land availability, economics, etc.

UNIT I: **(8 Sessions)**

Introduction: Uses of water by industry- sources and types of industrial waste water disposal and environmental impacts, waste water reuse and applications, public health and environment issues, constituents (Physical, chemical and biological) found in waste water, units to measure physical, chemical and biological parameters, water quality standards, An overview of waste water treatment, Eutrophication.

UNIT II: **(8 Sessions)**

Unit Operations for waste water treatment: Principle physical and chemical unit operations used in waste water treatment – aeration, coagulation and flocculation, screening, sedimentation, flotation, neutralization and equalization.

UNIT III: **(8 Sessions)**

Biological waste water treatment: Biological Waste treatment principle and objectives, Role of microorganisms in waste treatment, Bacterial growth kinetics, Biological organic material, Nitrogen and Phosphorus removal and its process description; Type of Biological process for waste water treatment: suspended and attached waste water treatment process with special reference to activated sludge process, oxidation ditch, Sequential batch reactor UFSBR, rotating biological contractors, trickling filters, packed bed reactor, designing and operating parameters for suspended and attached waste water treatment process, Solid Retention Time, Sluge Volume Index, Loading Rate, F/M ratio, Substrate utilization rate, substrate removal in attached growth process.

UNIT IV: **(8 Sessions)**

Advanced treatment processes and sludge Treatment: Sludge thickening and stabilization, aerobic anaerobic digesters, single stage and two stage anaerobic digesters, alkaline treatment, composting, Membrane filtration, carbon adsorption, Ion exchange, disinfection and theory of disinfection.

UNIT V: **(8 Sessions)**

Characteristic and treatment: Characteristic and treatment of industrial waste water treatment from textiles, pulp and paper, sugar and distilleries, dairy industries.

Course Outcomes:

At the end of the course students will able to:

CO1: Understand the Selection or construction of appropriate treatment schemes to remove certain pollutants present in water or wastewater for skill development and employability.

CO2: Learn to characterize wastewater and the best available techniques (BAT) for treatment of wastewater for skill development and employability.

CO3: Understand the role of microorganisms in wastewater treatment and calculate the amount of excess sludge, sludge volume, recycle ratio, and sludge age for skill development, employability and entrepreneurship development.

CO4: Learn advanced unit operation, processes, and biologic treatment methods.CO5 Learn how to characterize source water and the best available technologies for skill development, employability and entrepreneurship development.

CO 5: Learn how to characterize source water, and the best available technologies for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	3	2	3	2	3	3	2
CO2	2	2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	1	1	2	2	3	2	2	2
CO4	2	1	1	1	2	1	2	1	3	2	2	1
CO5	2	1	1	1	2	1	1	1	2	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	3
CO2	2	2	3
CO3	2	2	2
CO4	2	3	1
CO5	1	1	1

Suggested Readings:

1. Waste Water Engineering- Metcalf &Fuddy, 3rded. McGraw Hill.
2. Environmental Biotechnology Prof.S.V.SRana. Rastogi Publication.
3. Industrial & Environmental Biotechnology, Ahmed, Ane/Rout Publishers.
4. Introduction to Waste Water Treatment- R. S. Ramalho, Academic Press.
5. Environmental Biotechnology, B.C. Bhattacharya &Ritu Banerjee, Oxford Press, 2007.
6. Environmental Biotech.,PradiptaKrimar, I.K. International Pvt. Ltd., 2006.
7. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
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MTB206T COMPUTER AIDED DRUG DESIGN

Objective(s): The objectives of this course:

- Introduce basic understanding of bioinformatics and its applications.
- Study the tools and databases in homology modeling and sequence alignment.
- Structure visualization and designing new drug molecules.

Unit I: (8 Sessions)

Introduction: drug, classification of drug, drug candidate, drug target identification, enzyme, receptors, G-protein couple receptor, tyrosine kinase receptors, active site prediction in drug targets.

Unit II: (8 Sessions)

Pharmacokinetics: rule of five, (ADMET) drug absorption, drug distribution, drug metabolism, drug excretion, drug toxicity, drug administration, scatchard plot, efficacy.

Unit III: (8 Sessions)

Lead identification: High throughput screening, lead compound, binding interaction, ionic bonding, hydrogen bonding, Van der Waals interaction.

Unit IV: (8 Sessions)

Docking: Lead optimization, Structure based drug design, ligand-based drug design, ligand databases, introduction to Docking, flexible docking, rigid docking, protein-ligand docking, protein-protein docking.

Unit V: (8 Sessions)

Drug design: Pharmacophore, target-based pharmacophore, database searching for pharmacophore, quantitative structure activity relationship, 2D and 3D QSAR, Electronic and steric descriptors for QSAR.

Course Outcomes:

At the end of the course students will able to:

CO1: Understand drug molecules and active site prediction in drug target for skill development, employability and entrepreneurship development.

CO2: Understand the idea of drug discovery mechanism through pharmacokinetics which includes time course of drug absorption, distribution etc. for skill development, employability and entrepreneurship development.

