M.Sc. Microbiology

Course Curriculum

Academic Year: 2024-25

W.E.F. March 2024

GSFC UNIVERSITY

EDUCATION RE-ENVISIONED

GSFC University, Vigyan Bhavan, P. O. Fertilizernagar, Vadodara - 391750, Gujarat, India

- GSFCU strives to be the best compact boutique institution with a futuristic approach, encouraging student centric culture and sharpened focus on developing industry ready & employable students with all-round development.

MISSION

- Establish an institution, which promotes creativity and innovation.
- Develop unique quality standards for academic excellence and pedagogical innovations.
- Remain agile through learning ecosystem with flexible processes & systems.
- Holistic growth for industry readiness.

No.	Programme Outcomes (POs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PO1	To impart knowledge regarding basic concepts of applied biological sciences.	Basic Knowledge	Explain, Describe, Discuss, Recall, Locate
PO2	To explain the relationships between biological sciences, chemical sciences, physical sciences and mathematical sciences.	Interdisciplinary approach	Apply, Practice, Interpret, Select, Correlate
PO3	To perform procedures as per laboratory standards in the areas of Biological Sciences and to think analytically.	Practical learning	Compare, Classify, Select, Investigate
PO4	To communicate effectively in terms of reading, writing, speaking and delivering the view to others.	Effective Communication and social Interaction	Explain, Describe, outline, Predict, Summarize
PO5	To culminate and understand the moral values for any of the subjects with respect to good practices and humanity.	Ethics	Judge, Assess, Estimate, Predict, Argue
PO6	To explain the importance of ecological balance along with conservation of natural resources for human well being.	Environment and Sustainability	Construct, Develop, Produce

No.	Programme Specific Outcomes (PSOs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PSO1	Understanding of biotechnology related research and industrial applications.	Remembering and Understanding	Explain, Describe, Discuss, Recall, Locate
PSO2	Expertise in interpreting complex data related to biotechnology problems and challenges.	Application and Analysing	Apply, Practice, Interpret, Select, Correlate
PSO3	Expertise in knowledge needed to solve current and emerging technologies.	Analysing	Compare, Classify, Select, Investigate
PSO4	Understanding related to questions they need to ask and in – depth research they need to conduct.	Understanding	Explain, Describe, outline, Predict, Summarize
PSO5	Expertise in communicating issues related to industrial biotechnology to a wide audience.	Evaluating	Judge, Assess, Estimate, Predict, Argue
PSO6	Expertise in solving complex social and ethical problems confronting the industry and the government.	Creating	Construct, Develop, Produce

Mapping of POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	2	2	3	3	3	2
PSO2	3	2	2	2	3	3
PSO3	3	3	3	2	2	1
PSO4	3	3	2	2	2	2
PSO5	2	3	2	3	2	2
PSO6	2	2	2	2	3	2
Avg.	2.5	2.5	2.3	2.3	2.5	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
2 Hours Practical (P) per week	1 credit
1 Hour Practical (P) per week	0.5 credit
3 Hours Experiential learning	1 credit

Course code Definitions:

Lecture	L
Tutorial	T
Practical	P
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Sciences including Management courses	HSMC
Professional core courses /Major (Core)	PCC
Professional Elective courses /Minor Stream	PEC
Open Elective courses	OEC
Laboratory course	LC
Mandatory courses	MC
Non-credit courses	NC
Project (Experiential learning)	PROJ
Experiential learning ex. Internship, Industrial Visit, Field visit, etc,	EL
Multidisciplinary courses	MDC
Ability Enhancement Course	AEC
Skill Enhancement Course	SCE
Value Added Courses	VAC

Structure of Postgraduate Programme:

Sr. No.	Category	Credit Breakup
1	Professional core courses -**Major (Core)**	48
2	Professional Elective courses relevant to chosen specialization/branch - **Minor Stream**	6
3	Project work, seminar and internship in industry or elsewhere	26
4	Mandatory Courses [Environmental Sciences, Induction Programme, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
	Total	**80**

Table: Minimum Credit Requirement

S.No.	Broad Category of Course	**Minimum Credit Requirement**
		2-year PG
1	**Major (Core) (50% of total credit)**	**48**
2	**Skill Enhancement Courses (SEC) (from major & Minor)**	**-**
3	**Internship and Dissertation**	**26**
	Total	**74**

Semester- I

Sr. No.	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSMI111**	Advanced Biomolecules and Biochemistry	3	0	1	4	**150**
2.	**MSMI112**	Basics of Bioinformatics	3	0	1	4	**150**
3.	**MSMI113**	General Microbiology	3	0	1	4	**150**
4.	**MSMI114**	Molecular Diagnostics	3	0	1	4	**150**
5.	**MSMI115**	Biostatistics	2	0	0	2	**100**
6.	**MSMI116**	Mathematics	2	0	0	2	**100**
7.	**MSMI117**	BioPython	2	0	0	2	**100**

