



CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Cell Communication & Cell Signaling

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Learn cell-cell and cell-matrix adhesion, apoptosis, cell cycle regulation
- Introduce to various signalling pathways in living system, types of receptors
- Know pathways of intracellular transduction
- Gain the knowledge of host parasite interactions.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Cell junctions, Cell-adhesion & Extracellular matrix <ul style="list-style-type: none">Cell junctions: Anchoring junction, Occluding junction, Channel forming junctions, Signal relaying junctions, PlasmodesmataCell adhesion molecules: cadherins, Integrins, selectins, mucins, desmosomes, hemidesmosomeBasal lamina and extra cellular matrix. The Cytoskeleton <ul style="list-style-type: none">Organization and self-assembly of cytoskeletons, Microtubules and actin filaments	15



2	Mechanisms of Cell communication: <ul style="list-style-type: none">• 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 CAM kinase, heterotrimeric G-proteins,• Secondary messenger: NO , Calcium, cAMP• Src kinases,	15
3	Pathways of intracellular communication: <ul style="list-style-type: none">• Receptor Tyrosine kinases, Ras/MAPK pathways, PI3-kinase Lipid Signaling• Cytokine signaling/JAK-STAT/mTOR, TGF Beta signaling,• Wnt and Hedgehog Signaling, Notch/Delta signaling, ,NFkappa B signaling,• Signalling in bacteria and plants	15
4	Host Parasite interaction: <ul style="list-style-type: none">• Recognition and entry process of different pathogens like bacteria, viruses into cells.• Alteration of host cell behavior by pathogens. Cancer & Cell cycle <ul style="list-style-type: none">• 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• Cancer: Genetic rearrangement in progenitor cells, oncogenes, tumor suppressor genes	15

Reference Books:

1	Molecular Biology of THE CELL by Albert et al. 7 th Edition, 2022, Garland Science, W.W. Norton & Co. ISBN-13:978-0393884821
2	Cell and Molecular Biology: Concepts and Experiments by Gerald Karp (2020) 9 th Edition, Wiley International Edition, John Wiley & Sons, Inc. ISBN-13: 978-1-119-59824-4.
3	The Cell – A Molecular Approach by Geoffrey M. Cooper and Kenneth Adams. 9 th Edition, 2022, ASM Press, Sinauer Associates, Inc. ISBN:978-0197583722
4	Molecular cell Biology by Harvey Lodish, 5 th Edition, (2013) W. H. Freeman and Company, New York. ISBN:0-7167-4366-3.
5	Cell Biology by C.B. Powar (2019). Himalaya Publishing House, Mumbai. ISBN-978-93-5024-669-6.
6	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. ISBN-13:978-8121924429.



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	Students will learn about the different types of cell junctions, adhesion molecules, cytoskeleton and the structure and function of ECM.	25
CO-2	Students will learn about the different types of cell surface receptors and their role in signal transduction.	25
CO-3	Students will learn about the various pathways of intracellular communication.	25
CO-4	Students will get thorough knowledge of cell cycle and its regulation, apoptotic mechanism and molecular aspect of cancer.	25

Curriculum Revision:	
Version:	1.0
Drafted on (Month-Year):	January 2023
Last Reviewed on (Month-Year):	February 2023
Next Review on (Month-Year):	April 2025



FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Biodegradation & Bioremediation

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Understand determination of biodegradability of xenobiotic and toxic compounds.
- Learn microbial transformation of pesticides and chlorinated aliphatic compounds.
- Know process, advantages and limitations of In-situ and Ex-situ bioremediation.
- Recognize role of plasmids, metagenomics, and gene manipulation to improve bioremediation technologies.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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



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, phytovolatilization, rhizodegradation, rhizofiltration).	15
4	Use of bacteria fungi and algae in biosorption, Biomineralization 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, Biofiltration, Biofilter media, Microbial ecology of biofilters.	15

Reference Books:

1	Environmental Biotechnology by Alan Scragg (2005). 2 nd Edition. Oxford University Press. ISBN: 9780199268672.
2	Textbook of Environmental Biotechnology by Pradipta Kumar Mohapatra (2007). I. K. International Publishing House. ISBN: 81-88237-54-X.
3	Introduction to Biodeterioration by Dennis Allsopp, Kenneth J. Seal, Christine C. Gaylarde. (2004). 2 nd Edition. Cambridge University Press. ISBN: 0521528879.
4	Manual of Soil analysis- Monitoring and Assessing Soil Bioremediation by R. Margesin and F. Schinner (2005). 4 th Edition. Springer Publishers. ISBN: 3540253467.
5	Bioremediation by James J. Valdes (2000). 2000 th Edition. Springer Publishers. ISBN 0792364597.

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	Students will be able to determine the biodegradability of xenobiotic, recalcitrant and toxic compounds.	25
CO-2	Students will be familiar with the basics of microbial transformation of pesticides and chlorinated aliphatic compounds.	25
CO-3	Students will be able to understand the process, advantages and limitations of In-situ and Ex-situ bioremediation.	25
CO-4	Students will be able to know the Role of plasmids, metagenomics and gene manipulation to improve bioremediation technologies.	25

Curriculum Revision:

Version:	1.0
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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Food Biotechnology

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Opportunities and applications of food biotechnology.
- Microbial food borne diseases, infection and intoxications.
- Production of genetically modified foods, guidelines for their production and release.
- Application of biotechnology in improving nutritional value of food.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Scope of food biotechnology Food as a substrate for microorganisms 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



2	Microbial Foodborne Diseases Foodborne Infections & Foodborne Intoxications Food borne pathogens a) Bacterial food borne infections and intoxications- Brucella, Campylobacter, Clostridium, Escherichia (ETEC/EHEC/EPEC/EAEC), <i>Salmonella</i> , <i>Shigella</i> , <i>Listeria</i> and <i>Vibrio</i> 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 by William C. Frazier and Dennis C. Westhoff (2017). 5 th Edition, Published by McGraw Hill Education (India) Private Limited, Print Edition: ISBN-13: 978-1-25-906251-3, ISBN-13: 978-93-392-0322-1.
2	Food microbiology by Martin R. Adam and Maurice O. Moss (2015). 4 th Edition, Published by The Royal Society of Chemistry. ISBN 978-0-85404-284-5.
3	Dairy Microbiology Handbook Edited by Richard K. Robinson (2002). 3 rd Edition, Published by John Wiley & Sons, Inc., New York. ISBN 0-471-38506-4.
4	Fundamental Food Microbiology by Bibek Ray and Arun Bhuniya (2014). 5 th Edition, Published by CRC Press. ISBN-10: 0-8493-7529-0.

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

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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	Students will be able to understand opportunities and applications of food biotechnology.	25
CO-2	Students will be able to understand about food borne diseases, bacterial and non-bacterial food infections and intoxications.	25
CO-3	Students will know about the production of genetically modified foods, guidelines for their production and release.	25
CO-4	Students will be able to understand the Application of biotechnology in improving nutritional value of food.	25

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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

Programme: M. Sc. (Integrated Biotechnology) Industrial Biotechnology
Semester: VII
Course Code: To be given by the University
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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	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	Enrichment and Isolation of hydrocarbon degrading microorganisms.
2	Study of biosurfactant production through hydrocarbon degradation.
3	Detection of chromium from water/wastewater sample.
4	Detection of iron from water/wastewater sample.
5	Isolation of metal detoxifying microorganisms.
6	Study of biodegradation of aromatic compounds using TLC.
7	Decolourization of dye.



8	In situ bioremediation studies of biostimulation for hydrocarbon contaminated soil.
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Reference Books:

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

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25	25	15	15	15	05	

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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	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/Haemocytometer count
4	Microbiological quality testing of milk (MBRT test)
5	Most Probable Number [MPN] Test.
6	Estimation of Carbohydrate / Protein / lipid from food samples [e.g. Milk, cereals, grains].
7	Isolation and identification of pathogenic microorganisms using selective and differential Media.
8	Microscopic observation of different Fungi from spoiled foods.