CO3: Understand the concept of automated testing of drugs and properties of interaction & bonding in drugs for skill development, employability and entrepreneurship development.

CO4: Design potential drug molecule for docking for skill development and employability.

CO5: Work in drug designing softwares like CADD and QSAR for skill development and employability.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	2	2	2	2	2	3	1
CO2	2	2	1	3	3	3	1	2	3	2	3	2
CO3	1	1	2	1	2	3	1	3	3	3	2	3
CO4	2	2	2	1	2	2	1	3	3	2	2	2
CO5	2	1	3	2	1	2	2	2	2	3	1	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	3	3
CO2	2	2	2
CO3	1	2	2
CO4	3	3	2
CO5	2	2	1

Suggested Readings:

1. Baxevanis, Andreas D., and BF Francis Ouellette. Bioinformatics: a practical guide to the analysis of genes and proteins. Vol. 43. John Wiley & Sons, 2004.
2. Krane, Dan E. Fundamental concepts of bioinformatics. Pearson Education India, 2003.
3. Attwood, Teresa K., and David J. Parry-Smith. Introduction to bioinformatics. Prentice Hall, 2003.
4. Patrick, G. Instant notes Medicinal chemistry 2nd Editions) Viva Book Pvt. Ltd. 2002.

Websites Sources:

- http://www.bioinform.com/index
- http://bioinfo.ernet.in/
- www.ncbi.nlm.nih.gov
- http://www.bic.nus.edu.sg/

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology I Year (II Semester)

MTB207T METABOLIC ENGINEERING

Objective(s): The objectives of this course:

- Familiarize the students with the basic concepts in metabolic engineering.
- Acquaint the students to versatile tools and techniques employed in metabolic engineering and study metabolic pathways; and to appraise them about applications of metabolic engineering**.**

Unit I: **(8 Sessions)**

Cellular metabolism: Transport processes, fueling reactions, biosynthesis, growth energetic of cellular stoichiometry; Regulation of metabolic pathways: levels of regulation of enzymatic activity (overview of kinetics, reversible and irreversible inhibitions, allosteric enzymes and cooperativity); Regulation of enzymes concentration (control of transcription and translation, example with respect of *lac* operon and catabolite repression); Global control, regulation of metabolic networks (Branch point classification, coupled reactions and global currency metabolites and energy regulation).

Unit II: **(8 Sessions)**

Metabolic engineering in practice: Concept of directed cellular energy utilization, analytical and synthetic elements of metabolic engineering; targets of metabolic engineering; Metabolic Pathway analysis (Typical case study: Lysine Biosynthesis); Strategies for redirecting branched and linear pathways-Alteration of feedback regulation; Limiting accumulation of end product feedback resistant mutants; Alteration of permeability.

Unit III: **(8 Sessions)**

Metabolic Flux Analysis: Concept and utility of MFA- Theory, case studies over determined systems, experimental determination of MFA by isotope labelling. Applications of MFA: Case studies- concept and fundamentals of metabolic control analysis (Basic concept only).

Unit IV: **(8 Sessions)**

Application of pathway manipulations: Strategies for overproduction of primary metabolites; Strategies for overproduction of secondary metabolites (Precursor effects, prophophase idiophase relationship, enzyme induction, feedback regulation). Bioconversions: (ME concepts applied in process decisions for enhanced bioconversion).

Unit V: **(8 Sessions)**

Examples of pathway manipulations: Enhancement of product yield (alcohol, amino acids); Extension of substrate ranges (lignocelluloses utilization), Extension of product spectrum (antibiotic, biopolymers), Improvement of cellular properties- Alteration of metabolism, Enhanced efficiency and yield, Genetic stability.

Course Outcomes:

At the end of the course students will able to:

CO1: Understand the concept of cellular metabolism and enzyme regulation for skill development and employability.
CO2: Practice metabolic engineering and metabolic path analysis for skill development, employability and entrepreneurship development.
CO3: Learn the concept of metabolic flux analysis for skill development and employability.
CO4: Understand the application of various pathway manipulation for skill development, employability and entrepreneurship development.
CO5: Enhance the product yield and utilization of different types of substrate for skill development and employability.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	2	2	2	3	3	2	1	3
CO2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	1	2	2	2	3	1	1	2	1	3	2	2
CO4	2	2	2	1	2	2	2	1	2	2	2	2
CO5	1	2	1	1	2	2	1	2	1	1	3	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	3
CO2	2	2	3
CO3	1	2	2
CO4	2	2	2
CO5	1	1	2

Suggested Readings:

1. Stephanopoulos et al. Metabolic Engineering principles and Methodologies.
2. Scheper, T., Faurie, R. and Thommel, J. Advance in Biochemical engineering Biotechnology: Microbila production of L-Aminoacid
3. Jens Hoiriis Nielsen and Sabine Arnold: Biotechnology for the future.