8.	**MSMI118**	Internship	2	0	0	2	**50**

Semester- II

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSIM211**	Advanced cell and Molecular Biology	3	0	1	4	**150**
2.	**MSIM212**	Research Methodology & IPR	3	0	1	4	**150**
3.	**MSIM213**	Bioprocess Engg. and Technology	3	0	1	4	**150**
4.	**MSIM214**	Advance Immunology and Virology	3	0	1	4	**150**
5.	**MSIM215**	NanoScience	2	0	0	2	**100**
6.	**MSIM216**	Drug Discovery	2	0	0	2	**100**
7.	**MSIM217**	Internship	2	0	0	2	**50**

Semester- III

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSIM311**	Project proposal preparation	3	0	1	4	**150**
2.	**MSIM312**	Emerging Technology	3	0	1	4	**150**
3.	**MSIM313**	Medical Microbiology	3	0	1	4	**150**
4.	**MSIM314**	Microbial Physiology	3	0	1	4	**150**
5.	**MSIM315**	Environmental Microbiology	2	0	0	2	**100**
6.	**MSIM316**	Agriculture and plant pathogen interaction	2	0	0	2	**100**
7.	**MSIM317**	Internship	2	0	0	2	**50**

Semester- IV

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSIM411**	Dissertation and Viva			20	20	**600**

About the Programme:

Science is the basic foundation of any technological and engineering creation. In view of the changing scenario at the national and international level in the field of Science and Technology, there is a great demand for basic sciences with considerable knowledge of its applications. GSFC University is committed to high academic standards.

The M..Sc. Biotechnology Program is an Honours Degree which is designed for four Semesters in such a way that a good basic foundation of subjects is laid and applications along with recent developments are covered. Students will also get theoretical and practical knowledge by undergoing industrial internship after every semester.

The more focused specialization course of Microbiology is designed to full fill recent demands of industrial career.

COURSE CODE MSIM111	COURSE NAME ADVANCED BIOMOLECULES AND BIOCHEMISTRY	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	30	0	75	3	1	0	4

Course Pre-requisites	Students should have basic knowledge about advanced biomolecules and biochemistry
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Advanced biomolecules and biochemistry are vital for students as they provide a comprehensive understanding of the molecular basis of life processes, laying the foundation for research and innovation in biotechnology, medicine, and drug discovery, thereby preparing students for careers in academia, industry, and healthcare.
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	**1. Remember** To introduce the field of advanced biomolecules and biochemistry. **2. Apply** To understand advanced biomolecules and biochemistry. **3. Analyses** Understanding of advanced biomolecules and biochemistry **4. Create** Understanding of strategies to study advanced biomolecules and biochemistry **5. Understand** advanced biomolecules and biochemistry

Course Content (Theory)	Weightage	Contact hours
Unit 1: Carbohydrate and its metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 2: Protein and amino acid and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 3: Lipids and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 4: Nucleic acid and it's metabolism: Structure, classification, function, clinical significance and metabolism.	**20%**	**9**
Unit 5: Cell membrane: It's integrity, complexity and molecular structure.	**20%**	**9**
Practical: 1.Preparing various stock solutions and working solutions that will be needed for the course. 2 To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law. 3 To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbeck Equation. 4 Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography. 5 Experimental verification that absorption at OD260 is more for denatured DNA as compared to native double stranded DNA. 6 Reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size. 7 Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments) 8 Biophysical methods (Circular Dichroism Spectroscopy, Fluorescence Spectroscopy). (Online: Video Tutorials) 9 Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry (Online: Video Tutorials)		

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** They will be able to recall and describe key biochemical pathways and processes involved in metabolism, signaling, and regulation within living organisms.	Remember	Explain, Describe, Discuss, Recall,
CO2 They will demonstrate the ability to summarize and compare different biochemical processes and their significance in cellular function and organismal physiology.	Apply	Interpret, Select,
CO3 Students will critically evaluate scientific literature and research findings related to advanced biomolecules and biochemistry, identifying strengths, weaknesses, and gaps in existing knowledge.	Analyses and Evaluation	Compare, Classify, Select,
CO4 Utilizing their knowledge of biomolecules and biochemical principles, students will analyze experimental data and design experiments to investigate biological questions or solve practical problems.	Create	Construct, Develop,
CO5 They will demonstrate creativity and innovation in problem-solving, synthesizing information to generate new insights or applications in biotechnology, medicine, or other relevant fields.	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources	
1.	Textbook & Reference Books 1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006).Biochemistry. VI Edition. 2. W.H Freeman andCo. 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists. 3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, US 4. A.L. Lehninger: Biochemistry.
2.	Journals & Periodicals 1. JBC 2. Current Science
3	Other Electronic resources: NPTEL