List of Practicals / Tutorials: Plant Biotechnology (Elective)

1	Preparation of MS media for inoculation
2	Micropropagation through nodal explants
3	Callus induction
4	Mass multiplication of banana
5	<i>Agrobacterium tumefaciens</i> mediated plant transformation
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 complexometric 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

Reference Books:

1	Laboratory Manual of Food Microbiology by Neelima Garg, K.L. Garg, K.G. Mukerji (2013). ISBN: 9789389633023.
2	Analytical Food Microbiology: A Laboratory Manual by Ahmed E. Yousef, Joy G. Waite-Cusic, Jennifer J. Perry (2022). ISBN: 9780470425114.
3	A Laboratory Manual of Food Analysis by Shalini Sehgal (2020).ISBN: 9789389633238.
4	Standard Methods of Biochemical Analysis by S. R. Thimmaiah (2009). ISBN: 8176630675 9788176630672.



5	Experiments in microbiology, Plant Pathology and Biotechnology by K.R. Aneja(2005). New Age International Publishers, New Delhi, ISBN 978-81-224-1494-3.
6	Practical Pharmaceutical Analytical Chemistry by Alam MM, Akhtar Mymoona, Husain Asif, Shaquiquzzaman M (2010). ISBN: 9789354660429.
7	Text books of Medical Laboratory Technology by Dr. Praful B. Godkar (Reprint 2021), Bhalani Publishing House. ISBN-13:978-9381496190.
8	Practical application of plant molecular biology – R J Henry, Chapman & Hall. $\frac{3}{4}$ Elements of Biotechnology – P K Gupta.

Supplementary learning Material:	
1	https://nptel.ac.in/
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Pedagogy: Hands on training Discussion with students Demonstration Model Chart
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

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Curriculum Revision:	
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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Plant Biotechnology

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand tools and techniques of plant genetic engineering.
- Learn molecular biology of nitrogen fixation, nif gene transfer, herbicide resistant plants production.
- Gain knowledge of transgenic plants for agriculture and commercial applications.
- Acquire knowledge of plant tissue culture techniques

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Plant biotechnology present scenario, Micropropagation 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



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 Razdan. M.K. (2003). Oxford & IBH Publishing Co, New Delhi. ISBN-10: 9788120417939, ISBN-13 : 978-8120417939.
2	Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. (2008). Oxford University Press. ISBN: 978-0199282616.
3	Introduction of plant biotechnology by H.S. Chawla. (2009). Third Edition; Oxford and IBH publishing Co. Pvt. Ltd, New Delhi. ISBN: 9781315275369.
4	Applied and fundamental aspects of plant cell tissue and organ culture by Reinert & Bajaj Y P S. (1989). Springer Verlag. ISBN: 978-0387076775.
5	Cell culture and somatic cell genetics of plants: Plant Regeneration and Genetic Variability by Indra K Vasil. (1987). (Vols. 1 to 3) – Academic Press Inc. ISBN: 978-01271500531.
6	Plant cell and tissue culture by S. Narayanswamy (1997). Tata Mc Graw Hill Publishing Co. ISBN: 0074602772, 9780074602775.

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
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: Students will be able to acquire knowledge of tools and techniques of micropropagation and somaclonal variation.	25
CO-2	Students will get familiar with basic methods and applications of chloroplast transformation.	25
CO-3	Students will be able to acquire knowledge of basic biosynthetic pathways of secondary metabolites and its production by plant tissue culture techniques.	25
CO-4	Students will be able to understand transgenic plants for vaccine production and other agriculture and commercial applications.	25

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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Microbial Technology

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Exploit microorganisms for industrial product production (primary metabolites).
- Understand industrial production of secondary metabolites using microorganisms (e.g., antibiotics).
- Know steroid biotransformation and ergot alkaloids production, biofuels.
- Identify food and dairy products production e.g., Cheese, yoghurt, Beer, Wine.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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



CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

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 affecting fermentative production of exopolysaccharides and downstream processing (recovery). Production of bioplastics (Polyhydroxyalkanoates)	15
4	Microbiology and technology of fermented dairy products: Cheese making: Cheese varieties, manufacture of cheddar cheese, Sources and properties of rennets. Yoghurt making Beer and Wine production	15

Reference Books:

1	Comprehensive biotechnology by Murray MooYoung, Editor in Chief. Elsevier Press (2011), 2 nd Edition, 6 volume set. Volume 3: Industrial biotechnology and commodity products. ISBN: 978-0-444-53352-4.
2	Microbial Technology - Microbial Processes Edited by Henry. J. Peppler and D. Perlman, (1979). 2 nd Edition, Volume I - ACADEMIC PRESS, New York San Francisco London. ISBN 0-12-551501-4.
3	Microbial Technology Fermentation Technology Edited by Henry. J. Peppler and D. Perlman, (1979).- 2 nd Edition, Volume II, ACADEMIC PRESS, New York San Francisco London. ISBN 0-12-551502-2 (v. 2) Hardcover ISBN: 9780125515023, eBook ISBN: 9781483268279, Paperback ISBN: 9781483244693.
4	Biotechnology: a multi volume comprehensive treatise edited by H. J. Rehm and G. Reed in cooperation with A. Puhler and P. Stadler (1993). 2 nd edition, completely revised edition. VCH, (Weinheim), volume 6: Products of Primary metabolism and volume 7: Products of secondary metabolism ISBN 3-527-28310-2.
5	Microbiology and Technology of Fermented Foods edited by Robert W. Hutkins (2019). 2 nd Edition, Wiley-Blackwell Publishing. ISBN: 978-1-119-02744-7.
6	Modern Industrial Microbiology and Biotechnology edited by Nduka Okafor, Benedict C. Okeke (2017). 2 nd edition, CRC Press, ISBN 97803677816.

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 be able to explain exploitation of microorganisms for industrial product production (primary metabolites)	25
CO-2	The students will learn about the industrial production of secondary metabolites using microorganisms (e.g. antibiotics)	25
CO-3	The students will learn about the steroid biotransformation and ergot alkaloids production, biofuels.	25
CO-4	The students will learn about the food and dairy products production e.g. Cheese, yoghurt, Beer, Wine.	25

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	January 2023
Last Reviewed on (Month-Year):	February 2023
Next Review on (Month-Year):	April 2025



CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Environmental Chemistry

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand structure and composition of atmosphere, greenhouse effect.
- Know water cycle, its pollutants, types of reactions in various water bodies.
- Recognize organic and inorganic components of soil.
- Identify biochemical cycling of elements.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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



CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

2	Water Chemistry and Water Pollution: Chemistry of Natural Waters, Water resources, hydrological cycle, physical and chemical properties of water, complexation 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
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 by Gary W. Valoon & Stephen J. Duffy (2011). 3 rd Edition a global perspective, Oxford University Press. ISBN 13-978-0-19-965263-1.
2	Environmental chemistry by BK Sharma (2007). 7 th edition, GOEL Publishing House, Meerut India ISBN 81-8283-012-5.
3	Environmental Microbiology by Raina MM, Pepper IL and Gerba CP (2008). 2 nd Edition, Academic Press. ISBN: 978-0123705198.
4	Environmental Chemistry by AK de. (2006). 6th edition. New age International (P) Ltd., New Delhi, India. ISBN 81-224-1946-1.
5	Textbook of Environmental Chemistry by Tyagi OD, M Mehra and Mehta M (1996). Anmol Publisher; New edition. ISBN-10 : 8170413524, ISBN-13:978-8170413523.