Website Sources:

- https://onlinecourses.nptel.ac.in/

- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
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MTB201P MICROBIOLOGICAL TECHNOLOGY LAB

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To study different growth phases of bacterial population and plot a bacterial growth curve.	Experiment 1
6	To produce ethanol under submerged conditions using *Saccharomyces cerevisiae.*	Experiment 2
7	To purify ethanol produced under submerged conditions.	Experiment 3
8	To immobilize microbial cells using sodium- alginate gel entrapment method.	Experiment 4
9	To produce amylase enzyme under solid state fermentation and submerged state fermentation.	Experiment 5
10	Isolation of Antibiotic Producing Microbes from Soil.	Experiment 6
11	To extract the amylase enzyme produced and determination of enzymatic activity.	Experiment 7
12	To produce biopolymer Dextran from *Leuconostoc mesenteroides.*	Experiment 8

IFTM University, Moradabad
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MTB202P ENZYME & PROTEIN ENGINEERING LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To isolate and assay a plant enzyme, glucosidase.	Experiment 1
6	To determine the optimum temperature for enzyme activity.	Experiment 2
7	To determine the optimum pH for enzyme activity.	Experiment 3
8	To determine the effect of substrate concentration on the enzyme activity.	Experiment 4
9	To determine the effect of enzyme concentration on the enzyme activity.	Experiment 5
10	To determine Km and Vmax for alkaline phosphatase enzyme.	Experiment 6
11	Immobilization of salivary amylase enzyme.	Experiment 7
12	Estimation of disulphide bonds using Edman's reagent.	Experiment 8
13	To Perform chemical cleavage of proteins at methionyl-X peptide and cysteinyl-X peptide bonds.	Experiment 9
14	To perform enzymatic digestion of proteins in solution and SDS-polyacrylamide gels.	Experiments 10

IFTM University, Moradabad
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MTB203P RECOMBINANT DNA TECHNOLOGY LAB

1.	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To estimate the DNA concentration by DPA method	Experiment 1
6	To estimate the RNA concentration by orcinol method	Experiment 2
10	To extract the genomic DNA from Plant Leaves.	Experiment 3
11	Electrophoresis of extracted DNA.	Experiment 4
12	Isolation and purification of plasmid DNA.	Experiment 5
13	To perform restriction digestion of λ- DNA with EcoR1 & HIND-III enzymes and electrophoresis of digested DNA.	Experiment 6
2.	To perform ligation of Lambda (λ) HindIII digest.	Experiment 7
3.	To transform plasmid DNA into bacteria.	Experiment 8
4.	To amplify a specific DNA fragment by Polymerase Chain Reaction using random primers.	Experiment 9

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB301T IMMUNOTECHNOLOGY & IMMUNOINFORMATICS

Objective(s): The objectives of this course:

- Is to provide students with basic understanding and applications of bioinformatics in the field of immunology.
- Will provide the basic concepts of immunology and also help students understand the concepts behind the sequence and structural alignment, database searching, protein structure predictions and applications and limitations of T cell & B cell epitopes.

UNIT I: **(8 Sessions)**

Overview of Immune System: Types of Immunity, Cells of Immune system, Antigens, Fine structure and biological functions of Immunoglobulins, Phagocytosis, Opsonization and Neutralization, Cytokines and their role in immune response through JAK-STAT signaling.

UNIT II: **(8 Sessions)**

Antigen-Antibody Interactions: Flocculation, Precipitation, Agglutination, Immunodiffusion-principle and techniques, ELISA, Western blotting, Immunofluorescence, Flow cytometry for separation of immune cells, Complement system-components, activation, and its regulation.

UNIT III: **(8 Sessions)**

MHC and Transplantation Immunology: MHC and the HLA system – Structure of HLA class I, class II and class III molecules, Presentation and Processing of Antigen derived peptides by MHC (endocytic and cytosolic processing), Genetic Organization of HLA genes, Types of graft, Graft-Versus-Host Reactions (GVHR), Mechanism of graft rejection.

UNIT IV: **(8 Sessions)**

Immunization: Objectives of Immunization, Active and Passive Immunization, Types of Vaccines, methods for designing Vaccines, Vaccinology and immunoinformatics, Reverse Vaccinology, Databases & Tools for prediction of B & T-cell epitopes – SYFPEITHI, Pred, ProPred etc. and their limitations.

UNIT V: **(8 Sessions)**

Structure Activity Relationship: QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronics; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations.

Course Outcomes:

At the end of the course students will be able to:

CO1: Learn various types and roles of the immune system, Cells, and Organs of the immune system, antigens, and factors affecting antigenicity for skill development, employability and entrepreneurship development.

CO2: Understand the structure and role of Antibodies, Types of antibodies, production and application of monoclonal antibodies, the role of cytokines and complement systems for skill development and employability.

CO3: Learn the antigen-antibody reactions-precipitation, agglutination, RIA, ELISA, Immunological tools, MHC, and antigen presentation for skill development and employability.

CO4: Apply various tools of immunoinformatics, databases in immunology, T-cell and B-cell prediction methods and Reverse vaccinology for skill development and employability.

