FACULTY OF

SCIENCE

COURSE STRUCTURE & SYLLABUS

M. SC. BIOTECHNOLOGY (INDUSTRIAL BIOTECHNOLOGY)

Effective from Academic Year: 2022-23

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

Faculty Name: Science

Programme Name: M. Sc. Biotechnology (Industrial Biotechnology)

Programme Structure Summary

SEMESTER 1											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Cell Communication & Cell Signaling	4	3		1	4	50/20	50/20			100/40
Core	Biodegradation & Bioremediation	4	3		1	4	50/20	50/20			100/40
Core	Food Biotechnology	4	3		1	4	50/20	50/20			100/40
Core	Lab – I (Cell Communication & Cell Signaling and Biodegradation & Bioremediation)	4		8		8			50/20	50/20	100/40
Core	Lab – II (Food Biotechnology & Elective Course)	4		8		8			50/20	50/20	100/40
Elective (Any One)	Plant Biotechnology	4	3		1	4	50/20	50/20			100/40
	Microbial Technology	4	3		1	4	50/20	50/20			100/40
	Environmental Chemistry	4	3		1	4	50/20	50/20			100/40
	Clinical Biochemistry	4	3		1	4	50/20	50/20			100/40
Viva-Voce	Comprehensive Viva	1								50/20	50/20
	Total	**25**									

SEMESTER 2											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Industrial Waste Management	4	3		1	4	50/20	50/20			100/40
Core	Bioprocess Engineering and Technology	4	3		1	4	50/20	50/20			100/40
Core	O'-mics	4	3		1	4	50/20	50/20			100/40
Core	Lab – I (Industrial Waste Management and Bioprocess Engineering and Technology)	4		8		8			50/20	50/20	100/40
Core	Lab – II (O'-mics & Elective Course)	4		8		8			50/20	50/20	100/40
Elective (Any One)	Animal Biotechnology	4	3		1	4	50/20	50/20			100/40
	Bioseperation Technology	4	3		1	4	50/20	50/20			100/40
	Protein Engineering	4	3		1	4	50/20	50/20			100/40
	Environment Policy and Legislation	4	3		1	4	50/20	50/20			100/40
Viva-Voce	Comprehensive Viva	1								50/20	50/20
	Total	**25**									

SEMESTER 3											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Drug Design and Development	4	3		1	4	50/20	50/20			100/40
Core	Material Balance, Mass Transfer and Transport Process	4	3		1	4	50/20	50/20			100/40
Core	Metabolic Engineering	4	3		1	4	50/20	50/20			100/40
Core	Lab – I (Drug Design and Development and Material Balance, Mass Transfer and Transport Process)	4		8		8			50/20	50/20	100/40
Core	Lab – II (Metabolic Engineering and Elective Course)	4		8		8			50/20	50/20	100/40
Elective (Any One)	Environmental Engineering	4	3		1	4	50/20	50/20			100/40
	Nanobiotechnology & Applications	4	3		1	4	50/20	50/20			100/40
	Cancer Genetics	4	3		1	4	50/20	50/20			100/40
	Validation, Documentation and cGMP	4	3		1	4	50/20	50/20			100/40
Viva-Voce	Comprehensive Viva	1								50/20	50/20
	Total	**25**									

SEMESTER 4											
Course Group	Course Name	Cr	Teaching Scheme				INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
			T	P	Tu	Cont. Hrs					
Core	Biosafety, Bioethics & IPR	4	3		1	4	50/20	50/20			100/40
Core	Bioinformatics	4	3		1	4	50/20	50/20			100/40
Core	Lab – I (Biosafety, Bioethics & IPR and Bioinformatics)	4		8		8			50/20	50/20	100/40
Elective	Dissertation	12								300/120	300/120
Viva-Voce	Comprehensive Viva	1								50/20	50/20
	Total	**25**									

Programme Outcomes

PO-1	Students will be able to understand about cell communication & cell signaling, biodegradation & bioremediation, food biotechnology and related practical knowledge
PO-2	Students will be able to aware of the subjects like plant biotechnology, microbial technology, environmental chemistry, clinical biochemistry and their related practical knowledge
PO-3	Students will be able to understand about Industrial waste management, bioprocess engineering and technology, O'-mics and practical knowledge and their related practical knowledge
PO-4	Students will be able to aware of the subjects like animal biotechnology, bioseperation technology, protein engineering, environment policy and legislation and their related practical knowledge
PO-5	Students will be able to understand drug design and development, material balance, mass transfer and transport process, metabolic engineering and their related practical knowledge
PO-6	Students will be able to aware of the subjects like environmental engineering, nanobiotechnology & applications, cancer genetics, validation, documentation and cGMP and their related practical knowledge
PO-7	Students will be able to know biosafety, bioethics & IPR for the protection of scientific experiments and bioinformatics tools to develop the new drug and their targets.
PO-8	The dissertation work will allow the students to gather the knowledge about the research or scientific experiments.

Faculty Name: Science

Programme Name: M. Sc. Biotechnology (Industrial Biotechnology)

Semester: 1 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Biological Science	301420101	Cell Communication & Cell Signaling	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science	301420104	Biodegradation & Bioremediation	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science	301420105	Food Biotechnology	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science	301420113	Lab – I (Cell Communication & Cell Signaling and Biodegradation & Bioremediation)	4		8		8		P		3			50/20	50/20	100/40
Core	Biological Science	301420114	Lab – II (Food Biotechnology & Elective Course)	4		8		8		P		3			50/20	50/20	100/40
Elective (Any One)	Biological Science	301420121	Plant Biotechnology	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science	301420122	Microbial Technology	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science	301420123	Environmental Chemistry	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science	301420124	Clinical Biochemistry	4	3		1	4	T		2		50/20	50/20			100/40
Viva-Voce	Biological Science	301420117	Comprehensive Viva	1												50/20	50/20
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]:

Name & Sign [Dean / Director]:

CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420101**

Course Title: **Cell Communication & Cell Signaling**

Course Group: **CORE**

Course Objectives: Students should learn about

1. Membrane structure, transport across it, intracellular vesicular traffic
2. Cytoskeletal structures, cell cycle
3. Various signaling pathways in living system, types of receptors
4. Pathways of intracellular transduction

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Cell-cell and cell-matrix adhesion:** Cell adhesive molecules, cell junctions, cadherins mediate cell-cell adhesion, Desmosomes, Tight junction Integrins Mediate cell-ECM adhesion, Gap junction, Plasmodesmata Basal lamina and extra cellular matrix. Cell Cycle – Phases of Cell Cycle, functional importance of each phase, Molecular events during cell cycle, Checkpoints. General account on programmed cell death (Apoptosis) - intrinsic and extrinsic pathways	15

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2	**Mechanisms of Cell communication:** General principles of cell communication, Introduction to signalling Receptors (GPCRs, Ion Channel Coupled receptors, Enzyme coupled receptors) and ligands, Signalling through G-protein coupled receptors (GPCRs) - Adenylyl Cyclase, Phospholipase C and small mediators, heterotrimeric G-proteins, : effectors, Secondary messenger: NO , Calcium, cAMP Tyrosine kinase receptors, Cytokine receptors, Src kinases	**15**
3	**Pathways of intracellular transduction:** Wnt and Hedgehog Signaling, Notch/Delta signaling, ras/MAPK pathways, Mitogenicsignaling Cytokine signaling/JAK-STAT/mTOR, NFkappa B signaling, TGF Beta signaling, PI3-kinase Lipid Signaling	**15**
4	**Host Parasite interaction:** Recognition and entry process of different pathogens like bacteria, viruses into cells. Alteration of host cell behavior by pathogens. Cancer: Genetic rearrangement in progenitor cells, oncogenes, tumor suppressor genes	**15**

Reference Books:

1	Cell and Molecular Biology by E.D.P.DeRobertis and E.M.P.DeRobertis. 8th Edition, Reprinted -2007) B.I.PublicationsPvt. Ltd.(Indian Edition).ISBN: 0-7817-3493-2.
2	Cell and Molecular Biology: Concepts and Experiments by Gerald Karp.5th Edition, Wiley International Edition, John Wiley&Sons,Inc. ISBN: 0-471-65665-8.
3	Molecular Biology of THE CELL by Albert et al.4th Edition, 2002, Garland Science, Taylor & Francis Group. ISBN: 0-8153-3218-1
4	The Cell – A Molecular Approach by Geoffrey M. Cooper and Robert E. Hassman. 3rd Edition, 2004, ASM Press, Sinauer Associates, Inc.ISBN:0-87893-214-3.
5	Molecular cell Biology by Harvey Lodish, 5th Edition, (2004) W.H.Freeman and Company, New York.ISBN:0-7167-4366-3.
6	Cell Biology by C.B. Powar.(Reprinted-2004)Himalaya Publishing House, Mumbai.
7	Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agarwal(Reprinted -2007) Pub.S.Chand& Company Ltd.Ram Nagar, New Delhi.
8	Cytology by P.S. Verma and V.K. Agarwal (Reprinted -2006) Pub:S.Chand& Company Ltd.Ram Nagar, New Delhi-110055.ISBN: 81-219-0814-0.

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/

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4	https://epathshala.nic.in/

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students should have thorough understanding of Membrane structure, transport across it, intracellular vesicular traffic	**25**
CO-2	Cytoskeletal structures, cell cycle	**25**
CO-3	Various signaling pathways in living system, types of receptors	**25**
CO-4	Pathways of intracellular transduction	**25**

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420104**

Course Title: **Biodegradation & Bioremediation**

Course Group: **CORE**

Course Objectives: At the end of this course, the student will be able to:

1 Introduction to biodegradation, enzymes involved, degradation of hydrocarbons,
2 Microbial transformation of pesticides, degradation of woods, degradation of some VOC
3 Bioremediation of soil and water pollutants
4 Various bioremediation strategies, bioremediation of air pollutants

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Biodegradation-I: Introduction, Determination of biodegradability, Principles of bacterial degradation, environmental factors affecting biodegradation, enzymes, toxicity. Aerobic degradation of hydrocarbons, growth associated aliphatic compound degradation, Degradation of Aromatic compounds. Anaerobic bacterial degradation-biopolymer, fats, lipids, hydrocarbon, N-alkyl, S-alkyl, ketones compound degradation.	15

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2	Biodegradation-II: Microbial transformation of pesticides, Fundamental reactions of pesticide metabolism-β-oxidation, oxidative dehalogenation, dealkylation, decarboxylation, epoxidation. Aromatic Non-heterocyclic Ring Cleavage-Hydrolysis, Halogen reaction, Nitro-reduction. Anaerobic degradation of 2,4 D, 2,4,5-T and PCB. Degradation of selected volatile organic compounds in ground water-Chlorinated alkanes-PCE, PCA, TCA, TCE, DCA and CT (biotic, abiotic, aerobic and anaerobic transformations).	**15**
3	Overview of bioremediation strategies**,** Ex Situ versus In Situ Bioremediation**.** Factors affecting bioremediation. In-situ bioremediation- Biosparging, Bioventing, Bioaugmentation (Benefits, Limitation, Process and factors to consider). Ex-situ Bioremediation- Land farming, composting, Biopiles. Bioreactors. Phytoremediation: Types of phytoremediation technologies (phytoextraction, phytostabilization, phytovolatilaztion, rhizodegradation, rhizofilteration).	**15**
4	Use of bacteria fungi and algae in biosorption, Biomineralisation& Bioleaching: Microorganisms involved in Bioleaching of ores, mechanisms of bioleaching, Bioleaching & Metal recovery.Molecular techniques in bioremediation, Role of plasmids in bioremediation, Genetics and gene manipulation: Metagenomics in Bioremediation, Bio-surfactants in bioremediation, Microbial surfactants. Bioremediation of air pollutants-Microbial degradation of contaminants in gas phase, Biofilteration, Biofilter media, Microbial ecology of biofilters.	**15**

Reference Books:

1	Ronal L. Crawford, Don L. Crawford. Bioremediation: Principles and Applications. ISBN: 0521470412.
2	Anthony H. Rose. Microbial Biodeterioration. Academic Press. ISBN: 0125965567.
3	Dennis Allsopp, Kenneth J. Seal, Christine C. Gaylarde. Introduction to Biodeterioration. Cambridge University Press. ISBN 0521528879.
4	Alan Scragg. Environmental Biotechnology. 2nd Edition. Oxford Press. ISBN: 0-19926867-3.
5	Pradipta Kumar Mohaparta. Textbook of Environmental Biotechnology. I. K. International Publishing House Pvt. Ltd. ISBN: 81-88237-54-X.
6	R. Margesin and F. Schinner. Manual of Soil analysis: Monitoring and Assessing Soil Bioremediation. Springer Publishers ISBN: 3540253467.
7	James J. Valdes. Bioremediation Kluwer Academic Publishers ISBN 0792364597.
8	Subhas K. Sikdar and Robert L. Irvine Biodegradation Technology Developments Vol: II, Bioremediation: Principles and practice. CRC Press. ISBN-10: 1566763088.