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM112	COURSE NAME BASICS OF BIOINFORMATICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
45	30	0	75	3	1	0	4

Course Prerequisites	Basic Knowledge of computers
Course Category	Core
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python Retrieve and analyze the biological data
Course Revision/ Approval Date:	06/03/2024
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** the basic concepts of python • **Understand** to edit and run Python code • **To analyze and evaluate** file-processing python programs that produce output to the terminal and/or external files • **Apply** the knowledge of python to analyse the biological data • **To Create** stand-alone python programs to process biological data

Course Content Theory) Bioinformatics	**Weigh tage**	**Contact hours**
Unit 1: Introduction to Bioinformatics , applications and biological databases Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XMLDTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.	**20%**	**9**
Unit 2: Pair wise alignment: Introduction, Dot Plot, Dynamic Programming, K-tuple, Fasta, Blast, Other Tools and Softwares. where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating	**20%**	**9**
Unit 3: Multiple sequencing alignment: Introduction, Dynamic Programming; Progessive, Iterative, Marakov, HMM Methods, CLUSTALW, Other Tools and Softwares flexible sequence similarity searching with the FASTA program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment	**20%**	**9**

Unit 4: Phylogenic Analysis: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence. Phylogenetic representations, Definition and description, various types of trees; Steps in constructing a tree, Consensus (strict, semi-strict, Adams, majority rule, Nelson). Data partitioning and combination. Tree to tree distances, similarity. Phylogenetic analysis algorithms: Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining, jackknife, Probabilistic models and associated algorithms such as Probabilistic models of evolution and maximum likelihood algorithm, Bootstrapping methods. Use of HMM-based Algorithm for MSA	**20%**	**9**
Unit 5: Data ethics and Database: Data ethics, Introduction to Databases, DBMS Definition, Characteristics of DBMS, Application and advantages of DBMS, Instances, Schemas and Database States, Three Levels of Architecture, Data Independence, DBMS languages, Data Dictionary, Database Users, Data Administrators.	**20%**	**9**

Practicals:

1. Retrieving sequences from public databases (e.g., NCBI GenBank, UniProt).
2. Performing sequence similarity searches using tools like BLAST (Basic Local Alignment Search Tool).
3. Pairwise sequence alignment (e.g., global alignment, local alignment) using tools such as EMBOSS Needle or BLAST.
4. Multiple sequence alignment (e.g., using ClustalW, MUSCLE) to align multiple sequences for comparative analysis.
5. Identifying open reading frames (ORFs) in nucleotide sequences.
6. Predicting protein structure and function from amino acid sequences using tools like InterProScan or Pfam.
7. Constructing phylogenetic trees using various methods (e.g., Neighbor-Joining, Maximum Likelihood).

Learning Resources	
1.	**Textbook & Reference Book** 1. Lesk,A.M.(2002).IntroductiontoBioinformatics.Oxford:OxfordUniversityPress. 2. Mount, D. W.(2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring 3. Harbor, NY: Cold Spring Harbor Laboratory Press. 4. Baxevanis, A. D.,& Ouellette, B. F.(2001). Bioinformatics: a Practical Guide to the 5. Analysis of Genes and Proteins. New York:Wiley-Interscience. 6. Pevsner,J.(2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell
2.	**Journals & Periodicals** 1. Journal of Bioinformatics and Computational Biology 2. Bioinformatics 3. Bioinformatics and Biology Insights 4. BMC Bioinformatics

	5. Briefings in Bioinformatics
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

Evaluation Scheme		**Total Marks 100**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	10 marks
	Presentation/ miscellaneous activities	15 marks

Course Outcomes	1.Develop an understanding of basic theory of biological databases.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of bioinformatics tools
	3. Critically analyse and interpret results of bioinformatic analysis
	4. Develop the abilities for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1

CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM117			**COURSE NAME GENERAL MICROBIOLOGY**			**SEMESTER I**	
Teaching Scheme (Hours)				**Teaching Credit**			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	30	0	75	3	1	0	4