CO5: Learn QSAR, various descriptors used in QSAR, and principal component analysis in QSAR analysis for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3	3	2	3	3	3	2
CO2	2	2	2	2	2	3	2	2	2	2	3	2
CO3	2	3	1	1	1	2	3	1	1	2	2	1
CO4	2	1	2	1	3	2	3	2	3	2	2	3
CO5	2	1	3	2	2	3	2	2	2	1	3	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	2
CO2	2	1	2
CO3	2	2	1
CO4	1	1	2
CO5	1	1	2

Suggested Readings:

1. Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne Kuby Immunology 4th Edition.

2. Darren R Flower. Immunoinformatics: Predicting Immunogenicity in Silico.Publisher: Humana Press.
3. Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, Basic Immunology (Function and Disorder of Immune System), 4th Edition; Elsevier Publisher.
4. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, Kuby Immunology, 6th Edition; Publisher: W H Freeman & Co.
5. Roitt's Immunology, P.J. Delves, S. J. Martine, D.R. Burton, I.M. Roitt, 12th Edition. Wiley-Blackwell.
6. Shoba Ranganathan, Vladimir Brusic , Christian Schonbach. Immunoinformatics (Immunomics Reviews),Publisher: Springer.

Website Sources:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2967261/
- http://www.imgt.org/about/immunoinformatics.php
- https://www.biorxiv.org/content/10.1101/2020.02.28.970343v1.full
- https://www.limswiki.org/index.php/Immunoinformatics
- https://biology.mit.edu/faculty-and-research/areas-of-research/immunology/
- https://www.coursera.org/learn/immunologyfundamentalsimmunitybcells

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB302T BIOREACTOR ANALYSIS & DESIGN

Objective(s): The objectives of the course:

- Is to inculcate the different types of bioreactors used in biotechnology industries application of material and energy balance to design the reactor kinetics.
- Will give the explanation of mixing in transport phenomenon and scale up of bioreactors for large volume production.

UNIT I: **(8 Sessions)**

Basic concept: Definition of bioreactor, fundamental principles, classification of reactors and their configurations, general design information, concept in energy and mass balances, flow-sheet, piping and instrumentation, material for construction of bioprocess plant.

UNIT II: **(8 Sessions)**

Analysis of ideal reactors: Concepts of reactors based on flow characteristics, design of ideal reactors using material and energy balance, batch bioreactor design, chemostat analysis, definition of chemostat, turbidostat, single flow single stage chemostat, single flow multistage chemostat, recycle flow in chemostat, concepts of dilution rate productivity analysis.

UNIT III: **(8 Sessions)**

Mixing, mass transfer and instrumentation control of bioreactors: Concepts introduction, mass transfer, theory of mixing, rheological properties, bioreactor sensor, temperature measurement control, principle of dissolved oxygen measurement and control, principle of pH/redox measurement and control, deduction and prevention of foam.

UNIT IV: **(8 Sessions)**

Vessels for biotechnology application: Different bioreactor configuration, design considerations for maintaining sterility of process streams and process equipment, selection and specification of major equipment used in bioprocess industries.

UNIT V: **(8 Sessions)**

Specific Bioreactor analysis and scale up: Design and analysis of fed-batch and air-lift bioreactors, application in animal cell culture, basic concept of scale-up, non-dimensional analysis, utilities for biotechnology production plants, process economics, bioprocess validation, safety considerations.

Course Outcomes:

At the end of the course students will be able to:

CO 1: Understand the basic components of the bioreactor and its use in pharmaceuticals for skill development, employability and entrepreneurship development.

CO2: Design principles of the batch, fed-batch, and continuous bioreactors and analyze their behavior (dynamic and steady-state) for skill development, employability and entrepreneurship development.

CO3: Understand suitable process instrumentation for monitoring and control of bioreactors for skill development and employability.

CO4: Understand mass and heat transfer requirements for the fermentation system for skill development, employability and entrepreneurship development.

CO5: Identify suitable criteria for the scale-up of bioprocesses and characterize non-ideality in bioreactors for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	2	3	2	3	3	2	2
CO2	3	2	2	2	3	3	3	2	2	2	2	2
CO3	2	2	2	1	2	3	2	1	2	2	2	2
CO4	2	1	3	2	2	3	2	1	2	2	2	1
CO5	1	2	2	2	2	2	2	2	2	2	1	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	2
CO2	2	3	3
CO3	1	3	3
CO4	3	2	3
CO5	2	1	2

Suggested Readings:

1. Octave Levenspiel: Chemical Reaction Engineering, John Wiley & Sons,1999.
2. Rao, D.G.: Introduction to Biochemical Engineering. McGraw-Hill Inc.2005.
3. Doran, P.M.: Bioprocess Engineering Principles. Academic Press,1995.
4. Bailey, J. E. and Ollis, D. F.: Biochemical Engineering Fundamentals. Mc-Graw Hill Inc.1986.