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Supplementary learning Material:	
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4	https://epathshala.nic.in/

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Feedback
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Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to** explain biodegradation, enzymes involved, degradation of hydrocarbons,	**25**
CO-2	Microbial transformation of pesticides, degradation of woods, degradation of some VOC	**25**
CO-3	Bioremediation of soil and water pollutants	**25**
CO-4	Various bioremediation strategies, bioremediation of air pollutants	**25**

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420105**

Course Title: **Food Biotechnology**

Course Group: **CORE**

Course Objectives: **At the end of this course, the student will be able to:**

1 Opportunities and applications of food biotechnology
2 Probiotics and prebiotics: their significance and guidelines for use
3 Production of genetically modified foods, guidelines for their production and release
4 Application of biotechnology in improving nutritional value of food

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Scope of food biotechnology Food as a substrate Role of Microbes in food Biotechnology – Bacteria, yeasts and moulds Food Spoilage a) General principles underlying food spoilage and contamination. b) Spoilage of canned food,vegetables, fruits, meat and meat products,milk and milk products fish and seafood	15

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2	Food poisoning Food borne pathogens a) Bacterial food borne infections and intoxications- Brucella, Campylobacter, Clostridium, Escherichia (ETEC/EHEC/EPEC/EAEC), Salmonella, Shigella, Listeria and Vibrio b) Non- bacterial food borne infections and intoxications- Protozoa, fungi& viruses	**15**
3	a) Food preservation Principles of food preservation – Physical and chemical preservation methods, Bio preservatives b) Starter cultures for dairy &fermented foods Oriental fermented foods: Shoyu and Tempeh Fermented milk products: Yogurt and Kefir Fermented vegetables – Sauerkraut	**15**
4	Genetically modified foods Food research organizations/institutes in India Food sanitation – Microbiology of food plant sanitation, water and milk testing Food laws and quality control – HACCP, Codex Alimentarius, PFA, FPO, MFPO, BIS, AGMARK.	**15**

Reference Books:

1	Food Microbiology, Frazier and Westhoff
2	Food microbiology, Adam and Moss
3	Dairy Microbiology by Robinson. Volume I and II.
4	Fundamental Food Microbiology, Bibek Ray and ArunBhuniya

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to:** Opportunities and applications of food biotechnology	**25**
CO-2	Probiotics and prebiotics: their significance and guidelines for use	**25**
CO-3	Production of genetically modified foods, guidelines for their production and release	**25**
CO-4	**Application of biotechnology in improving nutritional value of food**	**25**

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420113**

Course Title: **Lab – I (Cell Communication & Cell Signaling and Biodegradation & Bioremediation)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: Cell Communication & Cell Signaling

1	Mitosis preparation
2	Meiosis preparation
3	Histological localization of DNA and RNA
4	Histone protein localization
5	Nucleolus localization
6	Enzyme localization
7	Protein localization
8	Lipid localization
9	PAS reaction for GAG molecules

List of Practicals / Tutorials: Biodegradation & Bioremediation

1	Isolation of hydrocarbon degrading microorganisms.
2	Analysis of Chromium.
3	Analysis of iron.
4	Isolation of metal detoxifying microorganisms.
5	Study of biodegradation of aromatic compounds using TLC.

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6	Decolourization of dye.
7	Study of biofilm: slide immersion tech and staining

Reference Books:

1	Cell Biology: Practical manual by Renu Gupta, Seema makhija& Ravi Toteja (2018) Prestige Publishers ISBN978-81-936512-1-6.
2	Baird, Rodger, and Laura. Bridgewater. 2017. Standard Methods for the Examination of Water and Wastewater. Washington, D.C.: American Public Health Association.
3	CPCB (2008) Guidelines for water quality monitoring. Parivesh Bhawan, Central Pollution Control Board, New Delhi. MINARS/27/2007-08. http://www.cpcb.nic.in/upload/NewItems/New
4	Huang, Y.; Zhou, H.; Zheng, G.; Li, Y.; Xie, Q.; You, S.; Zhang, C. Isolation, and characterization of biosurfactant-producing *Serratiamarcescens* ZCF25 from oil sludge and application to bioremediation. Environ. Sci. Pollut. Res. 2020, 27, 27762–27772.
5	A. Mittal and P. Singh, "Isolation of hydrocarbon degrading bacteria from soils contaminated with crude oil spills," *Indian Journal of Experimental Biology*, vol. 47, pp. 760–765, 2009.
6	Saikia, R.R.; Deka, S.; Deka, M.; Banat, I.M. Isolation of biosurfactant-producing Pseudomonas aeruginosa RS29 from oil contaminated soil and evaluation of different nitrogen sources in biosurfactant production. Ann. Microbiol. 2012, 62, 753–763.

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420114**

Course Title: **Lab – II (Food Biotechnology and Elective Course)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: Food Biotechnology (Core)

1	Microbiological examination of fresh and canned foods
2	Microbiological examination of spoiled foods and fruits.
3	Microbiological examination of milk by Breeds method
4	Microbiological quality testing of milk (MBRT test)
5	Extraction of Mycotoxins from contaminated grains/foods.
6	Detoxification of mycotoxins.
7	Isolation, Screening and Identification of bacterial probiotics like LAB
8	Isolation, Screening and Identification probiotic yeast
9	Microbiological examination of mushrooms

List of Practicals / Tutorials: Plant Biotechnology (Elective)

1	Preparation of MS media for inoculation
2	Micropropogation through nodal explants
3	Callus induction
4	Mass multiplication of banana
5	*Agrobacterium tumefaciens* mediated plant transformation

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6	Protoplast isolation
7	Embryo dissection and culture
8	DNA isolation of plant material

List of Practicals / Tutorials: Microbial Technology (Elective)

1	Production of cellulase enzyme by solid-state fermentation.
2	Saccharification of agro-waste by cellulase enzyme.
3	Bioassay of antibiotics
4	Production of citric acid by submerged fermentation
5	Production of protease by submerged fermentation.
6	Single cell oil production by Yeast
7	Production of Yoghurt
8	Downstream processing of penicillin

List of Practicals / Tutorials: Environmental Chemistry (Elective)

1	Spectrophotometric analysis of nitrate.
2	Spectrophotometric analysis of nitrite.
3	Analysis of ammonia.
4	Determination of sulphate by turbidometric method.
5	Determination of zinc by EDTA complexometic reaction.
6	Analysis of Total Hardness, Ca^{+2} Hardness and Mg^{+2} Hardness.
7	Analysis of Ca^{+2} from egg shell.
8	Analysis of sulfite.

List of Practicals / Tutorials: Clinical Biochemistry (Elective)

1	Preparation of standard solution, molar solution and other reagents
2	Analysis of normal and abnormal urine
3	Estimation of blood /serum glucose by various methods/ GTT
4	Glycosylated Hb, Hb Electrophoresis
5	Estimation Bilirubin, direct, total
6	Estimation of total protein and A/G ratio
7	Electrophoresis of plasma proteins
8	Estimation of total cholesterol and its fractions
9	Estimation of total lipids
10	Estimation of SGPT, SGOT
11	Hormone estimation: Determination of T3 or T4 by ELISA

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Reference Books:

1	Neelima Garg, K.L. Garg, K.G. Mukerji. (2013). Laboratory Manual of Food Microbiology. ISBN: 9789389633023.
2	Ahmed E. Yousef, Joy G. Waite-Cusic, Jennifer J. Perry. (2022). Analytical Food Microbiology: A Laboratory Manual. ISBN: 9780470425114.
3	Shalini Sehgal. (2020). A Laboratory Manual of Food Analysis. ISBN: 9789389633238.
4	S.R. Thimmaiah (2009). Standard Methods of Biochemical Analysis. ISBN: 8176630675 9788176630672
5	Experiments in microbiology, Plant Pathology and Biotechnology, K.R. Aneja New Age International Publishers, New Delhi, ISBN 978-81-224-1494-3
6	Practical Pharmaceutical Analytical Chemistry, Alam MM, Akhtar Mymoona, Husain Asif, Shaquiquzzaman M
7	Text books of Medical Laboratory Technology – Dr. Praful B. Godkar
8	Research articles

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420121**

Course Title: **Plant Biotechnology**

Course Group: **ELECTIVE**

Course Objectives: The student should be able to understand and apply

1 Tools and techniques of plant genetic engineering
2 Molecular biology of nitrogen fixation, nif gene transfer, herbicide resistant plants production
3 Transgenic plants for agriculture and commercial applications
4 Plant tissue culture techniques

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Plant biotechnology present scenario, Micropropogation and its application; Types of different organ culture and its application; Somaclonal variation: Introduction, Different pathways of somaclonal variation; factor affecting of somaclonal variation, Detection of somaclonal variation; Somaclonal variation its application in crop improvement.	15
2	Chloroplast transformation: Structure of chloroplast; Plastid chromosome; Transformation methods-Agrobacterium mediated transformation, Particle gun method, Gene replacement, Gene insertion; Limitation of chloroplast transformation; Application of chloroplast transformation.	15

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3	Secondary metabolite: Role of secondary metabolites, Basic biosynthetic pathways, Techniques used in biosynthesis, Source of secondary metabolites; criteria for cell selection, factor affecting the culture of cells, Different bioreactors and their use in secondary metabolites production, Production of bioactive secondary metabolites by plant tissue culture.	**15**
4	Transgenic plants production: Development of abiotic (Insect, Disease, Herbicide) and biotic (Drought) resistant plants. Peptide production, biodegradable plastic and edible vaccine. DNA barcoding in plants its application.	**15**

Reference Books:

1	An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.
2	Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
3	Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2002
4	Plant biotechnology – J Hammond, et. al., Springer Verlag.
5	Plant cell and tissue culture for production of food ingredients – T J Fu, G Singh, et. al.
6	Biotechnology in crop improvement – H S Chawla.
7	Practical application of plant molecular biology – R J Henry, Chapman & Hall. ¾ Elements of biotechnology – P K Gupta.
8	An introduction to plant tissue culture – M K Razdan.
9	Plant propagation by tissue culture: The technology (Vols. 1 & 2) – Edwin George.
10	Handbook of plant cell culture (Vols. 1 to 4) – Evans et. al., Macmillan. ¾ Plant tissue and cell culture – H E Street, Blackwell Scientific.
11	Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
12	Plant cell culture technology – M M Yeoman.
13	Plant tissue culture and its biotechnological applications – W Bary, et. al., Springer Verlag.
14	Principles of plant biotechnology: An introduction to genetic engineering in plants – S H Mantel, et. al.
15	Advances in biochemical engineering / Biotechnology – Anderson, et. al.
16	Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert& Bajaj Y P S, Springer Verlag.
17	Plant cell and tissue culture – S Narayanswamy, Tata Mc Graw Hill Co.
18	Introduction of plant biotechnology – H.S. Chawla. Third Edition; Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.