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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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 Structure and composition of atmosphere, greenhouse effect.	25
CO-2	Students will be able to understand Water cycle, its pollutants, types of reactions in various water bodies.	25
CO-3	Students will be able to know about Organic and inorganic components of soil.	25
CO-4	Students will be able to understand Biochemical cycling of elements, reactions with acids and bases.	25

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VII

Course Code: To be given by the University

Course Title: Clinical Biochemistry

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Learn specimen collection, preservation and transportation, composition of various body fluids.
- Know acid base balance and disorders, types, and functions of carbohydrates.
- Understand clinical enzymology, hemoglobin.
- Identify general organ function tests.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to clinical biochemistry: Definition and scope of clinical biochemistry in diagnosis, use of clinical laboratory and interpretation of results. 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	<p>Water and electrolytes balances and Imbalance: Distribution of body water and electrolytes in body, normal water balance, normal electrolyte balance, regulatory mechanisms, abnormal water and electrolyte metabolism, dehydration, pathological variations of water and electrolyte, water Intoxication.</p> <p>Acid base balance and Imbalance: Acid base balance in normal health, Buffers, Acid produced in the body, mechanism of regulation of pH, role of different buffer system, role of respiration in acid base regulation, Renal mechanisms of regulation of acid base balance, Acid base Imbalance, respiratory and metabolic acidosis and alkalosis.</p>	15
3	<p>Clinical Enzymology: Principle of diagnostic enzymology, cell and plasma derived enzymes.</p> <p>Clinical Significance of enzyme assays: serum enzymes in Liver, Heart, GI tract, muscles, bone diseases and malignancies. Isoenzymes of LDH, CPK and ALP.</p> <p>Biochemistry, synthesis and breakdown of Hemoglobin, Hemoglobinopathies, Thalessemia, Bilirubin metabolism, Jaundice, Vandenberg test.</p> <p>Biochemistry of Diabetes mellitus, Atherosclerosis, Fatty liver, and obesity.</p>	15
4	<p>Liver function tests: Functions of Liver, Test based on abnormalities of Bile pigments, Test based on Livers Part in carbohydrate metabolism, Test based on changes in Plasma proteins, Test based on abnormalities of the lipids, test based on the detoxicating function of the liver, test based on Excretory functions of the liver, test based on formation of prothrombin, amino acid catabolism, drug metabolism.</p> <p>Thyroid function tests: Test based on Primary function of thyroid, tests measuring blood level of thyroid hormones, tests based on metabolic effects of thyroid hormones, thyroid scanning, Immunological tests for thyroid functions.</p> <p>Gastric function tests: Examination of Resting content, fractional Gastric Analysis using test meals, Achylia GaSTICA, Stimulation tests, serum pepsinogen, Tube less Gastric Analysis.</p>	15

Reference Books:

1	Tietz Textbook of Clinical Chemistry by Carl A. Burtis, Edward R. Ashwood (1998). Harcourt Brace and Company Aisa Pvt. Ltd. ISBN-13:978-0721644721.
2	Tietz Textbook of Clinical Chemistry and Molecular Diagnostics By Carl A. Burtis, Edward R. Ashwood and David E. Bruns (2013). 4 th Edition. ISBN- 13:9780721601892.
3	Textbooks of Medical Laboratory Technology volume I and II by Dr. Praful B. Godkar (2020). ISBN-13:9789381496190.
4	Textbook of Biochemistry for Medical Students by DM Vasudevan, Sreekumari S, Kannan Vaidyanathan (2019). ISBN-13:978-9389034981.
5	Textbook of medical biochemistry by MN Chatterjea and Rana Shinde (2012). 8 th edition. ISBN-13:978-9350254844.



6	Henry's Clinical Diagnosis and Management by Laboratory Methods 2 Richard McPherson Matthew Pincus (2021). ISBN: 9780323673204.
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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	Students will be able to understand about the Specimen collection, preservation and transportation, composition of various body fluids.	25
CO-2	Students will be able to understand about the Acid base balance and disorders, types, and functions of carbohydrates.	25
CO-3	Students will be able to know about the clinical enzymology, haemoglobin.	25
CO-4	Students will be able to understand about the general organ function tests biochemistry of diabetes mellitus, obesity.	25

Curriculum Revision:	
Version:	1.0
Drafted on (Month-Year):	January 2023
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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

Programme: M.Sc. Biotechnology (Industrial Biotechnology)

Semester: VIII

Course Code: To be given by the University

Course Title: Industrial Waste Management

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Understand the methods for measurement of water pollution for wastewater management.
- Know aerobic and anaerobic biological treatment process.
- Understand the method of biomedical waste and hazardous waste management
- Know the dairy wastewaters treatment and tanning Industry effluents treatment method.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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



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	Wastewater microbiology by Bitton Gabriel., (2005). Third edition, John Wiley & Sons. ISBN: 0-471-65071-4.
2	Hazardous Wastes and Solid Wastes, Liu, D.H.F and Liptak, B.G (2000), Lewis Publishers, New York.
3	Wastewater treatment for pollution control bySoli J. Arceivala. (2006). 3 rd edition. McGraw-Hill-Publishing Company Limited. ISBN: 0-07-062099-7.
4	Biomedical waste disposal by Singh Anantpreet, Kam sukhjit. (2012).. Jaypee Brothers Medical Publishers Pvt. Ltd. ISBN: 9789350255544.
5	Handbook of Solid Waste Management by Tchobanoglous, George, and Frank Kreith, eds. (2002). 2 nd eds. New York: McGRAW-HILL. ISBN: 9780071356237.
6	Electronic waste management: design, analysis, and application byR. E. Hester and R M Harrison. (2009). 1 st Edition. Royal Society of Chemistry Publishing. ISBN: 978-0-854041121.



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	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 have proper understanding of: Waste water management, various measurements methods and their treatment.	25
CO-2	The students will gain knowledge about various Aerobic and anaerobic biological treatment process	25
CO-3	The students will learn about the Biochemical and Hazardous Waste management methods will be known	25
CO-4	The students will learn about the Wastewaters and Treatment of Dairy Effluent, Paper pulp and textile industry.	25

Curriculum Revision:	
Version:	1.0
Drafted on (Month-Year):	January 2023
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CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

Course Title: Bioprocess Engineering and Technology

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Design a fermenter and media for industrial fermentations.
- Know the sterilization of media and air, microbial growth kinetics.
- Understand the components of aeration and agitation, scale up and scale down, control systems.
- Know the bioprocess kinetics.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to Bioprocess technology, range of fermentation processes, Chronological development of fermentation industry, different types of fermentation processes, fermentation economics. 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



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, Incubation and sequence control, advanced control.	15

Reference Books:

1	Principles of Fermentation Technology by Peter F Stanbury, Allan Whitaker, Stephen J Hall. (2016). 3 rd edition by Butterworth-Heinemann is an imprint of Elsevier. ISBN: 978-0-08-099953-1
2	Comprehensive biotechnology by Murray Moo Young, 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 (1983). Ellis Horwood Publisher. ISBN 10:0853122032, 13:9780853122036.
4	Fermentation Microbiology and Biotechnology by E.M.T. El-Mansi, C.F.A. Bryce, Arnold L. Demain, A.R. Allman(2006). 2 nd Edition, CRC Press. ISBN 13:978-0-8493-5334-5.
5	Modern Industrial Microbiology and Biotechnology by Nduka Okafor, Benedict C. Okeke.(2017).2 nd edition by CRC Press. ISBN 13:978-1-1385-5018-6.
6	Industrial Microbiology: An Introduction by Mickael J. Waites, Neil L. Morgan, John S. Rockey and Gary Higton (2001). Blackwell Science Ltd. ISBN 0-632-05307-0.
7	Upstream Industrial Biotechnology Volume 1_ Expression Systems and Process Development; Volume 2_ Equipment, Process Design, Sensing, Control, and cGMP Operations by Michael C. Flickinger (2013). John Wiley & Sons, Inc., Hoboken, New Jersey. ISBN 978-1-118-13123-7.