Website Sources:

- https://nptel.ac.in/courses/103/103/103103035/
- http://www.ric.edu/faculty/ptiskus/reactions/
- https://www.khanacademy.org
- https://nptel.ac.in/courses/102/106/102106053/

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB303T SOLID WASTE MANAGEMENT

Objective(s): The objectives of this course:

- Has been design to familiarize a post graduate student with the understanding of the challenges that governing body has to face and how to tackle those challenges.
- Various adopted treatment technologies for MSW are critically reviewed, along with their advantages and limitations.

UNIT I: **(8 Sessions)**

Solid wastes: Sources, nature and characteristics, Quantities and qualities, Rates of generation and factors affecting them, Potential of diseases, nuisances and other problems due to solid wastes, Changing nature of solid wastes and its impact on solid waste management. Solid wastes management- Generation, on-site storage, collection, separation, processing and disposal. On-site storage methods-containers, their type, size and location

UNIT II: **(8 Sessions)**

Solid waste characterization: ultimate and proximate analysis , Waste reduction at source- volume reduction, Collection techniques Transport of solid waste and its optimization, transfer stations, Materials recovery/recycling; - Recycling of Aluminum, glass, plastic and, paper, Treatment and disposal techniques - Burning, Open dumping, Landfill : land filling methods and operation, Landfill emissions : Leachate and Landfill gas, Leachate collection & analysis, Composting, Vermi-composting, Incineration.

UNIT III: **(8 Sessions)**

Energy from Waste: Pyrolysis, Gasification, Refuse derived fuels, Merits and demerits of waste disposal methods, Municipal Waste (Management and Handling) Rules 2000Vadose and saturated zone monitoring of solid waste dumps, Evaluation of ground water pollution, sampling and analysis, protection at disposal sites.

UNIT IV: **(8 Sessions)**

Waste generation, Need and requirements for management and planning: Solid waste- types, generation trends, quality and quantity aspects, Integrated Solid waste Management. Biomedical waste: Introduction: definition, Classification, types and composition, Types of solids, liquids, sharps, blood and blood tissue, radioactive material, biological and chemical material.

UNIT V: **(8 Sessions)**

Industrial and Hazardous solid waste management: Urban solid waste management and its modeling. Disposal methods such as sanitary landfill, biological digestion etc.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand solid waste, its sources, and nature for skill development, employability and entrepreneurship development.
CO2: Learn about the solid waste characteristics, waste reduction, and treatment and disposal techniques for skill development and employability.
CO3: Understand about the energy from waste or fuels derived from waste for skill development, employability and entrepreneurship development.
CO4: Understand the requirement for management, planning and knowledge about biomedical waste for skill development and employability.
CO5: Learn about industrial and urban solid waste management and also about its disposal methods for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	3	1	2	3	2	1	2	2
CO2	2	2	2	2	2	2	3	3	3	2	3	2
CO3	2	2	3	2	2	2	2	2	3	3	3	1
CO4	2	2	2	3	2	2	3	3	3	2	3	2
CO5	1	2	2	2	2	1	3	2	2	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	3
CO2	2	1	3
CO3	2	1	2
CO4	2	1	2
CO5	1	2	1

Suggested Readings:

1. Tchobanogloas, G. Integrated Solid Waste Management: Engineering, Principle and Management. McGraw Hill, USA. 1993
2. Kreith, F. Handbook of Solid Waste Management. McGraw Hill Publishers, USA. 1999.

3. Shah, K. L. Basics of Solid and Hazardous Waste Management Technology. McGraw Hill, USA. 1999.
4. Vesilind, P. A., Worrell, W. and Reinhart, D. Solid Waste Engineering. Brooks/Cole Thomson Learning Inc., USA. 2002.
5. Peavey, H. S, Rowe, D. R and Tchobanoglous, G. Environmental Engineering. International Ed. McGraw-Hill, New York, USA. 1985.
6. White, P, Frank, M. and Hindle, P. Integrated Solid Waste Management- A Life Cycle Inventory. Chapman &Hall, USA. 1999.
7. Noble, G. Sanitary Landfill Design Handbook. Technomic Westport Connecticut, USA. 8. Evans, G. 2005. Biowaste and Biological Waste Treatment. James and James (Science Publishers) Ltd, U.K. 1976.
8. Kumar, R and Singh, R.N. Municipal Water and Wastewater Treatment. Capitol Pub. Co., New Delhi. 2006.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB304T PHARMACEUTICAL BIOTECHNOLOGY

Objective(s): The objective of the course is:

- To understand the aspects of biotechnology and its components to develop pharmaceutical manufactures.
- To learn the tools and techniques of animal and plant cell culture to synthesize new drug molecules.
- To study the genomics and proteomics in design of new potent drugs.
- To exercise the fermentation techniques for production of drug and antibiotics.