Supplementary learning Material:

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4	https://epathshala.nic.in/

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to explain** Tools and techniques of plant genetic engineering	**25**
CO-2	Molecular biology of nitrogen fixation, nif gene transfer, herbicide resistant plants production	**25**
CO-3	Transgenic plants for agriculture and commercial applications	**25**
CO-4	Plant tissue culture techniques	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420122**

Course Title: **Microbial Technology**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student will have understanding of

1. Exploitating microorganisms for industrial product production (primary metabolites)
2. Industrial production of secondary metabolites using microorganisms (e.g. antibiotics)
3. Steroidbiotransformation and ergot alkaloids production, biofuels.
4. Food and dairy products production e.g. Cheese, yoghurt, Beer, Wine.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Scope of Microbial biotechnology. Microbial production and applications of primary metabolites: Citric acid, Ethanol, L-Glutamic acid, Vitamin B_{12} Industrially important microbial enzymes: Types, mode of action and industrial applications of microbial amylases and proteases	15
2	Microbial production of therapeutically important products:- Antibiotics: Penicillin, Streptomycin Ergot alkaloids: Production by Saprophytic cultivation Biotransformations of steroids: Hydroxylation and dehydrogenation, Steroid biotransformations.	15

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3	Production of single cell protein from bacteria, fungi and algae, Characteristics, nutritional value and safety, substrates used, process examples, applications. Cultivation of edible and medicinal mushrooms: Nutritional and medicinal properties Production and applications of microbial exopolysaccharides: Classification, Biological functions, structure and biosynthesis of Xanthan and Alginate, Factors affectingfermentative production of exopolysaccharides and downstream processing(recovery). Production of bioplastics (Polyhydroxyalkonates)	**15**
4	Microbiology and technology of fermented dairy products: Cheese making: Cheese varieties, manufacture of cheddar cheese, Sources andproperties of rennets. Yoghurt making Beer and Wine production	**15**

Reference Books:

1	Biotechnology - Rehm and Reid.
2	Comprehensive biotechnology - Murray Moo Young.
3	Microbial Technology Vol I & II - Henry J. Peppler & D. Perlman
4	Microbiology & technology of fermented foods - Robert W. Hutkins. Blackwell publishing.
5	Modern Industrial Microbiology and Biotechnology 2nd edition - Nduka Okafor, Benedict C. Okeke - (2017, CRC Press).
6	Comprehensive biotechnology. Murray MooYoung, Editor in Chief. Pergamon Press, Oxford, 1985, 4 volume set. Volume 3 — The Practice of Biotechnology: Bulk Commodity Products. Volume Editors - Harvey W. Blanch, Stephen Drew and Daniel I.C. Wang, ISBN 10: 008026204X ISBN 13: 9780080262048
7	Microbial Technology - Second Edition, Volume I - Microbial Processes, Edited by Henry. J. Peppler and D. Perlman, ACADEMIC PRESS, New York San Francisco London 1979. ISBN 0-12-551501-4.
8	Microbial Technology - Second Edition, Volume II - Fermentation Technology, Edited by Henry. J. Peppler and D. Perlman, ACADEMIC PRESS, New York San Francisco London 1979. ISBN 0-12-551502-2 (v. 2) Hardcover ISBN: 9780125515023, eBook ISBN: 9781483268279, Paperback ISBN: 9781483244693
9	Biotechnology: a multi volume comprehensive treatise edited by H. J. Rehm and G. Reed in cooperation with A. Puhler and P. Stadler. – Second edition, completely revised edition. – VCH, (Weinheim) volume 6: Products of Primary metabolism and volume 7: Products of secondary metabolism ISBN 3-527-28310-2.
10	Microbiology and Technology of Fermented Foods, Second Edition, editor- Robert W. Hutkins, Wiley-Blackwell Publishing, ISBN: 978-1-119-02744-7.
11	Modern Industrial Microbiology and Biotechnology, Second edition, editors - Nduka Okafor, Benedict C. Okeke (2017), CRC Press, ISBN 97803677816.

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Pedagogy:
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to explain** Exploitation of microorganisms for industrial product production (primary metabolites)	**25**
CO-2	Industrial production of secondary metabolites using microorganisms (e.g. antibiotics)	**25**
CO-3	Steroid biotransformation and ergot alkaloids production, biofuels.	**25**
CO-4	Food and dairy products production e.g. Cheese, yoghurt, Beer, Wine.	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420123**

Course Title: **Environmental Chemistry**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student should be able to:

1 Structure and composition of atmosphere, greenhouse effect
2 Water cycle, its pollutants, types of reactions in various water bodies
3 Organic and inorganic components of soil
4 Biochemical cycling of elements

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Atmospheric Chemistry and Air Pollution: Chemical processes for formation of inorganic and organic particulate matter, thermochemical and photochemical reactions in the atmosphere.Gaseous pollutants, sources, reactions, control and effects of air pollutants on living and non-living things. Effects of meteorological and topographical factors. Global Climate change: Ozone depletion, Acid Rain and Greenhouse effect. Formation and effects of Photochemical smog.	15
2	Water Chemistry and Water Pollution: Chemistry of Natural Waters, Water resources, hydrological cycle, physical and chemical properties of water, complexion in natural and waste water, role of microorganisms, Water pollutants, Types, Sources, Heavy metals, Metalloids Organic, Inorganic, Biological and Radioactive. Types of reactions in various water bodies including marine environment, Eutrophication and ecological magnification due to water pollution.	15

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3	Biogeochemical cycling of elements:Gaia Hypothesis, The Carbon cycle-Carbon transfer through food webs-Carbon cycling within Habitats-Carbon Monoxide cycling. The Hydrogen Cycle, The oxygen Cycle. The Nitrogen Cycle-Ammonification, nitrification and denitrification. The Sulfur Cycle-Oxidative and reductive sulfur transformation. The phosphorus Cycle, Iron cycle, Manganese Cycle and Calcium Cycle.	**15**
4	Soil chemistry & soil composition: Soil profile: Organic & Inorganic components of soil, Physical and Chemical Properties, cation exchange capacity, soil pH, environmental properties of soils. Leaching and erosion. Reactions with acids and bases. Geochemical reactions that neutralize acidity. Biological Process that neutralize acidity, Pesticide and Polymer Pollution. Physiochemical control of soil pollution.	**15**

Reference Books:

1	Environmental Chemistry, a global perspective. Gary W. Valoon& Stephen J. Duffy, Oxford University Press.
2	Environmental chemistry, B. K. Sharma.
3	Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw-Hill, 1985.
4	M. Arora, Environmental management of toxic and hazardous waste.
5	Tyagi, O. D. and M. Mehra, Text book of Environmental Chemistry.
6	A.K. de. Environmental Chemistry 2000 (4th edition). New age International (P) Ltd., New Delhi, India.
7	Kenneth Wark , Cecil F. Warner, Wayne T. Davis, Air pollution origin and its control work, 3rd Edition, Prentice Hall.
8	R. M. Atlas. (1993) Microbial Ecology Fundamentals and Applications. 4th edition Pearson education Pte. Ltd. ISBN: 81-297-0771-3.
9	Stanley E. Manohar, Environmental Chemistry, Williard Grant press, Beston, Massachutes

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
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Pedagogy:
Direct Classroom teaching
Audiovisual
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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to:** Structure and composition of atmosphere, greenhouse effect	**25**
CO-2	Water cycle, its pollutants, types of reactions in various water bodies	**25**
CO-3	Organic and inorganic components of soil	**25**
CO-4	Biochemical cycling of elements	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **1**

Course Code: **301420124**

Course Title: **Clinical Biochemistry**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student should be able to:

1 Specimen collection, preservation and transportation, composition of various body fluids
2 Acid base balance and disorders, types and functions of carbohydrates
3 Clinical enzymology, haemoglobin
4 General organ function tests

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to clinical biochemistry: Specimen collection, preservation and transportation (blood, urine, spinal fluid, saliva, synovial fluid, amniotic fluid). Chemistry, composition & functions of lymph, CSF, ascitic fluid, pleural fluid & synovial fluid.	15
2	pH and Acid base balance & disorders, Electrolytes balance & imbalance, Blood gases and blood buffers. Types, function and importance of carbohydrates, proteins and lipid, Lipoproteins, Apolipoproteins, Lipoprotein metabolism and disorders.	15

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3	Clinical Enzymology: Principle of diagnostic enzymology, Liver, cardiac and skeletal enzyme, Digestive enzyme, Miscellaneous enzyme. Hemoglobin (Biochemistry, synthesis and breakdown), Hemoglobinopathies, Thalessemia, Bilirubin metabolism, Jaundice, Vandenbergh test.	**15**
4	General Organ function tests: Liver function tests, , Thyroid function tests, Pancreatic function tests, Cardiac Function Test. Biochemistry of Diabetes mellitus, Atherosclerosis, Fatty liver, and obesity.	**15**

Reference Books:

1	Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R. Ashwood, Harcourt Brace & Company AisaPvt. Ltd. ISBN-13: 978-0721656106
2	Commercial Biosensors: Graham Ramsay, John Wiley & Son, INC. (1998). ISBN-13: 978-0-471-58505-3
3	Essentials of Diagnostic Microbiology, Lisa Anne Shimeld.
4	Diagnostic Microbiology, Balley& Scott's. Eleventh Edition. ISBN 0-323-01678-2
5	Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 4th Edition By Carl A. Burtis, Edward R. Ashwood, and David E. Bruns, - ISBN -9780721601892
6	The Science of Laboratory Diagnosis, Crocker Burnett. ISBN 1899066624
7	Text books of Medical Laboratory Technology – Dr. Praful B. Godkar
8	Henry's Clinical Diagnosis and Management by Laboratory Methods 2 Richard McPherson Matthew Pincus ISBN: 978-1-4160-0287-
9	Biochemistry for medical students: Vasudeven andShreekumar Jay pee prakashan.
10	Practical Clinical biochemistry by Harold verly
11	Text book of medical biochemistry by- Chatterjea and Rana Shinde

Supplementary learning Material:	
1	https://nptel.ac.in/
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Pedagogy:
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to:** Specimen collection, preservation and transportation, composition of various body fluids	**25**
CO-2	Acid base balance and disorders, types and functions of carbohydrates	**25**
CO-3	Clinical enzymology, haemoglobin	**25**
CO-4	General organ function tests	**25**

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Drafted on (Month-Year):	June 2022
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Next Review on (Month-Year):	April 2023

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Faculty Name: Science

Programme Name: M. Sc. Biotechnology (Industrial Biotechnology)

Semester: 2 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Biological Science		Industrial Waste Management	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science		Bioprocess Engineering and Technology	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science		O'-mics	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science		Lab – I (Industrial Waste Management and Bioprocess Engineering and Technology)	4		8		8		P		3			50/20	50/20	100/40
Core	Biological Science		Lab – II (O'-mics and Elective Course)	4		8		8		P		3			50/20	50/20	100/40
Elective (Any One)	Biological Science		Animal Biotechnology	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science		Bioseparation Technology	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science		Protein Engineering	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science		Environment Policy and Legislation	4	3		1	4	T		2		50/20	50/20			100/40
Viva-Voce	Biological Science		Comprehensive Viva	1												50/20	50/20
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]:

Name & Sign [Dean / Director]:

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Industrial Waste Management**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able to understand

1. Waste water management
2. Aerobic and anaerobic biological treatment process
3. Paper pulp, dairy and textile industry

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Wastewater management:** Types and sources of water pollutants, Methods for measurement of water pollutants: BOD, COD, coliforms, biotechnological methods used for monitoring of pollutants. Wastewater treatment methods: Primary: Screening, grit removal, floatation tank, coagulation, flocculation, sedimentation. Secondary treatment methods: Biological treatment methods examples of attached and suspended techniques. Tertiary treatment methods: Nutrients removal, advanced oxidation processes and sludge treatment methods.	15