Course Pre-requisites	Students should have basic knowledge about Microbiology.
Course Category	Specialization
Course focus	Employability
Rationale	To have an overview of microbial response and it's components. The subject also explains the structure, function and regulation of Bacterial, Virus, Fungus and their effect on Human, environment.
Course Revision/ Approval Date:	06/03/24
Course Objectives **(As per Blooms' Taxonomy)**	1. **Remember** To introduce the field of microbiology with special emphasis on microbial diversity. 2. **Apply** To study microbial morphology, physiology and nutrition. 3. **Analyses** To know the methods of culturing microorganisms 4. **Create** To get insights in the methods involved in controlling growth of microbes. 5. **Understand** Host- microbe interactions.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Microbiology: History and scope of microbiology,Microbial diversity and classification, Microscopic techniques for studying microorganisms, Microbial cell structure and function	**20%**	**9+4**
Unit 2: Microbial Nutrition, Growth and Metabolism: Microbial nutrition and culture media, Bacterial growth kinetics, Factors affecting microbial growth, Metabolic diversity among microorganisms	**20%**	**9+4**
Unit 3: Environmental microbiology: microbial ecology, bioremediation, and wastewater treatment, Medical microbiology: diagnosis, treatment, and prevention of infectious diseases	**20%**	**9+4**
Unit 4: Microbial Pathogenesis: Host-microbe interactions, Mechanisms of bacterial and viral pathogenesis, Immune response to microbial infections, Epidemiology and control of infectious diseases	**20%**	**9+4**
Unit 5: Applied Microbiology: Industrial microbiology: fermentation and biotechnology, Agricultural microbiology: plant-microbe interactions, biofertilizers, and biopesticides	**20%**	**9+4**
Practicals: 1. Gram staining technique to differentiate between Gram-positive and Gram-negative bacteria. 2. Simple staining techniques (e.g., using methylene blue, crystal violet) to observe bacterial morphology. 3. Inoculation techniques (streak plate, spread plate, pour plate) to isolate bacterial colonies. 4. Pure culture techniques and maintenance of bacterial cultures. 5. Biochemical tests.		

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1 To introduce the field of microbiology with special emphasis on microbial diversity.	Remember	Explain, Describe, Discuss, Recall, Locate
CO2 To study microbial morphology, physiology and nutrition.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To know the methods of culturing microorganisms	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To get insights in the methods involved in controlling growth of microbes	Create	Construct, Develop, Produce
CO5 Host- microbe interactions	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources	
1.	Reference books: 1. Textbook 1. D.K Maheshwari (1999) A textbook of Microbiology 2. R.Vasanthakumari (2007) Textbook of Microbiology. 3. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). Microbiology (5th ed.). New York: McGraw-Hill.. 4. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's Microbiology. New York: McGraw-Hill.. 5. Matthai, W., Berg, C. Y., & Black, J. G. (2005). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons. 6
2.	Journals & Periodicals 1. Journal of Microbiology 2. Current Science Journal, Indian journal of Biotechnology 3. Nature Review microbiology 4. Macromolecules
5	Other Electronic resources: 1) MH Education 2) NPTEL

Evaluation Scheme	Total Marks

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<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO 1	1	-	2	1	1	-
CO 2	1	3	2	2	-	-
CO 3	1	-	-	1	2	1
CO 4	2	3	2	-	2	2
CO 5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO 1	3	2	-	2	2	1
CO 2	-	1	1	2	-	-
CO 3	2	-	-	1	2	1
CO 4	2	1	2	3	2	2
CO 5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM114	COURSE NAME MOLECULAR DIAGNOSTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
45	30	0	75	3	1	0	4

Course Pre-requisites	Students should know have basic knowledge of molecular diagnostics.
Course Category	Specialization
Course focus	Specialization
Rationale	Scientific Temperament & Employability
Course Revision/ Approval Date:	6/03/2024
Course Objectives (As per Blooms' Taxonomy)	1. The objectives of this course are to sensitize students about recent advances in diagnostics and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including preor post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer 2. Adequate knowledge about recent advances and technological developments in the field of diagnostics 3. Selection of an appropriate diagnostic method/tool for a particular disease condition and sample type. 4. Expertise to perform any diagnostic test with an ability to troubleshoot. 5. The objectives of this course are to sensitize students about recent advances in molecular biology.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Molecular Diagnostics	**20%**	**10**
Unit 2: Nucleic Acid Amplification Techniques	**20%**	**10**
Unit 3: Regression Analysis: Simple linear regression, Multiple linear regression, Logistic regression, Model diagnostics and interpretation	**20%**	**10**
Unit 4: Survival Analysis: Kaplan-Meier estimator, Cox proportional hazards model, Survival curves and censoring, Applications in clinical trials and epidemiological studies.	**20%**	**10**
Unit 5: Diagnostic Assays for Infectious Diseases and Epidemiological Study Designs: Observational studies vs. experimental studies, Cross-sectional studies, Cohort studies, Meta-analysis	**20%**	**05**

Practicals:

- Extraction of DNA and RNA from various sample types (e.g., cells, tissues, blood) using different methods (e.g., phenol-chloroform extraction, silica-based columns).
- Setting up and performing PCR reactions to amplify specific DNA sequences.
- Assessment of nucleic acid quality and quantity (e.g., spectrophotometry, fluorometry)
- Quantitative measurement of DNA or RNA targets. By using RT PCR

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** Able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate

CO2 Acquire knowledge of various diagnostic tools used in healthcare, industry and research **CO3** Identify the role and importance of molecular diagnostics such as real-time PCR, epidemiological genotyping, microfluidics, bio-imaging and sequencing technologies **CO4** Students will be able to Incorporate both in silico and lab based techniques as part of a combined molecular diagnostics strategy. **CO5** Perform selected laboratory techniques, interpret results and prepare reports	Apply Evaluate Apply Understand, Remember& apply	Apply, Practice, Interpret, Select, Correlate Compare, Classify, Select, Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook 1. Campbell, A. M., & Heyer, L. J. (2006). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings. 2. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw- Hill. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press. 4. Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
2	Reference book : Molecular Diagnostics, 3rd Edition Editors: George P. Patrinos Wilhelm Ansorge Phillip B. Danielson. Hardcover ISBN: 9780128029718. eBook ISBN: 9780128029886
3	Journal : Journal of Molecular Diagnostics, Nature reviews
5	Periodicals: Current science
6	Other Electronic resources: NPTL and UGC Pathshala lectures

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
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<tr><td>Journal</td><td>5 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM115	COURSE NAME BIOSTATISTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
30	0	0	30	2	0	0	2

Course Pre-requisites	Students should have basic Biostatistics
Course Category	Elective
Course focus	Skill development
Rationale	In this course students will learn descriptive statistics and its basic applications in real life. Students will also learn different types of tests for Hypothesis testing. Sutdents will understand the concepts of correlation and learn the methods of regression. They will also get an exposure to differntial and integral calculus and learn to solve the system of linear equations.
Course Revision/ Approval Date:	06/3/24
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: **1 Remember:** Use mean and variance to visualise the data and making decisions. **2 Apply:** Use the degree and direction of association between two variables, and fit a regression model to the given data **3 Understand, Apply:** Identify the type of statistical situation to which different tests can be applied. **4 Understand:** the fundamental concepts of Derivatives and Integration of functions **5 Understand, Apply:** Explain what is meant by statistical inference and concepts of approximation for system of equations

Course Content (Theory)	Weightage	Contact hours
Unit 1: Limits, Complete and Partial Differentials of Function	**20%**	**6**
Unit 2: Majors of Central tendency and Measures of dispersion	**20%**	**6**
Unit 3: Introduction to theory of Probability and Theoitical Distribution	**20%**	**6**
Unit 4: Correlation Analysis and Regression Analysis	**20%**	**6**
Unit 5: Statistical Inference and Tests of Hypothesis, ANNOVA	**20%**	**6**

Instructional Method and Pedagogy: Chalk-board, Presentation, Use ofGeogebra. Group Discussion, Case Study, Quizziz application.

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Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1: **Apply:** Calculate the simple linear regression equation for a set of data and able to solve the system of equations	Apply	Describe, Find
CO2: **Remember, Understand:** Know the practical issues arising in sampling studies	Remember, Understand	Demonstrate & Examine, Find
CO3: **Apply, Analyse:** Appropriately interpret results of analysis of variance tests, would be able to understand the variation in distribution of the data and importance of hypothesis testing using different tests.	Apply, Analyse:	Describe, Demonstrate & Examine, Find
CO4: **Analyse:** Analyse statistical data using MS-Excel.The student would be able to correlate the given data and estimate the value of unknown variable.	Analyse:	Describe, Demonstrate & Examine

Learning Resources	
1.	Reference Books: 1. Probability and Statistics By T K V Iyengar, S chand, 3rd Edition, 2011. 2. Fundamentals of Mathematical Statistics by S C Gupta & V K Kapoor, Sultan Chand & Sons, New Delhi 2009.

2.	Journals & Periodicals:
3.	Other Electronic Resources: Geometry and Algebra: Geogebra.org/Calculator MATLAB : Mathworks.com/ https://www.tutorialspoint.com/matlab/matlab_syntax.htm

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**
Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.: 30 marks Practical understanding of the subject on the Project/Industrial.: 30 marks Industry/ University mentor's feedback on the Project/ Industrial.: 30 marks Attendance: 10 marks **Total: 100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	0	0	0	1	1
CO2	1	2	0	0	0	1	1
CO3	1	2	0	0	0	1	1
CO4	2	2	1	0	0	1	2
CO5	2	3	0	1	0	1	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	0	0
CO2	2	2	1	1	0	0
CO3	1	2	1	1	0	0
CO4	2	2	2	1	1	0
CO5	2	2	1	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM116	COURSE NAME BIOPYTHON	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
30	0	0	30	2	0	0	2