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UNIT I: **(8 Sessions)**

Introduction: Biotechnology in the Pharmaceutical Industry- impact of biotechnology in biopharmaceuticals; Genetic manipulation methods; Bacteria, Fungi and Viruses: Structure, Chemistry and Morphology, Cultural, Physiological and Reproductive features, Methods of isolation, Cultivation; Industrially important microorganisms in pharmaceuticals

UNIT II: **(8 Sessions)**

Animal Cell Culture: Historical Background, Importance of and progress in Animal Cell Culture, Technology, Biology of Animal Cell; Cellular Interactions, Importance of Serum and Serum Free Media, Culturing and Sub-Culturing of Animal Cells, *In Vitro* Transformation of Animal Cells, Cell Differentiation & Cell Movement, Cloning of Animal Cells, Cell Line Preservation, Cell Line Characterization, Chromosome Spreading and Karyotype Analysis.

UNIT III: **(8 Sessions)**

Plant cell culture: History and evolution, Basics of aseptic culture, *In vitro* propagation, use of plant growth regulators in tissue culture, plant regeneration, organogenesis, somatic embryogenesis, protoplast isolation and culture, somaclonal variation, in vitro mutagenesis, in vitro selection, secondary metabolite production and cell transformation techniques.

UNIT IV: **(8 Sessions)**

Proteomics, Genomics and Metabolomics: Analyzing gene expression at the mRNA and protein level; Environmental impacts on gene expression; Basic principles of DNA/Protein microarrays and their applications; Construction and study of various types of genome maps and large-scale sequencing; Developing diagnostic tests for plant, animal and human diseases. Identification of biomarkers.

UNIT V: **(8 Sessions)**

Fermentation technology: Inoculum: preparation and development for industrial fermentation; optimization of the fermentation process (pH, temperature, and oxygen requirements; Fermentation products in Pharmaceutical industry: Antibodies, Therapeutic proteins, Vitamins, Amino acids, Monoclonal Antibodies.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the basic concepts of genetic manipulation of microbial cells for skill development, employability and entrepreneurship development.

CO2: Understand the technique of animal cell culture, the importance of culture media for skill development, employability and entrepreneurship development.

CO3: Learn the different types of plant cell culture techniques for the production of metabolites-primary and secondary for skill development and employability.

CO4: Understand the methods and protocols for analyzing genes, estimation of DNA/Protein. Learn the techniques for sequencing, construction of genome maps and development of diagnostic tests for diseases for skill development, employability and entrepreneurship development.

CO5: Explain the basic concept and techniques of fermentation. Learn the application of fermentation techniques for the production of drugs and antibiotics for skill development and employability.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	2	2	3	3	2	2	3
CO2	2	3	2	2	2	2	3	3	2	2	2	3
CO3	3	2	2	2	3	1	3	2	2	2	2	2
CO4	2	2	1	2	3	3	3	2	2	2	3	2
CO5	1	1	2	1	2	2	2	2	2	2	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	3
CO2	2	2	3
CO3	2	3	2

CO4	1	3	1
CO5	1	2	1

Suggested Readings:

1. Alexander N. Glazer, Hiroshi Nikaido MICROBIAL BIOTECHNOLOGY: Fundamentals of Applied Microbiology, Second Edition, 2007 cambridge press.
2. Ronald S. Oosting Ph.D. (auth.) & Daan J. A. Crommelin & Robert D. Sindelar & Bernd Meibohm (eds.): Pharmaceutical Biotechnology: Fundamentals and Applications, Springer 2013.
3. *Peter F. Stanbury, Allan Whitaker and Stephen J. Hal*: Principles of Fermentation Technology, Pergamon, 1995.

Website Sources:

- https://www.pdfdrive.com/pharmaceutical-biotechnology-fundamentals-and-applications-e164753639.html
- http://www.brainkart.com/subject/Pharmaceutical-Biotechnology--Fundamentals-and-Applications_231/
- https://sites.google.com/site/livescribesmartpennotes/biopharmaceutical-notes

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB305T BIOMEDICAL INSTRUMENTATION & MEASUREMENTS

Objective: The objective of this course:

- With widespread use and requirements of medical instruments, this course gives knowledge of the principle of operation and design of biomedical instruments.

UNIT I: **(8 Sessions)**

Overview of Biomedical Instrumentation system – History of biomedical instrumentation, Biometrics, Introduction to the man-instrument system, Components of the man-instrument system, Types of biomedical equipments – Analytical, Diagnostic, Therapeutic and Surgical equipments; Calibration of medical devices and testing of biomedical equipments; Electrical classification of Biomedical Equipments.

UNIT II: **(8 Sessions)**

Analytic Equipments: Flame photometers, Spectro photometers, Beer lambert law, Colorimeters, Blood gas analyzers –Electrodes for pH, pO_2 and pCO_2. Hb meter, Blood cell counters, Auto analyzers. transducer and transduction principles, Active transducers, Passive transducers, Transducers for biomedical applications.

UNIT III: **(8 Sessions)**

Diagnostic Equipments: Electrocardiography (ECG) –ECG in diagnosis, Lead systems, Artifacts, ECG Machine. Principles and applications–Vector cardiography (VCG), Magnetocardiography (MCG) – SQUIDS and Phonocardiography (PCG).Electro encephalography (EEG), EEG Machine, Electroretinography (ERG) and Electrooculography (EOG).Principles and applications–Electromyography (EMG); Electroneurography (ENG).Endoscopy, Laparoscopy.