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2	**Aerobic Biological Treatment Processes:** Process fundamentals Methods of aeration, design considerations, Operational difficulties. Description, design and operation of aerobic treatment systems: Activated Sludge process, Trickling Filters, Waste stabilization ponds. **Anaerobic Biological Treatment Processes:** Description, design and operation of attached and suspended growth processes: Anaerobic digestion, up flow anaerobic sludge blanket reactors (UASB), Septic tank. **Solid Waste Management**: Composting.	**15**
3	**Biomedical waste management**: Introduction, Types of biomedical waste, sources of biomedical wastes, Hazardous biomedical wastes. Waste segregation and labeling, Handling, Collection, Storage and transportation. **Hazardous Waste management:** Definition, sources, characteristics and categories of hazardous wastes. Toxicology and Risk Assessment, Environmental Fate of Hazardous Materials. Hazardous waste collection and transportation. Hazardous waste treatment technologies: Physical, chemical.	**15**
4	Dairy: General Characteristics of Dairy Wastewaters and Treatment of Dairy Effluent Wastewater. Paper Pulp: Problems Related with Pulp and Paper Industry. Textile industry: Characterization of textile industrial wastewater, Treatment Technologies of textile industrial effluents. Tanning Industry: Characterization of Effluents, Environmental Impact of Tannery Effluents. Pharmaceutical Industry: Characterization of effluents, treatment technologies for pharmaceutical effluents.	**15**

Reference Books:

1	Clesceri LS. Greenberg AE, Eaton AD. (2004) Standard methods for examination of water &wastewater. American Public Health Association.
2	Gabriel Bitton. Wastewater Microbiology. 3rd edition, A John Wiley & Sons, INC., Publication. ISBN: 0-471-65071-4.
3	Metcalf and Eddy Inc. (1979) Wastewater Engineering treatment, Disposal, Reuse. Tata McGraw Hill Publication. Co. Ltd.
4	Soli J. Arceivala. Wastewater treatment for pollution control. 2nd edition, Tata-McGrawHill Publishing Company Limited. ISBN: 0-07-463002-4. 11. M. N. Rao and A. K. Datta. Wastewater Treatment. ISBN: 8120402154.
5	Hazardous wastes: Sources Pathways Receptors by Richard J. Watts ISBN: 9780471002383.
6	Criteria for hazardous waste landfills – CPCB guidelines 2000.
7	Anantpreet Singh and Sukhjit Kaur. (2012). Biomedical Waste Disposal. Jaypee Brothers Medical Publishers. ISBN: 978-93-5025-554-4.
8	Indu Shekhar Thakur. Environmental Biotechnology Basic concepts and applications. IK International Pvt, Ltd. ISBN 81-88237-52-3.
9	M. N. Rao and A. K. Datta. Wastewater Treatment. ISBN: 8120402154.

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Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will have proper understanding of:** Waste water management	**25**
CO-2	Aerobic and anaerobic biological treatment process	**25**
CO-3	Biochemical and Hazardous Waste management	**25**
CO-4	Paper pulp, dairy and textile industry	**25**

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Bioprocess Engineering & Technology**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able to:

1 Design a fermenter and media for industrial fermentations
2 Sterilization of media and air, microbial growth kinetics
3 Components of Aeration and agitation, scale up and scale down, Control systems
4 Downstream processing

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to Bioprocess technology- History of fermentation, Range of fermentation processes, Chronological development of fermentation industry, Introduction of types of fermentation processes. Isolation, primary and secondary screening, preservation, maintenance and improvement of Industrially important organisms.	15
2	Media for industrial fermentation: Components of medium, Addition of precursor and Metabolic regulators to media, Media optimization by conventional and statistical methods (Plackett-Burman design, Response surface method) Sterilization of media and air: Kinetics of medium sterilization, Design of batch sterilization process, Scale up of batch sterilization process, Design of continuous sterilization process, Sterilization of air by filtration, Theory and design of depth filters	15

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3	Bioreactor design: Laboratory, pilot and large-scale reactors. Mechanical, pneumatic and Hydrodynamic systems. Plug flow reactors, immobilization and immobilized enzyme reactors. Scale up and Scale down and Aseptic operations &containment. Components of Agitation and aeration. Inoculum development.	**15**
4	Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and Continuous fermentation systems. Control of process parameters: Instrumentation for monitoring bioreactor and fermentation processes, Sensors, Controllers, fermentation control systems and architecture, Incubationand sequence control, advanced control.	**15**

Reference Books:

1	Principles of Fermentation Technology, 3 rd edition by Peter F Stanbury, Allan Whitaker, Stephen J Hall. Butterworth-Heinemann is an imprint of Elsevier (2016) ISBN: 978-0-08-099953-1
2	Comprehensive biotechnology. Murray MooYoung, Editor in Chief. Pergamon Press, Oxford, 1985, 4 volume set. Volume Editors - Harvey W. Blanch, Stephen Drew and Daniel I.C. Wang, ISBN 10: 008026204X ISBN 13: 9780080262048.
3	Methods in Industrial Microbiology by Bohumil Sikyta. Ellis Horwood Publisher (1983). ISBN 10:0853122032, 13:9780853122036.
4	Fermentation Microbiology and Biotechnology 2 nd Edition by E.M.T. El-Mansi, C.F.A. Bryce, Arnold L. Demain, A.R. Allman. CRC Press (2006) ISBN 13:978-0-8493-5334-5.
5	Modern Industrial Microbiology and Biotechnology 2 nd edition by Nduka Okafor, Benedict C. Okeke. CRC Press (2017) ISBN 13:978-1-1385-5018-6.
6	Industrial Microbiology: An Introduction – Mickael J. Waites, Neil L. Morgan, John S. Rockey & Gary Higton. Blackwell Science Ltd. ISBN 0-632-05307-0.
7	Upstream Industrial Biotechnology Volume 1_ Expression Systems & Process Development & Volume 2_ Equipment, Process Design, Sensing, Control, and cGMP Operations by Michael C. Flickinger. John Wiley & Sons, Inc., Hoboken, New Jersey ISBN 978-1-118-13123-7

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Direct Classroom teaching
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Assignments/Quiz
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Interactive participating methods Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should have knowledge about** Design of fermenter, media for industrial fermentations	**25**
CO-2	Sterilization of media and air, microbial growth kinetics	**25**
CO-3	Components of Aeration and agitation, scale up and scale down, Control systems	**25**
CO-4	Downstream processing	**25**

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **O'-mics**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able to tell about

1 Genome and proteome, DNA microarray
2 Human genome project, Large scale sequencing methods, some model organisms and their genome projects
3 Protein structure and function, Methods to study protein-protein interactions
4 Concept development about transcriptomics and metabolomics

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to the proteome and the genome, codon bias, gene expression, Genome size-C value paradox, DNA sequencing: Maxam-Gilbert, Sanger, Pyrosequencing, automated DNA sequencing. Other features of nucleic acid sequencing. Analysis and Annotation-ORF, Exon-intron boundaries	15
2	Human genome project- Strategies for large-scale sequencing projects; landmarks on chromosomes generated by various mapping methods; BAC libraries and shotgun libraries preparation; Physical map-cytogenetic map, contig map, restriction map. Model organisms and other genome projects (*Arabidopsis, Caenorhabditiselegans*); Comparative genomics of relevant organisms such as pathogens and non-pathogens	15

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3	Relationship between protein structure and function, Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting; Mass spectrometry: ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detector. Protein interaction maps. Protein arrays-definition, applications- diagnostics, expression profiling.	**15**
4	DNA Microarray technology: The generation of cDNA expression libraries, their robotic arraying, Complex hybridization on DNA chips. Transcriptomics: Comparative transcriptomics, Differential gene expression; Genotyping/SNP detection; Detection technology; Computational analysis of microarray data.	**15**

Reference Books:

1	Discovering Genomics, Proteomics and Bioinfo, A,M, Campbell, C,S,H, Press, (2003). ISBN
2	Essential of Genomics and Bioinformatics C,W, Sensen, Wiley (2003), ISBN (Print), 3
3	Hand book of Comparative Genomics: Principle and Methodology by Cecilia Saccone, Graziano Pesole, Wiley
4	Proteomics : From protein sequencing to function by S.R. Pennington and M.J. Dunn,Viva Books, Private Ltd (2001) ISBN
5	Introduction to Proteomics by Daniel C, Liebler, Humana Press ISBN
6	Discovering Genomics, Proteomics and Bioinfo, A,M, Campbell, C,S,H, Press, (2003). ISBN
7	Principles of Gene Manipulation and Genomics by Primrose
8	Genetics & Genomics By Csaba Szalai
9	Proteomics : From protein sequencing to function by S.R. Pennington and M.J. Dunn
10	Introduction to genomics by Arthur M Lesk

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Direct Classroom teaching
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will clear understanding of** Genome and proteome, DNA microarray	**25**
CO-2	Human genome project, Large scale sequencing methods, some model organisms and their genome projects	**25**
CO-3	Protein structure and function, Methods to study protein-protein interactions	**25**
CO-4	Concept development about transcriptomics and metabolomics	**25**

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Lab – I (Industrial Waste Management and Bioprocess Engineering & Technology)**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able to understand

1. Waste water management
2. Aerobic and anaerobic biological treatment process
3. Paper pulp, dairy and textile industry

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: Industrial Waste Management

1	Determination of Dissolved oxygen
2	Determination of BOD of sewage
3	Determination of COD sewage
4	Estimation of Total Solids (TS)
5	Estimation of Total Suspended Solids (TSS)
6	Estimation of Total Dissolved Solids (TDS)
7	Estimation of MLSS/MLVSS
8	IMViC tests.
9	Routine Bacteriological analysis of water: a. Tests for coliforms: Presumptive test, Confirmatory test and Completed test.
10	Determination of MPN of coliform.
11	Field trip to a wastewater treatment plant.

List of Practicals / Tutorials: Bioprocess Engineering & Technology

1	Screening for amylase producing organisms
2	Screening for organic acid producing microorganisms
3	Isolation of antibiotic producing microorganisms by crowded plate technique

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4	Isolation and culturing of yeasts
5	Separation of amino acids by chromatography
6	Estimation of glucose by DNS method
7	Estimation of ethanol by dichromate method
8	Immobilization of microbial cells by entrapment method

Reference Books::	
1	Experiments in microbiology, Plant Pathology and Biotechnology, K.R. Aneja New Age International Publishers, New Delhi, ISBN 978-81-224-1494-3.
2	Microbiological Techniques by N, Murugalatha, lali Growther, J. Vimalin Hena, N. Hema Shenpagam, R. Anitha, D. Kanchana Devi, G. Rajalakshmi, ISBN: 9788180941078.
3	Experimental Microbiology Vol. 1 and Vol. 2 by Rakesh Patel.
4	Microbiological Techniques, N Murugalatha, Lali Growther, J Vimalin Hena, N Hema Shenpagam, R Anitha , D Kanchana Devi, G Rajalakshmi - MJP PUBLISHERS (2019)
5	Baird, Rodger, and Laura. Bridgewater. 2017. Standard Methods for the Examination of Water and Wastewater. Washington, D.C.: American Public Health Association.
6	Maiti SK (2007) Handbook of methods in environmental studies. Water and wastewater analysis, vol I. ABD Publication, Jaipur.
7	CPCB (2008) Guidelines for water quality monitoring. PariveshBhawan: Central Pollution Control Board, New Delhi. MINARS/27/2007-08.
8	Experiments in microbiology, Plant Pathology and Biotechnology, K.R. Aneja New Age International Publishers, New Delhi, ISBN 978-81-224-1494-3
9	Microbiological Techniques by N, Murugalatha, laliGrowther, J. VimalinHena, N. Hema Shenpagam, R. Anitha, D. Kanchana Devi, G. Rajalakshmi, ISBN: 9788180941078
10	Experimental Microbiology Vol. 1 and Vol. 2 by Rakesh Patel
11	Research articles

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Lab – II (O'-mics and Elective Course)**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able to understand

1. Waste water management
2. Aerobic and anaerobic biological treatment process
3. Paper pulp, dairy and textile industry

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: O-mics (Core)

1	Introduction to genome sequence databases
2	Protein and DNA sequence databases
3	Designing a primer
4	Total Protein profile of plant system using PAGE.
5	Determination of molecular weight and quantitation of separated proteins.
6	Demonstration of 2D gel electrophoresis