Course Prerequisites	Basic Knowledge of computers
Course Category	Elective
Course focus	Scientific Temperament & Employability
Rationale	Know how to develop your skills in Python. Retrieve and analyze the biological data
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	• **To Remember** the basic concepts of python • **Understand** to edit and run Python code • **To analyze and evaluate** file-processing python programs that produce output to the terminal and/or external files • **Apply** the knowledge of python to analyse the biological data • **To Create** stand-alone python programs to process biological data

Course Content (Theory)	Weightage	Contact hours
Unit 1 Execution paradigms: how the computer turns your program into something it can run (interpretation, native compilation, bytecode compilation) Basic execution and memory model (Von Neumann architecture), Version control (likely SVN and git)	**20%**	**9**
Unit 2 Imperative programming constructs: functions, if-statements, loops (for, while), switchstatements, expressions. Basic data structuring constructs: variables, arrays, strings, structs, types, and pointers, Reading and writing files	**20%**	**9**
Unit 3: Unit tests — testing small sections of code,Debugging — strategies, debuggers, common errors Profiling — figuring out what's taking so long, Make — automating compilation, Basic data structures and algorithm design techniques: Sophisticated data structures,and algorithms will be introduced, along with more difficult programming assignments.	**20%**	**9**
Unit 4: Linear data structures: arrays, lists, stacks, queues; binary search,Dictionary data structures: binary search trees including tree traversals (DFS, BFS,pre-, in-, post-order); hash tables.	**20%**	**9**

Unit 5: Heaps, heapsort,Graphs; MST, Divide and conquer, recursion Dynamic programming	**20%**	**9**

Course Outcomes	1. Develope an understanding of basic theoretical concepts of Python.
	2. Appreciate their relevance for investigating specific contemporary biological questions through the use of Biopython
	3. Understand the concepts of object-oriented programming as used in Python
	4. Learn Biopython to enhance your skills for conducting in silico experiments.
	5. Demonstrate mastery of the core concepts of Bioinformatics
Additional Information to enhance learning	Expert talk required on specific topics.

Learning Resources	
1.	**Textbook & Reference Book** 1) Python: - The Bible- 3 Manuscripts in 1 Book: -Python Programming for Beginners -Python Programming for Intermediates -Python Programming for Advanced by Maurice J Thompson 2) Learning python (5th Edition) by Mark Lutz, O'Reilly Media, Inc (2013). ISBN:9781449355739 3) Python programming for biology by Tim J. Stevens and Wayne Boucher. Cambridge University Press 1st Ed. (2015) ISBN:9780511843556
2.	**Journals & Periodicals**

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Skill enhancement activities / case study	15marks
Presentation/ miscellaneous activities	10 marks
Total	**40 Marks**

Practical Marks

Attendance	05 marks
Practical Exam	30 marks
Viva	10 marks
Journal	5 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	3	3	1	2	0	3
CO2	2	2	3	2	1	2
CO3	3	2	3	2	2	2
CO4	2	3	2	2	1	1
CO5	3	2	2	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	0	0	2	0
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	2
CO4	1	3	2	1	3	3
CO5	2	2	3	2	3	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM1117	COURSE NAME MATHEMATICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
30	0	00	30	2	0	0	2

Course Pre-requisites	Students should have basic knowledge of Mathematics and statistics
Course Category	Elective
Course focus	Skill development
Rationale	In this course students will learn descriptive mathamatics and its basic applications in real life.
Course Revision/ Approval Date:	06/03/2024
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: **1 Remember:** Use mean and variance to visualise the data and making decisions. **2 Apply:** Use the degree and direction of association between two variables, and fit a regression model to the given data **3 Understand, Apply:** Identify the type of statistical situation to which different tests can be applied. **4 Understand:** the fundamental concepts of Derivatives and Integration of functions **5 Understand, Apply:** Explain what is meant by statistical inference and concepts of approximation for system of equations

Course Content (Theory)	Weightage	Contact hours
Unit 1: Basics of algebra, Linear algebra	**20%**	**6**
Unit 2: Matrices and determinants	**20%**	**6**
Unit 3: Trigonometry and its identities	**20%**	**6**
Unit 4: Geometry	**20%**	**6**
Unit 5: Discrete mathematics	**20%**	**6**

Instructional Method and Pedagogy: Chalk-board, Presentation, Group Discussion, Case Study, Quiz application.