Supplementary learning Material:

1	https://nptel.ac.in/
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**Pedagogy:**

Direct Classroom teaching
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Assignments/Quiz
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Seminar presentation

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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 knowledge about the design of fermenter, media for industrial fermentations	25
CO-2	The students will learn about the sterilization of media and air, microbial growth kinetics	25
CO-3	The students will learn about the components of aeration and agitation, scale up and scale down, Control systems	25
CO-4	The students will learn about the downstream processing, continuous fermentation systems, control of process parameters.	25

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	January 2023
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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

Course Title: O'-mics

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Understand the genome and proteome, Advance sequencing technique.
- Know human genome project, large scale sequencing methods, some model organisms and their genome projects.
- Identify Protein structure and function, Methods to study protein-protein interactions.
- Know the concept development about transcriptomics and metabolomics.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Functional Genomics Introduction to the proteomics, Metagenomics and Genomics, Structure of genome, Mechanism of genome evolution: Nucleotide substitution, CpG islands, Histone modification, Genome size-C value paradox and C-value enigma, Codon usage bias, Analysis and Annotation-ORF. DNA sequencing Techniques: sequencing by Ligation method, Cyclic Array sequencing, RNA sequencing method, other features of nucleic acid sequencing.	15



2	Human Genome Project and Model organism 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 (<i>Arabidopsis</i> , <i>Caenorhabditis elegans</i> , <i>Drosophila melanogaster</i> , <i>Mus musculus</i>); Comparative genomics of relevant organisms such as pathogens and non-pathogens	15
3	Proteomics 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	Transcriptomics Transcriptomics: Comparative transcriptomics, Differential gene expression; generation of cDNA expression libraries, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (EST), Genotyping/SNP detection; Gel based and Non Gel based method (Taq man Assay and Molecular beacons), DNA Microarray technology: Principle, uses and Applications of microarrays, Computational analysis of microarray data.	15

Reference Books:

1	Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick, Bernard R., Patten, Cheryl L., Pasternak, Jack J. (2010). 4 th Edition, Published by ASM Press. ISBN: 978-1-683-67366-8.
2	Hand book of Comparative Genomics: Principle and Methodology by Cecilia Saccone, Graziano Pesole, Wiley-Liss (25 February 2003). 1 st edition. ISBN-10:9780471391289, ISBN-13:978-04713912890.
3	Proteomics: From protein sequencing to function by S.R. Pennington and M.J. Dunn, (2002). Viva Books, Private Ltd. ISBN-10:9788176492904.
4	Discovering Genomics, Proteomics and Bioinfo by AM Campbell (2 March 2006). CSH Press, 2 nd edition. ISBN-10:0805382198, ISBN-13:978-805382198.
5	Principles of Gene Manipulation and Genomics by Primrose (3 June 2013). Wiley-Blackwell; 7 th edition. ISBN-13:978-1405135443.

Supplementary learning Material:

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3	https://diksha.gov.in/
4	https://epathshala.nic.in/

**Pedagogy:**

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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 clear understanding of genome and proteome, DNA microarray	25
CO-2	The students will learn about the human genome project, Large scale sequencing methods, some model organisms and their genome projects	25
CO-3	The students will learn about the protein structure and function, Methods to study protein-protein interactions	25
CO-4	The students will learn about the concept development about transcriptomics and metabolomics	25

Curriculum Revision:

Version:	1.0
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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

Programme: M. Sc. (Integrated Biotechnology) Industrial Biotechnology
Semester: VIII
Course Code: To be given by the University
Course Title: Lab - I (Industrial Waste Management and Bioprocess Engineering and Technology)
Course Group: CORE

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	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: 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
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	Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick, Bernard R., Patten, Cheryl L., Pasternak, Jack J(2010).Fourth edition, Published by ASM Press, ISBN: 978-1-683-67366-8.
2	Hand book of Comparative Genomics: Principle and Methodology by Cecilia Saccone, Graziano Pesole, (25 February 2003). Wiley-Liss; 1 st edition. ISBN-10:9780471391289; ISBN-13:978-0471391289.
3	Proteomics: From protein sequencing to function by S.R. Pennington and M.J. Dunn (2002). Viva Books, Private Ltd. ISBN-10:9788176492904.
4	Discovering Genomics, Proteomics and Bioinfo by AM Campbell (2 March 2006).C.S.H. Press, 2 nd edition. ISBN-10:9780805382198. ISBN-13:978-0805382198.
5	Principles of Gene Manipulation and Genomics by Primrose (3 June 2013). Wiley-Blackwell; 7 th edition. ISBN-13:978-1405135443.

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:	1.0
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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

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

Course Group: CORE

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	100/40

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

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

1	Introduction to Reactome to understand metabolism
2	Role of ipath in Metabolomics
3	Designing a primer
4	KEGG tool: An integrated pathway Analysis for Genomics
5	Use of pathway Hunter tool to shorten the pathway analysis.
6	Total Protein profile of plant system using PAGE.
7	Determination of molecular weight and quantitation of separated proteins.

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



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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	Studies of Tools related to Environmental risk analysis.
2	Case Study: Implementing environmental policies in India.
3	Case Study: Evolution of India's environmental policy.
4	Review of different case studies on environmental issues.
5	Case Study: Green & Clean policy adopted for reducing energy, water, and carbon footprint.
6	Case Study: Environment Management Strategies
7	Case Study: India's trade liberalization.

Reference Books:

1	Bioinformatics For Beginners: A Laboratory Manual by Department of Computer Science PSGR (2018).Published by Blue Hill Publishers. ISBN-9788193708828.
2	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis (2001).Published by A John Wiley & Sons, Inc., Publication. ISBN-0471383902.
3	Essential Bioinformatics by Jin Xiong (13 March 2006). Published by Cambridge University Press. ISBN-978-0521600828.
4	Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation and Cell Technology by Michael C Flickinger (2010). Published by A John Wiley & Sons, Inc., Publication. ISBN-9780471799306.
5	Bioseparations Downstream Processing for Biotechnology by Paul A Belter and E L Cussler (1988). 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 (1989).Published by ACS publications. ISBN-9780841217386.



7	Handbook of Methods in Environmental Studies by S. K. Maiti. (2003). Vol. 2: Air, Noise, Soil and Overburden Analysis, ABD Publishers, Jaipur. ISBN: 8185771588, 9788185771588.
8	CPCB (2008) Guidelines for water quality monitoring. Parivesh Bhawan, Central Pollution Control Board, New Delhi.
9	Standard methods for the examination of water and wastewater by Baird, R., & Bridgewater, L. (2017). 23rd edition. Washington, D.C.: American Public Health Association. ISBN: 9780875530130.
10	Handbook Of Methods in Environmental Studies by S. K. Maiti. (2004). Vol. 1: Water and Wastewater Analysis. ABD Publishers, Jaipur. ISBN: 9350440180, 9789350440186.

Supplementary learning Material:

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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:	1.0
Drafted on (Month-Year):	January 2023
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CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

Course Title: Animal Biotechnology

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand the scope of Animal Biotechnology.
- Know basic techniques in animal cell culture.
- Understand applications of animal tissue culture.
- Identify techniques for producing transgenic animals.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				Total
Lecture	Tutorial	Practical		Theory		J/V/P*		
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to Animal Biotechnology: Historical background, Advantages of tissue culture, limitations, major differences in vitro, types of tissue culture. Biology of cultured cells: Brief description on cell adhesion, cell proliferation, energy metabolism and origin of cultured cells. General out-line of cell types: epithelial tissue, connective tissue, muscular tissue and nervous tissue. Equipments and materials for animal cell culture technology: Inverted microscope, Laminar flow-hood, humid CO ₂ incubator, centrifuges, refrigerators and other miscellaneous equipments. Aseptic Techniques: Objectives of aseptic techniques, elements of aseptic environment, sterile handling. Sterilization: Different types - dry heat (hot air oven), wet heat (autoclaving), various chemical agents used in sterilization, irradiation techniques (UV and Gamma Ray). Biohazards and Bioethics	15



2	<p>Defined media and supplements: Physicochemical properties, Balanced salt solutions, serum, selection of medium and serum.</p> <p>Serum – Free Media: Disadvantages of serum, advantages of Serum – free media Preparation of serum free media, Animal protein free media.</p> <p>Primary culture: Initiation of primary cell culture, isolation of tissue, types of primary culture, mechanical and enzymatic disaggregation.</p> <p>Subculture and cell lines (Subculture and propagation, routine maintenance, subculture of monolayer and suspension cultures), Types of Cell cloning</p> <p>Monitoring for contamination – Visible microbial contamination, Mycoplasma, Viral contamination, Eradication of contamination.</p>	15
3	<p>Cell cloning and selection: Feeder layer, suspension cloning, separation of clones.</p> <p>Cell separation: Centrifugation, Antibody based techniques, FACS.</p> <p>Cell differentiation: Stem Cell plasticity, markers of differentiation, Induction of differentiation, differentiation and malignancy.</p> <p>Transformation and Immortalization: Immortalization with viral genes, Immortalization of human fibroblasts, telomerase induced immortalization, Aberrant growth control, Tumorigenicity.</p> <p>Characterization: Need for characterization, characterization based on cell morphology, DNA and RNA content, enzyme activity and antigenic markers.</p>	15
4	<p>Culture of specialized cells: Mammary epithelium, liver, epidermal keratinocytes, adipose tissue, muscle, glial cells, human astrocytes, lymphocytes, testis and ovary.</p> <p>Stem cells, germ cells and aminocytes: Culture of embryonic stem cells, culture of aminocytes, applications of stem cells.</p> <p>Embryo technology: Embryo sexing, embryo splitting; Assisted reproductive techniques (IVF, ISCI, ZIFT, GIFT)</p> <p>Scale-up and automation: Scale – up in suspension and monolayer culture.</p> <p>Three-Dimensional Cultures: Histotypic and organotypic cultures, tissue equivalents.</p> <p>Transgenic Animals:-Method and types for producing transgenic Animals, examples and application</p>	15