List of Practicals / Tutorials: Animal Biotechnology (Elective)

1	Introduction of animal tissue culture laboratory with necessary equipment and accessories.
2	Preparation of culture media
3	Sterilization of culture media
4	Primary culture from Chick embryo.
5	Cell counting using hemocytometer.
6	Cell viability

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7	Organ culture – trachea culture
8	Short term lymphocyte culture.
9	Chromosome preparation from cultured cells.
10	Cytotoxicity test-MTT

List of Practicals / Tutorials: Bioseparation Technology (Elective)

1	Determination of dry weight and wet weight of cells
2	Determination of total protein of cells by alkali lysis
3	Recovery and estimation of penicillin
4	Ammonium Sulphate fractionation of protein
5	Dialysis of fractionated proteins
6	Recovery of protein by acetone precipitation
7	Demonstration of chromatography techniques

List of Practicals / Tutorials: Protein Engineering (Elective)

1	To perform protein extraction.
2	Determine an importance of various electrophoresis techniques in protein engineering.
3	A study an application of liquid chromatographic technique.
4	To understand the importance of gas chromatographic techniques with demonstration.
5	Understanding of principles and applications of MALDI-TOF and SELDI TOFF

Practicals / Tutorials: Environment Policy and Legislation (Elective)	
1	Bio-ethanol production from waste materials.
2	Production of biodiesel from vegetable oil.
3	Production of biofuel from algae.
4	Physico-chemical analysis soil.
5	Isolation of *Actinomyctes* from soil.
6	Demonstration of Lab scale biogas production plant.
7	Saponification value of an oil sample

Reference Books:

1	"Bioinformatics For Beginners: A Laboratory Manual" by Department Of Computer Science PSGR, Published by Blue Hill Publishers. (ISBN: 9788193708828)
2	"Bioinformatics: A Practical Guide to theAnalysis of Genes and Proteins"by Andreas D. Baxevanis;Published by A John Wiley & Sons, Inc., Publication(ISBN: 0471383902)
3	"Essential Bioinformatics" by Jin Xiong; Published by Cambridge University Press.(ISBN:978-0521600828)
4	"Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology" by Michael C Flickinger; Published by A John Wiley & Sons, Inc., Publication. (ISBN: 9780471799306)

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5	"Bioseparations Downstream Processing for Biotechnology" by Paul A Belter and E L Cussler; Published by Wiley India Pvt Ltd. (ISBN: 9788126531974)
6	"Downstream Processing and Bioseparation: Recovery and Purification of Biological Products" by Jean-François Hamel and Subhas K Sikdar, Published by ACS publications. (ISBN: 9780841217386)

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	September 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Animal Biotechnology**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student Should be able to:

1 Understand the scope of Animal Biotechnology
2 Basic techniques in animal cell culture
3 Applications of animal tissue culture
4 Techniques for producing transgenic animals

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	• Introduction and scope of Animal Biotechnology • Basic requirements for animal tissue culture: Infrastructure, necessary equipments and accessories for animal tissue culture lab. • Culture Media: Different types of media-Natural media, Defined media, Serum free media Chemical, physical and metabolic functions of different constituents of culture media. • Role of serum in tissue culture media • Sterilization techniques • Biohazards and Bioethics	15

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2	• Biology and characterization of cultured cells • Basic techniques of animal cell culture: Primary culture techniques, • Enzymatic and mechanical disaggregation techniques • Sub culture methods • Development of cell lines, nomenclature and types of cell lines. • Explant culture, Organ culture – 3Dimensional culture • Large scale culture of cells-suspension and monolayer culture • Cell separation methods • Cell cloning • Transformation and immortalization	**15**
3	• Application of animal tissue culture • Contaminants- source, types and prevention • Cell viability Cytotoxicity assays • Cryopreservation of cultured cells • Hybridoma technology – production of MAbs. • Vaccine Production	**15**
4	• Transgenic Animal Technology: • Techniques for producing transgenic Animals, • Application of transgenic animals • Artificial animal breeding, Artificial insemination, • In vitro fertilization (IVF), Embryo Transfer, Embryo sexing • Tissue Engineering- scaffold materials, synthesis of scaffold, cell sources and applications of Tissue engineering	**15**

Reference Books:

1	Culture of animal cells: A manual of basic technique- R. Ian Freshney, Wiley Publication.
2	Animal cell culture &technology-M. Butler.
3	Animal cell culture techniques- M. Clynes, Springer.
4	Animal Biotechnology- M. M. Ranga. Agrobios (India).
5	Animal Biotechnology-Young, Murray, Moo. Pergamon Press, Oxford.
6	Methods in Cell Biology-Vol. 57, Animal cell culture methods- Mather, J.P., Academic Press.
7	Animal Cell Biotechnology-Spier, R.E. Academic press.
8	Animal biotechnology – P. Ramadass, MJP Publishers
9	Biotechnology- U.Styanarayan, Books and Allied (P) Ltd.

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/

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4	https://epathshala.nic.in/

Pedagogy:
Direct Classroom teaching Audiovisual Assignments/Quiz Feedback Interactive participating methods Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	**At the end of this course, the student will have clear understanding of** The scope of Animal Biotechnology	**25**
CO-2	Basic techniques in animal cell culture	**25**
CO-3	Applications of animal tissue culture	**25**
CO-4	Techniques for producing transgenic animals	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Bioseparation Technology**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student should be able to

1. Understand about various downstream processing
2. Product isolation and purification methods
3. Final Product Purification and Preparation

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to downstream processing, Characteristics of fermentation broth and its pretreatment, Separation of cells and suspended solids: Filtration: theory of filtration, use of filter aids, Batch filters, Continuous filters, cross flow filtration. **Membrane processes** – Dialysis, ultrafiltration, Reverse osmosis and electrodialysis	15
2	**Product isolation methods:** Centrifugation: Cell aggregation and flocculation, Types of commercial centrifuges Cell disruption by physical and chemical methods, Liquid-liquid extraction-choice of solvent, co current and counter current extraction, Centrifugal extractor, Solvent recovery, Two-phase aqueous extraction system, super criticalfluid extraction.	15

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3	**Chromatography techniques for product isolation and purification:** Adsorption chromatography, Gel permeation chromatography, Ion-exchange chromatography, hydrophobic chromatography, Affinity chromatography, High performance chromatography (HPLC). FPLC, Expanded bed chromatography	**15**
4	**Final Product Purification and Preparation** Crystallization; Drying and lyophilisation; Formulation Strategies Case studies: Recovery of Ethanol, Citric acid, Penicillin.	**15**

Reference Books:

1	Principles of Fermentation Technology – Peter F. Stanbury, Allan Whitaker and Stephen J. Hall.
2	Fermentation Microbiology and Biotechnology – E.M.T. El-Mansi and C.F.A. Bryee.
3	Comprehensive Biotechnology – Murray Moo Young
4	Biochemical Engineering Fundamentals – J.E.Bailey& D.F. Ollis.
5	Downstream industrial biotechnology : recovery and purification / edited by Michael C. Flickinger

Supplementary learning Material:	
1	https://nptel.ac.in/
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Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	**At the end of this course, the student will have clear understanding of** Various downstream processing	**25**
CO-2	Product isolation and purification methods	**25**
CO-3	Chromatographic techniques	**25**

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CO-4	Final Product Purification and Preparation	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Protein Engineering**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student should have clear understanding of :

1. Different tools and methods used in proteomic study.
2. The sources of protein, Industrial and medical application of proteins,
3. Different expression of proteins for large scale purifications,
4. Protein engineering strategy.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Proteomics: Sample preparation, Gel-based proteomics - two-dimensional gel electrophoresis (2-DGE), two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Staining methods, PF-2D, Tandem FPLC, Mass spectroscopy: basic principle, ionization sources, mass analyzers, different types of mass spectrometers (MALDI-TOF Q-TOF, LC-MS)	15
2	Multidimensional proteomics: SELDI-TOF. Quantitative proteomics - stable isotope labeling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Label-free proteomics., Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spinspin interaction, NOE, 2D-NMR, NOESY, COSEY.	15

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3	X-ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.	**15**
4	Protein Engineering: Protein sources, Industrial and medical application of proteins, different expression of proteins for large-scale purifications, protein engineering strategy, rational and random mutagenesis. Applications of protein engineering protein in Chemical and Medical Industries: Generation of heat stable, pH stable enzymes, application in vaccine development, drug development, sensor development. Practicals, Protein electrophoresis-1D+2D, HPLC, FPLC, MALDI-TOF & LC-MS	**15**

Reference Books:

1	Principles of Protein X-Ray Crystallography *[3rd ed.]* by Jan Drenth
2	Protein engineering in industrial biotechnology by L Alberghina,Net Library, Inc.
3	Protein Engineering Protocols *[1 ed.]* by Kristian Müller,Katja Arndt
4	Protein Engineering by C Kohrer, U Rajbhandary
5	Protein Engineering Handbook Volume 3 *[1 ed.]* by Stefan Lutz, Uwe Theo Bornscheuer
6	Protein Engineering by P. Kaumaya
7	Protein Structure Prediction: Methods and Protocols by Webster, David (Southern Cross Molecular Ltd., Bath, UK)
8	Essential Bioinformatics by JinXiong

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/

Pedagogy:
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Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will have clear understanding of** Different tools and methods used in proteomic study.	**25**
CO-2	The sources of protein, Industrial and medical application of proteins,	**25**
CO-3	Different expression of proteins for large scale purifications,	**25**
CO-4	Protein engineering strategy	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **2**

Course Code: **To be given by the University**

Course Title: **Environment Policy and Legislation**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student should have knowledge about

1. Legal structure of India and fundamentals of environmental legislation and policy making.
2. Understand the environmental performance including compliance with environmental legislation.
3. Implementation of environmental policies and practices and raise awareness about the emerging environmental issues.
4. Study of various acts, laws and rules related to air, water, environment and wastes in India

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**International Law and Environmental Protection:** Fundamental Principles of International Environmental Law. United Nations Conference on Human Environment, 1972 (Stockholm Conference) – Aims and Objectives of the Conference, Stockholm Declaration. UNEP- Vienna Convention & Montreal Protocol, World Charter for Nature, 1982. WCED – The Brundtland Commission, Brundtland Report 1987. United Nations Conference on Environment and Development (UNCED/Earth Summit) – Aims and Objectives of Conference, Rio Declaration 1992, Agenda 21, Convention on Biological Diversity. Earth Summit Plus Five - Kyoto Protocol, 1997; Millennium Development Goals. Johannesburg Conference 2002 (WSSD) - Johannesburg Declaration & Major Outcomes.	15

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2	**History and Development of Environmental Law in India:** Environmental Protection in Ancient Indian Tradition and Culture - Protection of Environment in Ancient India and During Medieval Period. Protection of Environment during British Period – Major Legislations. Protection of Environment during Post Independence Period – Pitambar Pant Committee, Tiwari Committee, NCEP, Department of Environment, MOEF Guidelines and Notifications, Appellate Authority Act, Other related Notifications.	**15**
3	**Protection of Environment under the Indian Constitution:** Introduction – Indirect Provisions, International Obligations, 42nd Constitution Amendment Act, 1976. Directive Principles of State Policy - Fundamental Duties. Development of Fundamental Right to Environment - Judicial Role, Expansion of Locus Standi, PIL, Constitutional Remedy for Protection of Environment, Dynamic Interpretation of Article 21, 14 & 19 of the Constitution. Right to Wholesome Environment – Right to Clean and Pollution-free Environment, Right to Sweet Water. Incorporation of International Principles under Indian Constitution – Sustainable Development - Precautionary and Polluter Pays Principles, Absolute and Strict Liability.	**15**
4	**Protection of Water, Air and Environment in India:** EP Act 1986, Air (Prevention and Control of pollution) Act, Water (Prevention and Control of pollution) Act, Mines and Mineral Act, Factories Act, Pesticides Act, Indian Forest Act, Wildlife Act, Ancient Monuments and Archaeological Sites and Remains Act, Hazardous Waste Management and Handling Rules / Biomedical Rules / Solid Waste Management Rules, Environment Tribunal Act, Climate change Protocols and Conventions	**15**

Reference Books:

1	S.C. Shastri, *Environmental Law,* (3rd Edition.), Eastern Book Company, Lucknow, 2008.
2	MaheshwaraSwamy, *Textbook on Environmental Law,* (2ndEdition.), Asia Law House, Hyderabad, 2008.
3	Shyam Divan and Armin Rosencranz, *Environmental Law and Policy in India,* Oxford University Press, New Delhi, 2005.
4	Amod S. Tilak, *Environmental Law,* (1stEdition.), Snow White Publication, Mumbai, 2009.
5	I.A. Khan, *Environmental Law,* (2ndEdition.), Central Law Agency, Allahabad, 2002.
6	P Leelakrishnan, *Environmental Law in India,* (2ndEdition.), Lexis Nexis, New Delhi, 2005.
7	S. Shantakumar, *Introduction to Environmental Law,* (2ndEdition.), Wadhwa& Company, Nagpur, 2005.