- Course Outcome:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1: **Apply:** Calculate the simple linear regression equation for a set of data and able to solve the system of equations	Apply	Describe, Find
CO2: **Remember, Understand:** Know the practical issues arising in sampling studies	Remember, Understand	Demonstrate & Examine, Find
CO3: **Apply, Analyse:** Appropriately interpret results of analysis of variance tests, would be able to understand the variation in distribution of the data and importance of hypothesis testing using different tests.	Apply, Analyse:	Describe, Demonstrate & Examine, Find
CO4: **Analyse:** Analyse statistical data using MS-Excel.The student would be able to correlate the given data and estimate the value of unknown variable.	Analyse:	Describe, Demonstrate & Examine

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1. Fundamentals of Mathematical Statistics by S C Gupta & V K Kapoor, Sultan Chand & Sons, New Delhi 2009.
2. Higher Engineering Mathematics By Dr. B. S. Grewal, Khanna Publishers
3. Differential Calculus, Shanti Narayan, P.K. Mittle, S. Chand, New Delhi 2005
4. Integral Calculus, Shanti Narayan, P.K. Mittle, S. Chand, New Delhi 2005</td></tr>
<tr><td>2.</td><td colspan="2">Journals & Periodicals:
Mathematics Open</td></tr>
<tr><td>3.</td><td colspan="2">Other Electronic Resources:
Geometry and Algebra: Geogebra.org/Calculator
MATLAB : Mathworks.com/
https://www.tutorialspoint.com/matlab/matlab_syntax.htm</td></tr>
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Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	0	0	0	1	1
CO2	1	2	0	0	0	1	1
CO3	1	2	0	0	0	1	1
CO4	2	2	1	0	0	1	2
CO5	2	3	0	1	0	1	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	0	0
CO2	2	2	1	1	0	0
CO3	1	2	1	1	0	0
CO4	2	2	2	1	1	0
CO5	2	2	1	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM211	COURSE NAME ADVANCED CELL AND MOLECULAR BIOLOGY	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
45	30	0	75	3	1	0	4

Course Pre-requisites	Students should know have basic knowledge of Cell and Molecular Biology
Course Category	Compulsory
Rationale	As we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomesdeeper and inclusive.
Course Revision/ Approval Date:	06/03/2024
Course Objectives (As per Blooms' Taxonomy)	**Remember** To introduce the advanced field of cell and molecular biology. **Apply** To understand advanced cellular and molecular functions. **Analyses** Underlying mechanisms of cellular and molecular functions. **Create** Understanding of strategies to develop drugs based on gained knowledge. **Understand** Drugs discovery and development based on basic cellularfunctions.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Cellular Membranes and Organelles	**20%**	**10**
Unit 2: Gene Expression and Regulation	**20%**	**10**
Unit 3: Signal Transduction Pathways	**20%**	**10**
Unit 4: Molecular Genetics	**20%**	**10**
Unit 5: Cell Cycle Regulation and Cell Division, Stem Cells and Regenerative Medicine	**20%**	**10**

Practicals:

1. Genomic DNA Extraction, Purification and Quantitation
2. Plasmid DNA Extraction, Purification and Quantitation
3. RNA Extraction, Purification and Quantitation
4. Protein Extraction,
5. Protein Purification
6. Protein Quantitation
7. Observation of various cell types under Microscope
8. Cell cycle analysis – onion root tip experiment
9. Cell counting and viability test
10. Sub cellular fractionation of cellular organelle (nuclear, mitochondrial and cytosolic fraction) by differential centrifugation
11. To demonstrate selective permeability of an artificial membrane (cellophane)
12. Preparation of human karyotype

Instructional Method and Pedagogy: Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** The structure, function, and biosynthesis of cellular membranes and organelles.	Understand, Remember & apply	Explain, Describe, Discuss, Recall, Locate

CO2 Cell growth and cell cycle regulation	Apply	Apply, Practice, Interpret,
CO3 Cellular transport, receptors, and cell signaling	Evaluate	Select, Correlate
CO4 The cytoskeleton, the extracellular matrix, and cell movements	Apply	Compare, Classify, Select,
CO5 Gene expression and regulation	Understand, Remember & apply	Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook 1. Alberts, B., Johnson, A., Lewis, J.,Raff, M., Roberts, K., & Walter,P.(2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. 2. Lodish, H. F.(2016). Molecular Cell Biology (8thEd.). New York:W.H.Freeman. 3.Krebs,J.E.,Lewin,B.,Kilpatrick,S.T.,& Goldstein,E.S.(2014).Lewin'sGenesXI. Burlington, MA: Jones & Bartlett Learning. 4.Cooper,G.M.,&Hausman,R.E.(2013).TheCell:aMolecularApproach(6thEd.). Washington: ASM ; Sunderland. 5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W.M. (2012). Becker's World of the Cell. Boston (8th Ed.). BenjaminCummings. 6. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings. Reference books 1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. 2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. VIII Edition. 3. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. V Edition. ASMPress
2	Journals & Periodicals Journal https://www.omicsonline.org/cellular-and-molecular-biology.php 1. Resonance 2. Current Science 3. Science Reporter 4. Safari
3	Other Electronic resources: 1) MH Education 2) NPTEL E- Links 1. The Inner Life of the Cell