UNIT IV: **(8 Sessions)**

Patient monitoring system–Bed-side monitors, Central station monitors, Computerized arrhythmia monitors, Cardio scope, Ambulatory monitors, Neonatal monitors, Holter monitoring, Infant Warmer, Neonatal Incubator, Infusion pump, syringe pump, Cardiotocograph – Plethysmography, Measurement of heart sounds Methods of monitoring fetal heart rate. Biotelemetry – Principles – Types – Single channel and Multichannel – Frequency division and Time division multiplexing, Tele-stimulation, Telemedicine – Principles and applications.

UNIT V: **(8 Sessions)**

Audiometers –Pure tone, Speech and Mask audiometers, Bekesy audiometers, Tympanometers. Hearing aids, Cochlear implants, Ear moulds. Densitometers – Principle and applications. Robotic surgery –Orthopedic prostheses fixation.

Course Outcomes:

At the end of the course students will be able to:

CO1: Understand the working, principle of biomedical instrumentation as well as calibration of medical devices for skill development and employability.

CO2: Learn various applications of different types of analytic equipment for skill development, employability and entrepreneurship development.

CO3: Understand the principle and working of diagnostic equipment for skill development and employability.

CO4: Learn the patient monitoring system, principles and various types of biotelemetry for skill development, employability and entrepreneurship development.

CO5: Learn the audiometers and related measurements for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**3**	**1**	**3**	**2**	**3**	**1**	**3**	**3**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**1**	**2**	**3**	**2**
CO3	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**1**	**2**	**1**
CO4	**2**	**2**	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**2**	**2**	**2**
CO5	**1**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**2**	**2**	**1**	**1**

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	1
CO2	3	3	2
CO3	2	3	3
CO4	2	3	3
CO5	2	3	1

Suggested Readings:

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer.
2. Medical Instrumentation for Health Care by Leslie Cromwell.
3. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop.

4. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris.
5. Biomedical Instrumentation: Technology and Applications by Raghbir Singh

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/
- https://study.com

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB306T IPR, BIOETHICS & BIOSAFETY

Objective: The main objective of this course:

- To introduce fundamental aspects of IPR to students who are going to play a major role in R&D, management of innovative projects in industries. To aware about current trends in IPR and Govt. steps in fostering IPR

UNIT I: **(8 Sessions)**

Jurisprudential definition and concept of property, rights, duties and their correlation. History and evolution of IPR- like patent, design and copy right, Indian patent act 1970 (amendment 2000), International convention in IPR, major changes in Indian patent system as post TRIPS effects (i) obtaining patent (ii) geographical indication.

UNIT II: **(8 Sessions)**

Distinction among various forms of IPR, Requirement of a patentable novelty, invention step and prior art and state of art, importance of intellectual property rights, International and National convention on biotechnology and related areas.

UNIT III: **(8 Sessions)**

Detailed information on patenting biological products, Biodiversity, Budapest treaty, India's latest patent litigation cases: Novartis Vs Cipla, Basmati rice case study, Neem patent case study. Right/protection, infringement or violation, remedies against infringement-civil and criminal.

UNIT IV: **(8 Sessions)**

Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology-interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.

UNIT V: **(8 Sessions)**

Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety regulation: handling of recombinant DNA products and process in industry and in institutions.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand different types of Intellectual Properties (IPs), laws and agreements related to IPR for

skill development, employability and entrepreneurship development.
CO2: Understand the importance and requirement of IPR and the role of convention related to IPR for skill development and employability.
CO3: Understand the detailed information on patenting biological products as well as India's latest patent litigation cases for skill development and employability.
CO4: Understand the ethical issues in biotechnological products and NGOs for bioethics for skill development, employability and entrepreneurship development.
CO5: Understand the importance and types of biosafety levels and handling of rDNA products and processes in industry and institutions for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	2	2	2	2	1	2	3	2
CO3	1	2	2	3	2	3	2	1	2	3	2	3
CO4	2	1	2	1	2	2	2	1	1	2	2	2
CO5	1	2	1	1	1	2	1	2	2	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	3
CO2	2	2	2
CO3	3	3	3
CO4	1	2	2
CO5	1	1	1

Suggested Readings:

1. Patent Strategy for Researches & Research Manegers- Knight, Wiley Publications.
2. V. Santaniello & R E Evenson, University Press, Agriculture & Intellectual & Property Rights.
3. Phillipe Cullet, Ldexix Nexis Butterworths, Intellectual Property Protection & Sustainable Development.
4. Thomas, Biotechnology & Safety Assessment, Ane/Rout Publishers.
5. Fuchs, Biotechnology in Comparative Perspective, Ane/Rout Publishers.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/
- https://www.researchgate.net
- https://www.wipo.int/

IFTM University, Moradabad
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MTB307T MEDICAL BIOTECHNOLOGY

Objective: The main objective of this course:

- Is to introduce the student to basic role of biotechnology techniques in medical and their use in measurement of different parameters in biosystems and related constraints.