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
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4	https://epathshala.nic.in/

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Pedagogy:
Direct Classroom teaching Audiovisual Assignments/Quiz Feedback Interactive participating methods Seminar presentation

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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should be clear about** Legal structure of India and fundamentals of environmental legislation and policy making.	**25**
CO-2	Understand the environmental performance including compliance with environmental legislation	**25**
CO-3	Implementation of environmental policies and practices and raise awareness about the emerging environmental issues	**25**
CO-4	Study of various acts, laws and rules related to air, water, environment and wastes in India	**25**

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Faculty Name: Science

Programme Name: M. Sc. Biotechnology (Industrial Biotechnology)

Semester: 3 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Biological Science		Drug Design and Development	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science		Material Balance, Mass Transfer and Transport Process	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science		Metabolic Engineering	4	3		1	4	T		2		50/20	50/20			100/40
Core	Biological Science		Lab – I (Drug Design and Development and Material Balance, Mass Transfer and Transport Process)	4		8		8		P		3			50/20	50/20	100/40
Core	Biological Science		Lab – II (Metabolic Engineering and Elective Course)	4		8		8		P		3			50/20	50/20	100/40
Elective (Any One)	Biological Science		Environmental Engineering	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science		Nanobiotechnology & Applications	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science		Cancer Genetics	4	3		1	4	T		2		50/20	50/20			100/40
	Biological Science		Validation, Documentation and cGMP	4	3		1	4	T		2		50/20	50/20			100/40
Viva-voce	Biological Science		Comprehensive Viva-Voce	1												50/20	50/20
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]:

Name & Sign [Dean / Director]:

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Drug Design and Development**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able to identify

1 Approaches to find drug targets
2 Protein and receptors as drug targets
3 Drug design and optimizing homology model
4 Preclinical and clinical study, regulatory affairs

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Finding a target:** Choose a disease, finding a target, Identify a bioassay, Find a lead compound, Identify the pharmacophore, determine the structure of the lead compound	15
2	**Protein as – drug target** Protein – drug interaction (viz. Intramolecular bonding forces), Drug action at protein, Peptide or protein as drugs, Monoclonal antibodies in medicinal chemistry, Enzymes as – drug target : Enzymes as catalyst, The active sites of an enzymes, Substrate binding at active sites, The catalytic role of enzymes, Regulations of enzymes, Isoenzymes, Enzymes inhibitors and Enzymes kinetics and case study. **Receptor as – drug target:** Introduction to receptor & Receptors role, Neurotransmitter and hormones, Change in the shape, Design of agonist, antagonist	15

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3	**Drug Design and optimizing homology modelling** Identify structure – activity relationship (SARs), Binding role of various functional groups,Strategies in drug design, Improve absorption, Making drugs less resistant to drug metabolism, Targeting drugs, Reducing toxicity, Prodrug, Drug alliances, Endogenous compounds as a drug.	**15**
4	**Drug Development** Preclinical and clinical study, Patenting and regulatory affairs, Chemical and process development, Design a manufacturing process, Register and market the drug.	**15**

Reference Books:

1	An Introduction to Medicinal Chemistry; G.L. Patrick, 2nd Ed., Oxford University Press, ISBN 0-19-850533-7
2	Wilson and Gisvold's Textbooks of Organic Medicinal and pharmaceutical chemistry, 11th edition, by John H. Block and John M. Beale Jr.
3	Foye's Principles of Medicinal Chemistry, 5th edition, by David A. Williams and Thomas L. Lenke.
4	Medicinal chemistry – A biochemical Approach – Oxford University Press, New York, Oxford by T. Nogradyedey.
5	Medicinal Chemistry, Principles and Practice; Ed. F.D. King, Royal Society of Chemistry, 1994,
6	Introductory Medicinal Chemistry; J.B. Taylor and P.D. Kennewell, Ellis Horwood, John – Wiley &Sons, New York.
7	Burger's Medicinal Chemistry & drug Discovery, 5th edition, 1997, Volume – 1, 2,3,4,5 – edited by Manfred E. Wolff, John – Wiley & Sons, New York, ISBN 0-417-27090-3.

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will have clear understanding of different** Approaches to find drug targets	**25**
CO-2	Proteinand receptors as drug targets	**25**
CO-3	Drug design and optimizing homology model	**25**
CO-4	Preclinical and clinical study, regulatory affairs	**25**

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Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M.Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Material Balance, Mass Transfer & Transport Process**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should have

1. Ability to solve problems involving reaction stoichiometry.
2. Ability to solve problems involving mass transfer due to diffusion, chemical reaction, and convection]
3. Ability to size some basic heat and mass transfer equipment
4. Ability to apply engineering judgment including an appreciation of cost and safety
5. Ability to solve mass transfer problems involving biological and environmental systems

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Mole concept:** Matter and Its nature, concept of atom, molecules, element and compounds, Laws of chemical combination Unit& dimension, conservation of Mass & Energy. Atomic weight, equivalent weight and molecular weight. Mathematical problems	15
2	**Stoichiometry:** Mole concept, Molar Masses, Percentage Yield and percentage composition, empirical & molecular formula. Chemical equation and reaction stoichiometry. Mathematical problems	15

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3	**Material balances:** Introduction, Process classification, Balance equation. Balance on continuous steady state process, Integral process. Material balance for unit operations like absorption, distillation, extraction, drying and evaporation. Humidification operation	**15**
4	**Energy balances and heat Transfer:** Definition, forms of energy, Transfer of energy, First law of Thermodynamics, Kinetic energy equation, Energy balance in open, close and reactive system, Fundamentals of Heat transfer, Different mode of Heat Transfer Mathematical problems	**15**

List of Practicals / Tutorials: Material Balance, Mass Transfer & Transport (Elective)

1	Determination of K_La by sulphite oxidation method.
2	Ethanol production, distillation and estimation for percentage product yield estimation.
3	Citric acid fermentation and its estimation.
4	Fermentation time profile with respect to Glucose consumption and biomass formation by Yeast / Bacteria.
5	Determination of purity of fermentation products on the basis of its physical properties (Boiling point/Melting point, Density/Specific gravity, Viscosity etc.)

Reference Books:

1	Basic Principles & Calculations in Chemical Engineering, D.M.Himmelblau.,6th Ed., 2004
2	Stoichiometry, B.I.Bhatt&Thakore, Tata McGraw Hill Book Company, 5th Ed,2010
3	Chemical Process Principles, Vol.1, O.A.Hougen, K.M.Watson, R.A.Ragatz., Indian print, CBS Publishers,2nd Ed., 1995
4	Stoichiometry & Process Calculations, Narayanan K.V., &Lakshmikutti B., Prentice Hall, 2006
5	Process Calculations, V Venkataramani and N Anantharaman, PHI Learning, 2004
6	Chemical Process Calculations Manual, David CarrIgbinoghene, McGraw Hill Professional,2004
7	Optimization of Chemical Processes, T F Edgar, D M Himmelblau and L S Lasden, Tata McGraw Hill, 2001
8	Bioprocess Engineering Principles, Second Edition, Pauline M. Doran - Academic Press (2012)
9	Biochemical Engineering Fundamentals, James E. Bailey, David F. Ollis - McGraw-Hill Education (1986)

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching

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Audiovisual Assignments/Quiz Feedback Interactive participating methods Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should have knowledge about** Ability to solve problems involving reaction stoichiometry and mass transfer due to diffusion, chemical reaction, and convection	**25**
CO-2	Ability to size some basic heat and mass transfer equipment	**25**
CO-3	Ability to apply engineering judgment including an appreciation of cost and safety	**25**
CO-4	Ability to solve mass transfer problems involving biological and environmental systems	**25**

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Metabolic Engineering**

Course Group: **CORE**

Course Objectives: At the end of this course, the student should be able know:

1 Metabolic regulation and its modification, enzyme kinetics
2 Metabolic flux balance analysis
3 Metabolic engineering strategies for production of PHA, solvents.
4 Metabolic engineering of yeast for substrate utilization, bioinformatics for reconstruction of metabolic network

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Overview of metabolism and its regulation;** Introduction to Metabolism and Metabolic Engineering, Enzyme Kinetics, and inhibition kinetics, Regulation of Metabolic pathways and Networks	15
2	**Metabolic flux balance analysis:** Determine, Underdetermine and over-determined systems, Metabolic Control analysis, Engineering of the central metabolism of *Escherichia coli*, Metabolic engineering of *Escherichia coli* for the production of aromatic compounds,	15

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3	Metabolic engineering strategies for the production of polyhydroxyalkanoates, a family of biodegradable polymers, Metabolic engineering for amino acid production (lysine,threonine and tryptphan), Metabolic engineering of antibiotic biosynthesis for process improvement (increasing the metabolic flux by enhancing enzymatic activity), Metabolic engineering of *Clostridium acetobutylicum* for solvent production (acetone)	**15**
4	Metabolic engineering of yeast for substrate utilization and metabolite production, metabolic engineering for biodegradation of recalcitrant pollutants, Functional genomics: microarrays, proteomics and metabolomics, Bioinformatics for reconstruction of metabolic networks, Systems biology frameworks for metabolic engineering.	**15**

Reference Books:

1	Metabolic Engineering by Sang Yup Lee and Eleftherios T Papoutsakis.(Power engineering: 23). ISBN: 0-8247-4875-1.
2	Metabolic Engineering (Biotechnology and Bioprocessing Series) by Sang Yup Lee - Hardcover, 1st Edition, 450 pages, CRC (1999) ISBN: 082477390X.
3	Pathway Analysis and Optimization in Metabolic engineering by Eberhard O Voit ISBN 0521800382.
4	Metabolic Engineering - by E Terry Papoutsakis Marcel Dekker Inc publisher (ISBN: 9780824773908).
5	Metabolic Engineering: Principles and Methodologies by Gregory Stephanopoulos, Jens Nielsen, George Stephanopoulos Publisher: Elsevier Science & Technology Books Date Published: 1998 ISBN-13: 9780126662603 ISBN: 0126662606.
6	"Applied Metabolic Engineering: Theory and Practical Applications" by Mario Jolicoeur, Michel Perrier, Olivier Henry, Maria Klapa, Mathieu Cloutier; Published by Wiley–Blackwell (ISBN: 978-0470595404)
7	"Metabolic Engineering"by Sang Yup Lee, E. Terry Papoutsakis, Published by CRC Press. (ISBN 9780824773908)

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods

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Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should have knowledge of** Metabolic regulation and its modification, enzyme kinetics	**25**
CO-2	Metabolic flux balance analysis	**25**
CO-3	Metabolic engineering strategies for production of PHA, solvents.	**25**
CO-4	Metabolic engineering of yeast for substrate utilization, bioinformatics for reconstruction of metabolic network	**25**

Curriculum Revision:	
Version:	2nd
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Lab – I (Drug Design and Development and Material Balance, Mass Transfer & Transport Process)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: Drug Design and Development

1	Retrieval of structure for PBP and Ramchandran plot.
2	Homology modelling.
3	Docking
4	Q SAR of selective compound

List of Practicals / Tutorials: Material Balance, Mass Transfer & Transport

1	Determination of K_La by sulphite oxidation method.
2	Ethanol production, distillation and estimation for percentage product yield estimation.
3	Citric acid fermentation and its estimation.
4	Fermentation time profile with respect to Glucose consumption and biomass formation by Yeast / Bacteria.
5	Determination of purity of fermentation products on the basis of its physical properties (Boiling point/Melting point, Density/Specific gravity, Viscosity etc.)