Reference Books:

1	Culture of animal cells: A manual of basic technique by R. Ian Freshney (2021). Wiley Publication. ISBN: 978-1-119-51304-9.
2	Animal cell culture & technology by M. Butler (2003). ISBN 9781859960493.
3	Animal cell culture techniques by M. Clynes, Springer (1998). ISBN: 978-3-642-80412-0.
4	Animal Biotechnology by Young, Murray, Moo. (1989), 1st Edition, Pergamon Press, Oxford. ISBN-13:978-0080347301.
5	Animal Cell Biotechnology by Spier (1994).6th Edition R.E. Academic press. ISBN-978-0-08-092599-8.
6	Animal biotechnology by P. Ramadass (2017). MJP Publishers. ISBN 13: 9788180940422
7	Biotechnology by U. Styanarayan (Reprints 2020). Books and Allied (P) Ltd. ISBN-13 : 978-8187134909.



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	Students will be able to know the scope of Animal Biotechnology; understand about General out-line of cell types, Equipment, and materials for animal cell culture technology and about Biohazards and Bioethics in animal cell culture.	25
CO-2	Students will be able to understand different media and supplements used in the cell culture with different basic techniques in animal cell culture.	25
CO-3	Students can understand techniques in Cell cloning and selection of animal cells for culture.	25
CO-4	Students will learn techniques for culture of specialized cells, producing transgenic animals and Applications of animal tissue culture.	25

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	January 2023
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CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

Course Title: Bioseparation Technology

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand about various downstream processing.
- Learn product isolation and purification methods.
- Know chromatography techniques for product isolation and purification.
- Gain knowledge final Product Purification and Preparation.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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 critical fluid extraction.	15
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; Importance, Challenge, Process Drying: Vaccum Tray, Freeze, Rotary-Drum, Spray, Conveyor Lyophilisation, Formulation Strategies A Detailed Case studies on the Extraction and Recovery of Ethanol, Citric acid and Penicillin.	15

Reference Books:

1	Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker and Stephen J. Hall. (14 September 2016). Butterworth-Heinemann; 3 rd edition. ISBN-10:0080999530.
2	Fermentation Microbiology and Biotechnology by E.M.T. El-Mansi and C.F.A. Bryee (26 August 1999). CRC Press; 1 st edition.ISBN-10:0748407347. ISBN-13:9780748407347.
3	Comprehensive Biotechnology by Murray Moo Young (17 July 2019). Pergamon Press Inc; 3 rd edition. ISBN-10:0444640460, ISBN-13:978-0444640468.
4	Biochemical Engineering Fundamentals by J.E. Bailey & D.F. Ollis. (1 July 2017). McGraw Hill Education; 2 nd edition. ISBN-10:9780070701236, ISBN-13:978-0070701236.
5	Downstream industrial biotechnology: recovery and purification edited by Michael C. Flickinger (16 July 2013). Wiley; 1 st edition. ASIN:B00E0J2I02.

Supplementary learning Material:

1	https://nptel.ac.in/
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3	https://diksha.gov.in/
4	https://epathshala.nic.in/



CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

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 students will have clear understanding of various downstream processing	25
CO-2	Students will be able to execute product isolation and purification methods	25
CO-3	Students will be able to identify chromatographic techniques for product isolation and purification	25
CO-4	Students will be able to learn final product purification and preparation by crystallization, drying and lyophilisation.	25

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

Course Title: Protein Engineering

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Recognize different tools and methods used in proteomic study.
- Know the sources of protein, Industrial and medical application of proteins,
- Understand different expression of proteins for large scale purifications,
- Execute protein engineering strategy.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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, spin-spin interaction, NOE, 2D-NMR, NOESY, COSEY.	15



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. (2007). Springer New York. ISBN: 978-0-387-33746-3.
2	Protein Engineering in Industrial Biotechnology by Lilia Alberghina. (2000). 1 st Edition, CRC Press. ISBN: 9780367398972.
3	Protein Engineering Protocols: Methods in Molecular Biology, Volume 352 by Katja Arndt and, Kristian Müller (2006). Humana Press. ISBN: 1-58829-072-7, 1-59745-187-8.
4	Protein Engineering by Caroline Köhrer, Uttam L. Rajbhandary (2009). Springer-Verlag New York, LLC. ISBN: 978-3-540-70941-1, 3540709371.
5	Protein Engineering Handbook Volume 3, 1 st Edition by Stefan Lutz (2012). Wiley-VCH. ISBN -13:978-3527331239.
6	Protein Structure Prediction: Methods and Protocols by Webster, David (Southern Cross Molecular Ltd., Bath, UK). (2000). Humana Press. ISBN-10:0896036375, ISBN-13:978-0896036376.
7	Principles of Protein X-Ray Crystallography [3rd ed.] by Jan Drenth (2007). Springer New York. ISBN: 978-0-387-33746-3.

Supplementary learning Material:

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Pedagogy:

Direct Classroom teaching
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Assignments/Quiz
Feedback
Interactive participating methods
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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 Students will be acquiring knowledge about different tools and methods used in proteomic study.	25
CO-2	Students will be able to understand the sources of protein, Industrial and medical application of proteins,	25
CO-3	Students will learn different expression of proteins for large scale purifications.	25
CO-4	Students will be able to execute protein engineering strategy.	25

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: VIII

Course Code: To be given by the University

Course Title: Environment Policy and Legislation

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Learn legal structure of India and fundamentals of environmental legislation and policy making.
- Understand the environmental performance including compliance with environmental legislation.
- Execute environmental policies and practices and raise awareness about the emerging environmental issues.
- Know 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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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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UNIVERSITY

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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, 42 nd 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	Environmental Law by S.C. Shastri. (2012). 4 th Edition, Eastern Book Company, Lucknow. ISBN-13-5028-480-7.
2	Textbook on Environmental Law by Maheshwara Swamy. (2008). 2 nd Edition, Asia Law House, Hyderabad. ISBN-9789392135415.
3	Environmental Law and Policy in India by Shyam Divan and Armin Rosencranz. (2005). Oxford University Press, New Delhi. ISBN-513-978-0-19-566-173-6.
4	Environmental Law by Amod S. Tilak. (2009). 1 st Edition, Snow White Publication, Mumbai. ISBN-9788181593696.
5	Environmental Law in India by Leelakrishnan P. (2005). 2 nd Edition, Lexis Nexis, New Delhi. ISBN-9789386515872.