UNIT I: **(8 Sessions)**

Introduction to medical biotechnology: Medical significance of biochemical tests and their role in the diagnosis and monitoring of disease; Clinical characteristic of disease; Role of pharmacological testing in clinical management of disease; Role of Clinical Biochemistry in detection, diagnosis and therapy of genetically inherited diseases and cancer.

UNIT II: **(8 Sessions)**

Genetic diseases: Type of inheritance: single-gene and multi factorial inheritance; Example of genetic diseases; Therapeutic intervention in blood disorder by stem cell transplantation/gene therapy.

UNIT III: **(8 Sessions)**

Medically important taxonomic grouping of bacteria: Staphylococci, Streptococci etc; Isolation and identification strategies; Aetiology-identification of disease agents and their source; Transmission, portals of entry, noscomial infections; Epidemiology-epidemics, pandemics and endemics disease; Control measure of microbial diseases-public health control methods; Hygiene regulations, population screening for disease; Anti- microbial chemotherapy; Modes of action of major groups of antibiotics.

UNIT IV: **(8 Sessions)**

Insights in cellular and molecular mechanism of diseases: Cellular and molecular mechanism of human diseases, transgenesis-animal models of human diseases; Animals for pharmaceutical protein production.

UNIT V: **(8 Sessions)**

Applications: Manipulation of reproduction and development for application in medicine, agriculture, aquaculture and conservation; Management of Clinical Data.

Course Outcomes:

At the end of the course students will be able to:

CO1: Learn about the biochemical and pharmacological methods for clinical diagnostics in the case of molecular genetics related disorders for skill development, employability and entrepreneurship development.
CO2: Know about the genetic disease and their causes along with the significance of stem cell and gene therapy for their management for skill development, employability and entrepreneurship development.
CO3: Learn about the cause and spread of pathogenic disease as epidemics with the role of hygiene, antibiotics and chemotherapy in disease control for skill development and employability.
CO4: Know the connection of the cell's molecular mechanism in relation to diseases and how transgenic proteins are produced to cure the diseases for skill development and employability.
CO5: Learn about the management of clinical data for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	2	2	3	2	2	3	3	1
CO2	2	2	1	3	3	3	2	2	3	3	2	2
CO3	2	2	1	2	2	2	3	2	3	2	2	3
CO4	2	2	2	2	3	2	2	1	3	2	2	3
CO5	2	2	2	2	2	3	1	2	2	2	1	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	1
CO2	1	2	2
CO3	2	2	2
CO4	1	1	3
CO5	2	3	2

Suggested Readings:

1. Marshall, W J, Clinical Chemistry, 3rd edition, Mosby, 1997.
2. Harper's Biochemistry K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell, McGraw Hill/ Appleton and Lange
3. Sudbery, P. Human molecular genetics. Addison Wesley Longman (1998)

4. David L. Nelson; Michael M. Cox.Lehninger Principles of Biochemistry, Fourth Edition.W. H. Freeman, 2004,

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/
- https://study.com/

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB301P IMMUNOTECHNOLOGY AND IMMUNOINFORMATICS LAB

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To enumerate the total number of RBCs and WBCs in the blood sample.	Experiment 1
6	Estimation of specific antibodies present in serum by rapid slide test (WIDAL test).	Experiment 2
7	To Perform Ouchterlony double diffusion.	Experiment 3
8	To perform Sandwich ELISA by using microtiter plate reader.	Experiment 4
9	To perform Counter current immune electrophoresis.	Experiment 5
10	To isolate the lymphocyte from whole blood by density gradient centrifugation method.	Experiment 6
11	To perform the precipitation technique by single radial immunodiffusion.	Experiment 7
12	To perform the technique of Immunoprecipitation to precipitate of the antigen-antibody complex by using Protein A beads.	Experiment 8

IFTM University, Moradabad
Master of Technology (M. Tech.), Program
M. Tech. Biotechnology II Year (III Semester)

MTB303P SOLID WASTE MANAGEMENT LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	Isolation and enumeration of microorganisms from soil by serial dilution agar plating method and to obtain pure culture of microorganisms by pour, spread and streak plate method	Experiment 1
6.	To determine the alkalinity of given sample of water in mg/l.	Experiment 2
7.	To determine the chloride content of the given sample by Mohr's method.	Experiment 3
8.	To determine the total suspended solids, total dissolved solids and total solids of given sample.	Experiment 4
9.	To determine the turbidity of the given sample using nephelometer in N.T.U.	Experiment 5
10.	To determine the hardness of the given water sample using EDTA method.	Experiment 6
11.	To determine the amount of dissolved oxygen present in the given sample.	Experiment 7
12.	To determine the BOD of the given sample.	Experiment 8
13.	To determine the Chemical oxygen demand (COD) of the given sample.	Experiment 9
14.	To perform presumptive test for water potability.	Experiment 10