Reference Books:

1	Homology modelling: tutorial https://youtu.be/Zb98mmfnsvg
2	Molecular Docking Tutorial: AUTODOCK VINA - PART 1
3	Molecular Docking with all new AutoDock Vina 1.2: https://youtu.be/TpofopDIIy4

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Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Lab – II (Metabolic Engineering and Elective Course)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: Drug Design and Development (Core)

1	Determination of K_m and V_{max} of enzyme
2	Screening and isolation of PHA producing microorganisms
3	Optimization of conditions for PHA production
4	Understanding of Flux balance analysis using appropriate examples
5	Reconstruction of metabolic network from genome annotation using bioinformatics tools
6	Flux balance analysis to redistribute flux using bioinformatics tools

List of Practicals / Tutorials: Environmental Engineering (Elective)

1	Chromatographic techniques – Paper chromatography in the identification of amino acids and plant pigments.
2	Determination of kinetic Coefficients in batch wastewater treatment process.
3	Checking of aerobic decomposition of industrial waste.
4	Checking of anaerobic decomposition of industrial waste.
5	Treatability studies of wastewater. A. Coagulation-Flocculation Jar Test of Water/Effluents. B. Sludge Volume Index (SVI). C. Food/Microorganisms (F/M) Ratio.
6	Determination of volatile fatty acids (VFAs).
7	Biofilm formation and its role in fixed film processes.

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List of Practicals / Tutorials: Nanobiotechnology & Applications (Elective)

1	Synthesis of magnetic nanoparticles by coprecipitation method.
2	Biosynthesis of nanoparticles by microorganisms.
3	Preparation of quantum dots of CdS nanoparticles.
4	Activity profile of metal nanoparticles in terms of antimicrobial activity
5	Liposome synthesis and delivery of proteins in the field of nanomedicine.

List of Practicals / Tutorials: Cancer Genetics (Elective)

1	Preparation of Culture Media for Chromosomes analysis.
2	Human Blood Lymphocyte Culture
3	Genetic diagnosis of cancer by PCR
4	Visit to medical hospitals and report submission

List of Practicals / Tutorials: Validation, Documentation and cGMP (Elective)

1	Working knowledge, calibration of Laboratory equipment like pipette, burette, thermometer etc.
2	Validation of the Modern analytical Instruments like UV spectrometer, IR-spectrophotometer, HPLC, etc.
3	Validation of sterilization equipments e.g. Hot air oven, Autoclave.
4	Validation of Analytical procedures Analysis of pharmaceutical and cosmetic raw materials with the help of instruments.

Reference Books:

1	Baird, Rodger, and Laura. Bridgewater. 2017. Standard Methods for the Examination of Water and Wastewater. Washington, D.C.: American Public Health Association.
2	CPCB (2008) Guidelines for water quality monitoring. Parivesh Bhawan,: Central Pollution Control Board, New Delhi. MINARS/27/2007-08.
3	A. Diaz, N. Rincon, A. Escorihuela, N. Fernandez, E. Chacin, and C. F. Forster, "A preliminary evaluation of turbidity removal by natural coagulants indigenous to Venezuela," Process Biochemistry, vol. 35, pp. 391-395, 11// 1999.
4	Metcalf & Eddy Inc., Tchobanoglous, G., Burton, F. L., Tsuchihashi, R., &Stensel, H. D. (2013). Wastewater engineering: Treatment and resource recovery (5th ed.). McGraw-Hill Professional.
5	APHA (American Public Health Association) Handbook, 1998
6	Constitutional Analysis by D. E. Rooney. Oxford University Press. New York (ISBN: 0-19-96384-3)

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

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Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Environmental Engineering**

Course Group: **ELECTIVE**

Course Objectives: At the end of this course, the student should be able to:

1 Fundamentals of biological treatment
2 Principle of physical and chemical treatment methods
3 Advanced waste water treatment
4 Design of waste water treatment plants

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Fundamentals of Biological Treatment: Bacterial growth and energetic, Microbial Growth Kinetics: Rate of substrate utilization-Active Biomass-Net and Observed Biomass, Calculation of Kinetic coefficients (k, K_S, Y and K_d), Modelling suspended growth treatment processes: biomass balance, Aerobic biological oxidation, Biological nitrification, Biological denitrification, Biological Phosphorus Removal.	15
2	**Physical unit operations:** Screening, Flow equalization, Grit removal, Sedimentation, Membrane filtration processes: Reverse osmosis, Nano filtration, ultra filtration, micro filtration and electrodialysis. **Chemical unit processes**: Chemical coagulation, Chemical precipitation, Chemical oxidation and Chemical neutralization. Chemical storage, feeding, piping and control system. Chemical precipitation for phosphorus removal.	15

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3	**Advanced wastewater treatment:** Technologies used for advanced treatment, Removal of organic, inorganic, biological constituents, depth filtration, surface filtration, adsorption, ion-exchange, advanced oxidation processes, Multi Effect Evaporator (need for MEE, design details and principle of MEE, process and operation handling and applications), Disinfection processes, Disinfection with chlorine dioxide, ozone and UV radiation. Dechlorination: Need for dechlorination, Dechlorination with chemicals. Advanced oxidation processes.	**15**
4	**Treatment and disposal of solids:** Solids sources and characteristics. Disposal of solids, Composting: Process microbiology, Thickening, Dewatering: Centrifugation, Belt-filter press, Filter presses, Sludge drying beds and lagoons. Heat Drying: Heat transfer methods: process description. Conditioning: Chemical conditioning.	**15**

Reference Books:

1	Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
2	Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002
3	Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
4	Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, NewYork 2006

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should have knowledge about** Fundamentals of biological treatment	**25**
CO-2	Principle of physical and chemical treatment methods	**25**
CO-3	Advanced waste water treatment	**25**
CO-4	Design of waste water treatment plants	**25**

Curriculum Revision:	
Version:	2nd
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Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Nanobiotechnology & Applications**

Course Group: **ELECTIVE**

Course Objectives: To make the student aware about

1 Introduction to nanoworld, nanomaterials, their properties, top down and bottom up approaches
2 Preparation, characterization and properties of nanostructures materials
3 Biomolecules as nanostructures and their applications in nanotechnology
4 Biofunctionalization of nanomaterials

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to Nanoworld, Nanoscience and Nanotechnology, Introduction to nanomaterials, Properties of materials & nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state From Biotechnology to Nanobiotechnology. What is Nanobiotechnology? Information-Driven Nanoassembly, Energetics, Top down and bottom up approach for building Nanomaterial	15

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2	Introductory overview, preparation, characterization, and properties of nanostructured materials (e.g., metal nanoparticle, quantum dot, carbon nanotube, polymeric nanocarrier, and silica nanoparticle); Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Metal nanocrystals by reduction,Sol-gel synthesis. Fabrication of Nanomaterials by Physical Methods: -Iner tgas condensation, Plasma arc technique, Laser pyrolysis, Ball Milling, Chemical vapor deposition and electro-deposition.	**15**
3	Nanobiotechnology: Introduction, Biomolecules as nanostructures and their applications in nanotechnology viz. Biosensors, separation of cells and cell organelles, drug delivery, gene therapy etc., Nanosensors-Miniaturization of Biosensors, Nanomaterial Based Biosensors. Effect of Biosensor in biological and physicochemical techniques, Applications of nanobiotechnology in early medical diagnostics, drug targeting, drug delivery, nanosurgery and other biomedical field.	**15**
4	Biofunctionalization of nanomaterials (e.g., cell, nucleic acid, and protein); applications of biofunctionalized nanomaterials (e.g., diagnostics and screening technologies, drug delivery); Structural Principles of Nanobiotechnology Construction of Nanomachines, The Raw Materials: Biomolecular Structure and Stability, Protein Folding, Self-Assembly, Self-organization, Molecular Recognition. Flexibility poses great challenges for the design of nanobiomachine, DNA nanostructures DNA Templated Electronics, Sequence –specific molecular lithography, Single Biomolecule Manipulation for Bioelectronics, DNA as a semiconductor, Applications in implants, prostheses, and tissue engineering; toxicity, health, and environmental issues	**15**

Reference Books:

1	Niemeyer, C.M. and Mirkin, C.A., Nanobiotechnology: Concepts, Applications, and Perspectives, John Wiley & Sons,2004.
2	Malsch, N.H., Biomedical Nanotechnology, Taylor & Francis,2005.
3	Jain, K.K., Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications, Horizon Bioscience,2006.
4	Rosanthal, S.J. and Wright, D.W., Nanobiotechnology Protocols, Humana Press,2005.
5	Nalwa, H.S., Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology, American Scientific Publishers,2005.
6	Stroscio, M. and Dutta, M., Biological Nanostructures and Applications of Nanostructures in Biology: Electrical, Mechanical, and Optical Properties, Springer,2004.
7	Kumar, C.S.S.R., Biofunctionalization of Nanomaterials, John Wiley & Sons,2006.
8	Kelsall, R., Hamley, I.W. and Geoghegan, M., Nanoscale Science and Technology, John Wiley & Sons,2005.
9	Poole, C.P. and Owens, F.J., Introduction to Nanotechnology, John Wiley & Sons, 2003.

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10	Wilson, M., Kannangara, K., Smith, G., Simmons, M. and Raguse, B., Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall/CRC,2002.

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %					
R	**U**	**A**	**N**	**E**	**C**
25	**25**	**15**	**15**	**15**	**05**

R: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student will be able to know about** Nanoworld, nanomaterials, their properties, top down and bottom up approaches	**25**
CO-2	Preparation, characterization and properties of nanostructures materials	**25**
CO-3	Biomolecules as nanostructures and their applications in nanotechnology	**25**
CO-4	Biofunctionalization of nanomaterials	**25**

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
Last Reviewed on (Month-Year):	September 2022
Next Review on (Month-Year):	April 2023

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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Cancer Genetics**

Course Group: **ELECTIVE**

Course Objectives: The student should be able to:

1. Understand various types, properties and progression of cancers.
2. Provides information about various genetics and epigenetics factors causing cancers.
3. Focusing on tumor markers, Tumor viruses and Chromosomal defects in cancers.
4. Students understand selected familial cancers occurring in populations.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to cancer, Types and properties of cancers, Cell transformation and tumourigenesis Genetic heterogeneity and clonal evolution, Cancer and environment: physical, chemical and biological carcinogens	15
2	Oncogenes, Tumour suppressor genes, DNA repair genes and genetic instability, Epigenetic modifications, telomerase activity, centrosome malfunction	15
3	Chromosomal aberrations in neoplasia, Tumour specific markers, Overview of Tumor viruses and Cervical cancer	15
4	**Familial cancers:** Retinoblastoma, Wilms' tumour, Prostate cancer, Colorectal cancer, Breast cancer	15

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Reference Books:

1	Molecular Biology of the Cell by Alberts *et al*
2	Genes VIII by Lewin
3	Molecular Cell Biology by Lodish*et al*
4	Molecular Genetics of Cancer by Stillman
5	Cell Biology by Cooper

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	**At the end of this course, the student will be able to understand** Various types, properties and progression of cancers.	**25**
CO-2	Provides information about various genetics and epigenetics factors causing cancers.	**25**
CO-3	Focusing on tumor markers, Tumor viruses and Chromosomal defects in cancers.	**25**
CO-4	Students understand selected familial cancers occurring in populations.	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **3**