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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 should be clear about legal structure of India and fundamentals of environmental legislation and policy making.	25
CO-2	The students will understand the environmental performance including compliance with environmental legislation.	25
CO-3	The students will learn about the implementation of environmental policies and practices and raise awareness about the emerging environmental issues.	25
CO-4	The students will study about various acts, laws and rules related to air, water, environment and wastes in India.	25

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	January 2023
Last Reviewed on (Month-Year):	February 2023
Next Review on (Month-Year):	April 2025



FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Drug Design and Development

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Understand the approaches to find drug targets.
- Know the protein and receptors as drug targets.
- Learn drug design and optimizing homology model.
- Recognize the preclinical and clinical study, regulatory affairs.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Drug and Drug Classification, Ideal characteristics of drug, General mechanism of drug action, 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
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. QSAR, combinatorial synthesis, Limitations and testing for activity.	15
4	Drug Development Preclinical trials-Toxicity testing, Drug metabolism studies, Pharmacology, formulation and Stability test. Clinical Trials – Phase-I, Phase-II, Phase-III, Phase-IV studies, Ethical issues Patenting and Regulatory affairs – Patents, Regulatory Affair, Regulatory process, fast tracking and orphan drugs. Chemical and process development – Chemical development: Stages in chemical development. Process development-process development.	15

Reference Books:

1	An Introduction to Medicinal Chemistry by G. L. Patrick (2013). 3 rd Ed., Oxford University Press. ISBN 978-0-19-969739-7.
2	Wilson and Gisvold's Textbooks of Organic Medicinal and pharmaceutical chemistry by John H. Block and John M. Beale Jr. (2012). 12 th edition. ISBN 978-0-7817-7929-6.
3	Foye's Principles of Medicinal Chemistry by David A. Williams and Thomas L. Lenke (2012).7 th edition. ISBN 13-978-1451175721.
4	Medicinal chemistry – A biochemical Approach by T. Nogradyedey (2005).3 rd edition – Oxford University Press, New York, Oxford ISBN 13 978-0-19510455-4; 978-0-19-510456-1.
5	The Organic Chemistry of Drug design and drug action by R. B. Silverman (2014).2 nd edition Acedemic press. ISBN -13 978-0123820303.
6	Burger's Medicinal Chemistry & drug Discovery edited by Manfred E. Wolff (1997).5 th edition, Volume – 1, 2,3,4,5 –, 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 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 different approaches to find drug targets.	25
CO-2	Students will understand about the protein and receptors as drug targets.	25
CO-3	The students will learn about the drug design and optimizing homology modelling and to identify the structures of molecule.	25
CO-4	Students will understand about the preclinical and clinical study and regulatory affairs.	25

Curriculum Revision:

Version:	1.0
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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd. 1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Material Balance, Mass Transfer and Transport Process

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Know the problems involved in reaction stoichiometry.
- Solve problems involving mass transfer due to diffusion, chemical reaction, and convection.
- Understand the size of basic heat and mass transfer equipment.
- Apply engineering judgment including an appreciation of cost and safety.
- Identify the mass transfer problems involving biological and environmental systems.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to Biochemical engineering: Unit operation, Unit process, Process classification, Basic processing function, mode of process operation, process modeling, absorption, distillation, extraction, drying and evaporation. Humidification operation, transport phenomenon, mass, heat, material transfer and its application in biochemical engineering.	15
2	Stoichiometric Calculations: General terminology, Stoichiometric coefficient, stoichiometric ration, Limiting reagent and excess yield based on feed and reactant consume medium formulation and yield factor, yield factor, RQ and role of RQ in calculations. Degree of reduction, effect of temperature, pH and Oxygen, Mathematical problems.	15



3	Material balances: Introduction, General strategy for solving material balance, Type of Material balance problems, basis of material balances, material balances of steady state and non steady state processes for single unit and multi unit. Balance on continuous steady state process, Integral process. Recycle, bypass purge and industrial application of material balances. Mass transfer, mass transfer coefficient and its calculations.	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 Transport processes, Heat Transfer: Introduction: Mechanisms and applications of heat transfer-mode of Heat transfer and heat transfer-conduction, convection and radiation. Steady state heat transfer fundamentals: Heat transfer in heat exchangers and fermenter coils, jacketed vessels. Principles of heat transfer underlying condensation and evaporation. Unsteady state heat transfer fundamentals. Mathematical problems	15

Reference Books:

1	Basic Principles & Calculations in Chemical Engineering by D. M. Himmelblau and James B. Riggs (2012). 8 th Ed., ISBN-10: 0-13-234660-5.
2	Stoichiometry by B. I. Bhatt & Thakore (2010). Tata McGraw Hill Book Company, 5 th Eds. ISBN, 1283188570, 9781283188579.
3	Bioprocess Engineering Principles, Second Edition by Pauline M. Doran (2013). Academic Press. ISBN-012220851X, 9780122208515.
4	Process Calculations by V Venkataramani and N. Anantharaman (2011). Publisher, PHI Learning Pvt. Ltd. ISBN-8120341996, 9788120341999.
5	Chemical Process Principles by O. A. Hougen, K.M. Watson, R.A. Ragatz (2018). 2 nd edition, Indian print, CBS Publishers, 2 nd Ed., ISBN-13 979-8123909539.

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	The student will learn about process functions, mode of operation and transport phenomenon.	25
CO-2	The student will learn about stoichiometric calculations, media formulation and yield factor.	25
CO-3	The student will learn about the material balance problems, single and multi-unit state processes.	25
CO-4	The student will learn about the kinetic energy equations, heat transfer mode and its exchangers.	25

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Metabolic Engineering

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Understand the metabolic regulation and its modification, enzyme kinetics.
- Know the metabolic flux balance analysis.
- Identify the metabolic engineering strategies for production of PHA, solvents.
- Recognize metabolic engineering for substrate utilization, reconstruction of metabolic network.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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 <i>Escherichia coli</i> , Metabolic engineering of <i>Escherichia coli</i> for the production of aromatic compounds,	15
3	Metabolic engineering strategies for the production of polyhydroxyalkanoates, a family of biodegradable polymers, amino acid production (lysine, threonine and tryptophan), Metabolic engineering of <i>Clostridium acetobutylicum</i> for solvent production (acetone)	15



4	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
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Reference Books:

1	Metabolic Engineering: Concepts and Applications by Jens Nielsen, Gregory Stephanopoulos, Sang Yup Lee (2021). Published by Wiley Online Library, Volume 13b, 1 st Edition. ISBN: 9783527823468.	
2	Metabolic Engineering by Ralph Becker (2016). Published by Syrawood Publishing House, 1 st Edition. ISBN: 9781682861530.	
3	Metabolic Regulation and Metabolic Engineering for Biofuel and Biochemical Production by Kazayuki Shimizu (2017). Published by CRC Press, 1 st Edition. ISBN: 9781498768375.	
4	Metabolic Engineering: 73 (Advances in Biochemical Engineering/Biotechnology) by Jens Nielsen; published (2010). Springer, 2 nd Edition. ISBN: 978-3642075346.	
5	Applied Metabolic Engineering: Theory and Practical Applications” by Mario Jolicoeur, Michel Perrier, Olivier Henry, Maria Klapa, Mathieu Cloutier (2010). Published by Wiley–Blackwell, 1 st Edition. ISBN: 978-0470595404.	
6	Metabolic Engineering by Sang Yup Lee, E. Terry Papoutsakis (1999). Published by CRC Press. 1 st Edition. 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
 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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UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

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	The students will learn about the metabolic flux balance analysis	25
CO-3	The students will learn about the metabolic engineering strategies for production of PHA, solvents.	25
CO-4	The students will learn about the metabolic engineering of yeast for substrate utilization, bioinformatics for reconstruction of metabolic network	25

Curriculum Revision:	
Version:	1.0
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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

Programme: M. Sc. (Integrated Biotechnology) Industrial Biotechnology
Semester: IX
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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	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
5	Estimation of commercial drugs using spectroscopic techniques.
6	Comparative study of antibacterial activity of natural product versus commercial drugs

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

1	Determination of K_{1a} by sulphite oxidation method.
2	Ethanol production, distillation and estimation for percentage product yield estimation.
3	Citric acid fermentation and its estimation for percentage product yield 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/TpofopDIly4

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.

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	100/40

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

List of Practicals / Tutorials: Metabolic Engineering (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	Determination of kinetic Coefficients in batch wastewater treatment process.
2	Checking of aerobic decomposition of industrial waste.
3	Checking of anaerobic decomposition of industrial waste.
4	Determination of phenol.
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	Determination of turbidity in water/wastewater samples.