Course Code: **To be given by the University**

Course Title: **Validation, Documentation and cGMP**

Course Group: **ELECTIVE**

Course Objectives: The student should be able to grasp

1. Concepts of quality, quality management and its implementation
2. Regulatory guidance's and guidelines like ICH, WHO and other relevant documents
3. Good Laboratory Practices, SOPs, handling of deviation
4. Documentation and relevant process related documents

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Building and facilities: Location, design, plant layout, maintenance and sanitation, environmental controls. Utilities and services: air/gas, air handling and HVAC systems, sterile and non-sterile area, aseptic process and sterilization methods, Water: purified, distilled and sterile.	15
2	Concept and philosophy of cGMP in manufacturing, processing, packaging and holding. Organization and personal responsibilities, qualification, experience, training, personal hygiene and clothing.	15
3	Introduction, definition of validation, planning of validation – the consultant, task force, dedicated group, process characterization, validation protocol.	15

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4	Prerequisite of validation- design qualification (DQ), Installation qualification (IQ), operational qualification (OQ) and performance qualification (PQ). Validation options, analytical methods validation, cleaning validation and revalidation. Complaints and product recall.	**15**

Reference Books:

1	Robert A. Nash, Alfred H. Wachter, *Pharmaceutical Process Validation*, Vol. 129, Marcel Dekker Inc.
2	Sidney H. Willing and Murray M. Tuckerman, *Good Manufacturing Practices for Pharmaceuticals*, Vol. 16, Marcel Dekker Inc.
3	James Swarbrick, James C. Boylan, *Encyclopedia by pharmaceutical technology,* Marcel Dekker Inc.gtg
4	Sharma PP, *How to practice GMPs,* 3rd Ed., Vandana Publication.
5	*Drug and Cosmetic Act and Rules* (Governent of India).
6	Potdar MA, *Current Good Manufacturing Practices* Pharma-Med Press, Hyderabad.
7	Potdar MA, *Pharmaceutical Quality Assurance*, Nirali Prakashan, Pune.
8	

Supplementary learning Material:	
1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.in/
5	https://www.coursera.org/career-academy/?trk_ref=globalnav

Pedagogy:
Direct Classroom teaching
Audiovisual
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Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should be able to:** Concepts of quality, quality management and its implementation	**25**
CO-2	Regulatory guidance's and guidelines like ICH, WHO and other relevant documents	**25**
CO-3	Good Laboratory Practices, SOPs, handling of deviation	**25**
CO-4	Documentation and relevant process related documents	**25**

Curriculum Revision:	
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Faculty Name: Science

Programme Name: M. Sc. Biotechnology (Industrial Biotechnology)

Semester: 4 Academic Batch: 2022-23

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Core	Biological Science		Biosafety, Bioethics & IPR	4	3		1	4	T		3		50/20	50/20			100/40
Core	Biological Science		Bioinformatics	4	3		1	4	T		3		50/20	50/20			100/40
Core	Biological Science		Lab – I (Biosafety, Bioethics & IPR and Bioinformatics)	4		8		8		P		3			50/20	50/20	100/40
Elective	Biological Science		Dissertation	12												300/120	300/120
Viva-voce	Biological Science		Comprehensive Viva-Voce	1												50/20	50/20
			Total	**25**													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]:

Name & Sign [Dean / Director]:

FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **4**

Course Code: **To be Given by University**

Course Title: **Biosafety, Bioethics & IPR**

Course Group: **CORE**

Course Objectives:

1. Learn about the ethical issues in biomedical research and the guidelines to be followed
2. Information about various biosafety issues in biotechnological research and guidelines to be followed
3. Exposure about types of IR and patent system in India.
5. Role of WTO, TRIPS. Biodiversity and Indigenous knowledge.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Bioethics** Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy. Blue Cross in India, Green Peace: Human rights and responsibilities.	15

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2	**Biosafety** Biosafety & Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.	**15**
3	**Introduction to IPR** Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.	**15**
4	**National and International Regulations** International regulations – Cartagena protocol, OECD consensus documents & Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety & Standards Authority of India (FSSAI).	**15**

Reference Books:

1	M. K. Satish (2011) Bioethics and Biosafety IK International, (P) Ltd, New Delhi
2	Biotechnology and Safety Assessment (3rd Ed). Fleming, D.A., Hunt, D.L., (2000). Academic press. ISBN- 1555811804,9781555811808.
3	Biotechnology and safety assessment (3rd Ed). Thomas, J.A., Fuch, R.L. (1999). CRC press, Washington. ISBN: 1560327219, 9781560327219
4	Law and Strategy of biotechnological patents by Sibley. Butterworth publication. (2007) ISBN: 075069440, 9780750694445.
5	Intellectual property rights-Ganguli-Tata McGraw Hill. (2001) ISBN-10: 0074638602,
6	Intellectual Property Right-Wattal-Oxford Publication House.(1997) ISBN:0195905024.
7	Biotechnology -A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd Ed) ISBN-10 3527304320.
8	Encyclopedia of Bioethics 5 Vol set, (2003) ISBN-10: 0028657748.

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9	Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3 rd Ed) Academic press.
10	H.K.Das. Text book of biotechnology 3rd edition.
11	Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
12	National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
13	Kuhse, H. (2010). Bioethics: An Anthology. Malden, MA: Blackwell.
14	Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
15	Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences - Case Studies of Policy Challenges from New Technologies, MIT Press
16	World Trade Organisation. http://www.wto.org
17	World Intellectual Property Organisation.
18	International Union for the Protection of New Varieties of Plants. http://www.upov.int
19	National Portal of India. http://www.archive.india.gov.in
20	National Biodiversity Authority.
21	Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from
22	Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
23	Craig, W., Tepfer, M., Degrassi, G., &Ripandelli, D. (2008). An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853- 880. doi:10.1007/s10681-007-9643-8
24	Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
25	Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008.
26	Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure “Fit for Purpose” Risk Assessments. Retrieved from

Supplementary learning Material:	
1	http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
2	http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.
3	http://www.igmoris.nic.in/guidelines1.asp
4	http://www.nbaindia.org
5	http://www.wipo.int

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods

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Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	**At the end of this course, the student should have knowledge about** The ethical issues in biomedical research and the guidelines to be followed	**25**
CO-2	Students will be able to know information about various biosafety issues in biotechnological research and guidelines to be followed	**25**
CO-3	Students will be able to be familiar with types of IR and patent system in India.	**25**
CO-4	Students will be able to elaborate the role of WTO, TRIPS. Biodiversity and Indigenous knowledge.	**25**

Curriculum Revision:	
Version:	2nd
Drafted on (Month-Year):	June 2022
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **4**

Course Code: **To be Given by University**

Course Title: **Bioinformatics**

Course Group: **CORE**

Course Objectives:

1. Knowledge of various databases and their uses. Concepts of scoring matrices and sequence alignment.
2. Various methods for prediction of gene structure in Prokaryotes and Eukaryotes, methods for complete transcript cataloguing and gene discovery
3. Concepts and tools for genomics and comparative genomics, phylogenetic analysis by various types of trees and methods
4. Learning about the tools for proteomics, different algorithms for prediction of secondary & 3D structure of protein and protein folding.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	1		4	50/20	50/20			100/40

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**UNIT I: Introduction to Bioinformatics:-** Overview, Internet and bioinformatics, Applications. Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ Protein sequence databases: SWISS-PROT, PDB, SCOP, CATH Genome Databases at NCBI, EBI, Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources)	15

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	Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrf, pir etc. Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus.	
2	**Sequence analysis:-** Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series. Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA. Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA	**15**
3	**Functional genomics:-** Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results. Multiple sequence Alignment: CLUSTAL W Putting together all of the information into a genome database. Definition and description of phylogenetic trees and various types of trees, Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony).	**15**
4	**Molecular Modelling:-** Structural classification of proteins, Protein structure analysis structure alignment and comparison, Classes, folds, motif, domain Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods. Tertiary Structure: basic principles and protocols, Methods to study 3D structure. Active site prediction, Protein folding, Protein modeling and drug design.	**15**

Reference Books:

1	Mount DW, Bioinformatics: Sequence and Genome Analysis (2nd edition). Spring Harbor Press.
2	Arthur Lesk. Introduction to Bioinformatics. Oxford Uni. Press.
3	Rastogi. Bioinformatics : Methods and Applications.
4	Ghosh Z and Mallick B, Bioinformatics - Principles and Applications, Oxford University. Press (First Print: 2008; Second Print: 2009)
5	Creighton TE, Protein Structure: A Practical Approach
6	Creighton TE, Protein Structure and Molecular Properties, Freeman
7	Leach AR, Molecular Modeling : Principles and Application
8	Bourne PE, Weissig H, Structural Bioinformatics, Wiley Schlick T. Molecular Modelling and Simulation An Inter disciplinary Guide, Springer
9	Pevzner PA Computational Molecular BiologyAn Algorithmic Approach. Prentice Hall
10	Thomas Lengauer ,Bioinformatics - From Genomes to Therapies: Volume 1

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Supplementary learning Material:	
1	https://www.ncbi.nlm.nih.gov/
2	https://www.embl.org/
3	https://www.ddbj.nig.ac.jp/index-e.html
4	https://www.rcsb.org/
5	https://www.expasy.org/resources/uniprotkb-swiss-prot

Pedagogy:
Direct Classroom teaching
Audiovisual
Assignments/Quiz
Feedback
Interactive participating methods
Seminar presentation

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will be able to understand the knowledge of various databases and their uses. Concepts of scoring matrices and sequence alignment for analysis of Nucleic acid and protein sequences.	**25**
CO-2	Students will be able to aware of the various methods for prediction of gene structure in Prokaryotes and Eukaryotes, computational RNA Structure analysis and various methods for complete transcript cataloguing and gene discovery.	**25**
CO-3	Students will be able to know about various tools for genomics and comparative genomics, phylogenetic analysis by various types of trees and methods.	**25**
CO-4	Students will be able to recognize the tools for proteomics, different algorithms for prediction of secondary & 3D structure of protein and protein folding.	**25**

Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2022-23

Programme: **M. Sc. Biotechnology (Industrial Biotechnology)**

Semester: **4**

Course Code: **To be Given by University**

Course Title: **Lab – I (Biosafety, Bioethics & IPR and Bioinformatics)**

Course Group: **CORE**

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		8	4			50/20	50/20	100/40

* **J**: Jury; **V**: Viva; **P**: Practical

List of Practicals / Tutorials: Biosafety, Bioethics & IPR

1	Good lab Practices
2	Handling of rDNA in laboratory
3	Disposal of Hazardous waste in laboratory
4	Patent Filing

List of Practicals / Tutorials: Bioinformatics

1	Introduction of different database of NCBI,
2	Protein Sequence Databases (PIR, SwissProt)
3	Introduction of PIR, ExPasy, EMBL, SCOP, CATH
4	Database introduction-Prosite, BLOCKS, Pfam/ Prodom
5	Introduction of Genome browser – UCSC, ensemble, vista
6	Use of L-ALIGN
7	Alignment using BLAST
8	Clustal-W and Phylogenetic Analysis
9	Visualization by RASMOL & SPDBV
10	Homology modeling
11	Docking
12	Ramchandran Plot

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Supplementary learning Material:	
1	https://rcb.res.in/upload/Biosafety_Guidelines.pdf
2	https://dbtindia.gov.in/guidelines-biosafety
3	https://ipindia.gov.in/
4	"Bioinformatics For Beginners: A Laboratory Manual" by Department Of Computer Science PSGR, Published by Blue Hill Publishers. (ISBN: 9788193708828)
5	"Bioinformatics: A Practical Guide to theAnalysis of Genes and Proteins"by Andreas D. Baxevanis;Published by A John Wiley & Sons, Inc., Publication(ISBN: 0471383902)
6	"Essential Bioinformatics" by Jin Xiong; Published by Cambridge University Press.(ISBN:978-0521600828)

Pedagogy:
Hands on training
Discussion with students
Demonstration
Model
Chart

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
25	**25**	**15**	**15**	**15**	**05**	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Curriculum Revision:	
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Drafted on (Month-Year):	June 2022
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