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	Standard Methods for the Examination of Water and Wastewater by Baird, Rodger, and Laura. Bridgewater 2017. 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	Wastewater engineering: Treatment and resource recovery by Metcalf & Eddy Inc., Tchobanoglous G, Burton FL, Tsuchihashi R, & Stensel HD (2017). 5 th eds. McGraw-Hill Professional. ISBN: 10- 9780070495395, ISBN: 13- 978-0070495395
4	Constitutional Analysis by D. E. Rooney (1992). Oxford University Press. New York. ISBN-10 : 0199632871, ISBN-13 0199632879-978 :
5	Experimental Microbiology by Patel. R.J., Patel. K. R. (2008). Vol-II, Aditya Publications, Ahmedabad, India. ISBN: Not given.
6	Experiments in Applied Microbiology by Samuel Singer (2001). Academic Press. ISBN 10: 0126459606 ISBN 13: 9780126459609.

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



CVM UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd. 1945)

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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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Environmental Engineering

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand fundamentals of biological treatment.
- Know Principle of physical and chemical treatment methods.
- Learn advanced wastewater treatment.
- Explain design of wastewater treatment plants.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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 electro dialysis. 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



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	Wastewater Engineering, Treatment and Reuse by Metcalf and Eddy (2003). Tata McGraw Hill, New Delhi (2003).ISBN-10:007041677X.
2	Water works Engineering – Planning, Design and Operation by Qasim, S.R., Motley, E.M. and Zhu.G. (16 April 2000). Prentice Hall, New Delhi. ISBN-10:8120321537.
3	Handbook of Environmental Engineering Calculations by Lee, C.C. and Shundar Lin (2McGraw-Hill Education.ISBN-10:0070381836.
4	Water Treatment Unit Processes – Physical and Chemicalby Hendricks (9 November 2010). D. CRC Press Inc; 1st edition. ISBN-10:9781420061918, ISBN-13:978-1420061918.

Supplementary learning Material:

1	https://nptel.ac.in/
2	https://swayam.gov.in/
3	https://diksha.gov.in/
4	https://epathshala.nic.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 knowledge about growth kinetics, kinetic coefficients and treatment processes	25
CO-2	The students will learn about the principle of physical and chemical treatment methods	25
CO-3	The students will learn about the advanced waste water treatment technologies	25
CO-4	The students will learn about the treatment and disposal of solid wastes	25

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Nanobiotechnology & Applications

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand nanoworld, nanomaterials, their properties, top down and bottom-up approaches.
- Learn preparation, characterization, and properties of nanostructures materials.
- Recognize biomolecules as nanostructures and their applications in nanotechnology.
- Execute biofunctionalization of nanomaterials.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to Nanoworld, Nanoscience and Nanotechnology, Nanomaterials (Properties of materials & nanomaterials, role of size in nanomaterials), Nanoparticles, Nanowire. Top down and bottom up approach for building Nanomaterial. Importance of nano materials in biotechnology.	15
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: -Inertgas condensation, Plasma arc technique, Laser pyrolysis, Ball Milling, Chemical vapor deposition and electro-deposition.	15



CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

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	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	Nanobiotechnology: Concepts, Applications and Perspectives by Niemeyer CM and Mirkin CA (2004). John Wiley and Sons, 1 st Edition. ISBN-9783527605910.
2	Biomedical Nanotechnology by Malsch NH (2005). Taylor and Francis, 1 st Edition. ISBN-9780429132995.
3	Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications by Jain KK (2006). Horizon Bioscience, 1 st Edition. ISBN-9781904933175.
4	Nanobiotechnology Protocols by Humana Rosanthal SJ and Wright DW (April 27, 2005). 5 th edition. ISBN-10:1588292762, ISBN-13:978-1588292766.
5	Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology by Nalwa HS (May 25, 2006). American Scientific Publishers, ISBN-10:1588830330, ISBN-13:978-1588830333.
6	Biological Nanostructures and Applications of Nanostructures in Biology: Electrical, Mechanical, and Optical Properties by Stroschio M and Dutta M (3 October 2013). Springer. ISBN-10:1475779461, ISBN-13:978-1475779462.

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 know about nanoworld, nanomaterials, their properties, top down and bottom up approaches	25
CO-2	The students will learn about the preparation, characterization and properties of nanostructures materials with applications and recent advancement	25
CO-3	The students will learn about the biomolecules as nanostructures and their applications in nanotechnology and sensor based applications	25
CO-4	The students will learn about the biofunctionalization of nanomaterials, application of nanotechnology in biological and medical science.	25

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	January 2023
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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Cancer Genetics

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand various types, properties, and progression of cancers.
- Provide information about various genetics and epigenetics factors causing cancers.
- Focus on tumour markers, Tumour viruses and Chromosomal defects in cancers.
- Learn selected familial cancers occurring in populations.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction to cancer, Characteristics of cancer cells, types of cancers, Cell transformation and tumourigenesis. Molecular basis of cancer cell behavior, Cancer Classification: TNM system, Types of staging Cancer and environment: physical, chemical and biological carcinogens. methods to study cancer critical genes.	15
2	Oncogenes, Tumour suppressor genes, DNA repair genes, mutations causing genetic instability: mechanism of genetic destabilization, Epigenetic modifications, telomerase activity, centrosome malfunction Chromosomal aberrations in neoplasia	15



3	Apoptosis Necrosis and autophagy and cancer Genetic heterogeneity and clonal evolution Tumour specific markers Cancer stem cells Overview of Tumor viruses and Cervical cancer	15
4	Familial cancers: Retinoblastoma, Wilms' tumour, Prostate cancer, Colorectal cancer, Breast cancer Cancer Genomics: Cancer Genome project, Genomic landscape of Cancer, cancer genomics and drug resistance Cancer Treatment: Present and future	15

Reference Books:

1	Molecular Biology of the Cell by Bruce Alberts. A, Johnson, J. Lewis Garland Science; 6 th edition (November 19, 2014). ISBN-10:0815345240, ISBN-13:978-0815345244.
2	The biology of cancer by Robert A. Weinberg (2013), 2 nd edition, W. W. Norton & Company, Garland Science, ISBN-13 978-0815342205.
3	Lewin's Genes XII, by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2017), ISBN-978-1284104493.
4	Cancer: Principles and Practice of Oncology Primer of Molecular Biology in Cancer by Vincent T. DeVita (2021). 3 rd Edition. LWW NP 9781975149116.
5	Molecular Cell Biology by Anold Berk, Chris A. Kaiser, Harvey Lodish, Angelika Amon, Hidde Ploegh, Anthony Bretscher, Monty Krieger, Kelsey C. Martin(1 April 2016). W H Freeman; 8th edition. ISBN-10:1464183392, ISBN-13:978-1464183393.
6	The Cell: A molecular approach by G. M. Cooper and R.E. Hausman (February 1, 2013). 6 th edition, Sinauer Associates, Inc. 6 th edition. ISBN-10:9780878939640, ISBN-13:978-0878939640.

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	The students will learn about the various genetics and epigenetics factors causing cancers.	25
CO-3	The students will learn about the tumor markers, tumor viruses and cancer stem cells.	25
CO-4	Students will understand selected familial cancers occurring in populations.	25

Curriculum Revision:

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CVM
UNIVERSITY

Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: IX

Course Code: To be given by the University

Course Title: Validation, Documentation and cGMP

Course Group: ELECTIVE

Course Objectives:

The objectives of this course are to enable students to...

- Understand concepts of quality, quality management and its implementation.
- Learn regulatory guidance and guidelines like ICH, WHO and other relevant documents.
- Identify good Laboratory Practices, SOPs, handling of deviation.
- Execute documentation and relevant process related documents.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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



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
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Reference Books:

1	Pharmaceutical Process Validation by Robert A. Nash and Alfred H. Wachter (1993).3 rd Edition, Marcel Dekker Inc. ISBN: 0-8247-0838-5.
2	Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control: 52 (Drugs and the Pharmaceutical Sciences) by Sidney H. Willig, Stoker. Marcel Dekker Inc; 3 rd edition (1 December 1991) ISBN 10: 0824785940, ISBN 13 :978-0824785949.
3	Encyclopedia by pharmaceutical technology by James Swarbrick, James C. Boylan (2002). Marcel Dekker Inc. ISBN: 9780824728250, 9780824728229, 9780824728236.
4	How to practice GMPs by Sharma P. P. (2015) 7 th Ed., Vandana Publication. ISBN: 8190595792.
5	The drugs and cosmetics act and rules, ministry of health and family welfare (Department of Health), (As amended up to the 31st December 2016).
6	cGMP Current Good Manufacturing Practices for Pharmaceuticals by Manohar A. Potdar, Ramkumar Dubey (2022). PharmaMed Press / BSP Books. ISBN: 9789387593060.

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.



CVM
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Aegis: Charutar Vidya Mandal (Estd.1945)

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	At the end of this course, the student should be able to understand the concepts of quality, quality management and its implementation	25
CO-2	The students will learn about the regulatory guidance's and guidelines like ICH, WHO and other relevant documents	25
CO-3	The students will learn about the Good Laboratory Practices, SOPs, handling of deviation	25
CO-4	The students will learn about the documentation and relevant process related documents	25

Curriculum Revision:

Version:	1.0
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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: X

Course Code: To be Given by University

Course Title: Biosafety, Bioethics & IPR

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Learn about the ethical issues in biomedical research and the guidelines to be followed.
- Gather information about various biosafety issues in biotechnological research and guidelines to be followed.
- Get exposure about types of IPR and patent system in India.
- Know the role of WTO, TRIPS, Biodiversity and Indigenous knowledge.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	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, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, Agricultural biotechnology - Genetically engineered food, environmental risk, labelling and public opinion. Overview of ICMR guidelines for research on human subjects Blue Cross in India, Green Peace	15



2	Biosafety Biosafety & Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary & secondary containment for biohazards; biosafety levels; GRAS organisms; 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; Risk Assessment: risk characterization and development of analysis plan; risk assessment of transgenic crops vs CIS genic plants, Plants or products derived from RNAi, gene 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, Types of patent applications, Infringement, protection of new GMOs; International framework for the protection of IP, PCT; Introduction to Paris Convention, 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)	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, RDAC, IBSC and other regulatory bodies; Overview of Biosafety guidelines in India; category of rDNA experiments; field trials – biosafety research trials – standard operating procedures; GM labelling – Food Safety & Standards Authority of India (FSSAI).	15

Reference Books:

1	Bioethics and Biosafety by M. K. Satish (2011). IK International, (P) Ltd, New Delhi. ISBN: : 9788190675703.
2	Intellectual Property Rights-In the WTO and developing countries by Jayshree Watal (2003). Oxford University Press. ISBN-13: 978-0195661705, ISBN-10:0195661702.
3	Intellectual property rights by Prabudha Ganguly (2001). Tata McGraw Hill. ISBN-10: 0074638602.
4	Biotechnology and Safety Assessment by Fleming, D.A., Hunt, D.L., (2000). 3 rd Eds. Academic press. ISBN- 1555811804, 9781555811808.
5	Biotechnology and safety Assessment by Thomas, J.A., Fuch, R.L. (2002). 3 rd Eds. Academic press. ISBN-10:0126887217, ISBN-13:9780126887211.

Supplementary learning Material:

1	http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
2	guidelines-biosafety">https://dbtindia.gov.in.>guidelines-biosafety
3	http://www.igmoris.nic.in/guidelines1.asp



4	http://www.nbaindia.org
5	http://www.wipo.int
6	https://dpiit.gov.in/ National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
7	http://www.ipindia.nic.in/ Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India.
8	Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants by Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). <i>Transgenic Research</i> , 19(3), 425-436. doi:10.1007/s11248-009-9321-9
9	An Overview of General Features of Risk Assessments of Genetically Modified Crops by Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). <i>Euphytica</i> , 164(3), 853- 880. doi:10.1007/s10681-007-9643-8
10	National Biodiversity Authority.
11	Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from
12	World Trade Organisation. http://www.wto.org
13	Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008
14	Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008.

<p>Pedagogy: Direct Classroom teaching Audiovisual Assignments/Quiz Feedback Interactive participating methods Seminar presentation</p>
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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 the knowledge about the ethical issues in biomedical research, modern biotechnology and the guidelines to be followed	25
CO-2	Students will gain information about various biosafety issues in biotechnological research and guidelines to be followed	25



CO-3	Students will be familiar with types of IPR; patent system in India and international patent system.	25
CO-4	Students will be able to elaborate on the role of WTO, TRIPS. Learn about the Biodiversity and Indigenous knowledge, national and international regulations in biotechnology.	25

Curriculum Revision:	
Version:	1.0
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FACULTY OF SCIENCE

Effective from Academic Batch: 2020-21

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

Semester: X

Course Code: To be Given by University

Course Title: Bioinformatics

Course Group: CORE

Course Objectives:

The objectives of this course are to enable students to...

- Understand various databases and their uses. Concepts of scoring matrices and sequence alignment.
- Recognize various methods for prediction of gene structure in Prokaryotes and Eukaryotes, methods for complete transcript cataloguing and gene discovery.
- Learn concepts and tools for genomics and comparative genomics, phylogenetic analysis by various types of trees and methods.
- Identify 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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
3	1	---	4	40/16	60/24	---	---	100/40

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

Detailed Syllabus:

Sr.	Contents	Hours
1	UNIT I: Introduction to Bioinformatics:- Bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer etc.). Protein databases (Primary, Composite, and Secondary), Structure databases of protein (CATH, SCOP, Pfam, Prodom). Data generation and analysis; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, Mass/Ms-MALDI, X-Ray Diffraction, and microarray). Applications of Bioinformatics.	15



2	UNIT II: 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	UNIT III: 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 Definition and description of phylogenetic trees and various types of trees, Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus. Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony).	15
4	UNIT IV: Structural biology and Molecular Modelling Structural classification of proteins, Protein structure analysis, structure alignment and comparison, conformational study, importance of 310 helix and loops, biophysical aspects of proteins and nucleic acids, Ramachandran plot. Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods. Tertiary Structure: basic principles and protocols, Methods to study 3D structure. Structure-based drug designing Introduction, Structure-based drug designing approaches: - Target Identification and Validation. Ligand-based drug designing and docking Introduction, Ligand-based drug designing approaches: Lead Designing, ADME property.	15

Reference Books:

1	Bioinformatics - Principles and Applications by Ghosh Z and Mallick B (2009). Oxford University Press. ISBN-13:978-0-19-569230-3.
2	Bioinformatics: Sequence and Genome Analysis by Mount DW (2004) Spring Harbor Press, 2 nd Eds.ISBN-13-978-0879697129.
3	Bioinformatics: Methods and Applications by Rastogi SC (2013). PHI Publishing, 4th Eds. ISBN-13-978-8120347854.
4	Computational Molecular Biology An Algorithmic Approach by Pevzner PA (2000). Prentice Hall, MIT Press, ISBN-9780262528177.
5	Bioinformatics Algorithms: An Active Learning Approach by Phillip Compeau, Pavel Pevzner (2018). Active Learning Publishers, ISBN-9780990374633.
6	Molecular Modeling : Principles and Application by Leach AR (2010) 2 nd Eds. ISBN 978-1-4419-6350-5.
7	Structural Bioinformatics edited by Bourne PE, Weissig H (2003).John Wiley & Sons, Inc. ISBN 0-471-20200-2.



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

<p>Pedagogy: Direct Classroom teaching Audiovisual Assignments/Quiz Feedback Interactive participating methods Seminar presentation</p>
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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	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 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: 2020-21

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

Semester: X

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)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				Internal	External	Internal	External	
---	---	6	4	---	---	40/16	60/24	100/40

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

List of Practicals / Tutorials: Biosafety, Bioethics & IPR

1	Good lab Practices
2	Lab designs according to biosafety levels
3	Handling of rDNA in laboratory
4	Disposal of Biohazardous waste
5	Patent Filing & Infringement of patents (case study)
6	Traditional knowledge: case study

List of Practicals / Tutorials: Bioinformatics

1	Introduction of different database of NCBI,
2	Protein Sequence Databases (PIR, SwissProt)
3	Introduction of PIR, SCOP, CATH
4	Database introduction-Prosites, Pfam/ Prodom
5	Introduction of Genome browser - UCSC, GenScan
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



Reference Books:	
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 the Analysis 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.

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