	2. Mitosis World Movies 3. Davidson College Biology Videos 4. Borisy Lab Movie Page 5. The Biology Project Meiosis I and II Movies

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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM212	COURSE NAME RESEARCH METHODOLOGY AND IPR	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
45	30	0	75	3	1	0	4

Course Pre-requisites	Basic Understanding of Science and Communication.
Course Category	Compulsory
Course focus	Employability
Rationale	To have an idea how research methodology lies in its ability to provide a systematic approach to investigating and answering research questions. It serves as a roadmap for researchers, helping them design and conduct their studies effectively and ensure the validity and reliability of their findings. Here are a few key points that highlight the rationale behind research methodology
Course Revision/ Approval Date:	06/03/24
Course Objectives **(As per Blooms' Taxonomy)**	**Remember:** To give background on history of science, emphasizing methodologies used to do research and India's IPR Policy. **Apply:** To introduce the framework of research methodologies for understanding effective lab practices and scientific communication and intellectual property rights and their implications in biological research and product development. **Analyses:** To inculcate scientific and professional ethics to learn biosafety and risk assessment of biotechnology products **Create:** To impart skills related to various media for scientific communication and regulations of products derived from biotechnology **Understand:** To impart basic knowledge of lab skills to learn risk assessment on biotechnology and microbiology, become familiar with ethical issues in biological research.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Research Methodology: Definition and importance of research, Types of research (qualitative, quantitative, mixed methods), The research process (formulating research questions, hypothesis, etc.) Ethical considerations in research	**20%**	**9**
Unit 2: Research Design: Experimental design Quasi-experimental design, Non-experimental design	**20%**	**9**
Unit 3: Sampling Techniques, Data Collection Methods and Analysis, research writing and ethics.	**20%**	**9**
Unit 4: Introduction To Intellectual Property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs	**20%**	**9**
Unit 5: International Framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction history of GATT, WTO, WIPO and TRIPS	**20%**	**9**

Practicals:

1. Discussing ethical considerations in research involving human subjects, animals, and biohazards.
2. Understanding regulatory requirements (e.g., IRB approval, animal care protocols).
3. Conducting literature searches using databases like PubMed, Google Scholar.
4. Critical evaluation and synthesis of scientific literature relevant to a research topic.
5. Formulating testable hypotheses based on literature review and research questions.
6. Designing experiments to test hypotheses, including control and experimental group considerations.

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1** To become familiar with India's IPR Policy, and research methodology	Remember	Explain, Describe, Discuss, Recall, Locate
CO2 To provide basic knowledge on intellectual property rights andtheir implications in biological research and product development and	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To learn biosafety and risk assessment of biotechnology products and learn about research methodology and to inculcate scientific and professional ethics	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To become familiar with regulations of products derived frombiotechnology and to learn about research methodology	Create	Construct, Develop, Produce
CO5 To learn risk assessment on biotechnology and microbiology, become familiar with ethical issues in biological research,	Understand	Explain, Describe, outline, Predict, Summarize

Learning Resources

1.	On Being a Scientist: a Guide to Responsible Conduct Research. (2009). Washington, D.C.: National Academies Press. Gopen, G. D., & Smith, J.A. The Science of Scientific Writing. American Scientist,78 (Nov-Dec 1990), 550-558. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
2.	Ganguli,P.(2001).Intellectual Property Rights: Unleashing TheKnowledge Economy. New Delhi: Tata McGraw-Hill Pub National IPR Policy, Department ofIndustrial Policy & Promotion, Ministry of Commerce, GoI
5	Complete Reference to Intellectual Property Rights Laws. (2007). Snow White PublicationOct. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell. Karen F.Greif and Jon F. Merz, Current Controversies in the Biological Sciences - Case Studies of Policy Challenges from New Technologies, MIT Press. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J.W., Burachik, M., Gray, A., Wu,F.

	(2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9 Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features Of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007- 9643-8 Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008. Journals & Periodicals 1. International Journal of Research Methodology 2. International Journal of Science and Research Methodology 3. The WIPO Journal Periodicals: Journal of Research Practice • Other Electronic resources: Movies: Naturally Obsessed, The Making of a Scientist • Office the Controller General Patents, Designs & Trademarks; Department Of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/ 2. World Intellectual PropertyOrganisation. http://www.wipo.int 3. International Union for the Protection of New Varieties of Plants. http://www.upov.int 4. World Trade Organisation. http://www.wto.org 5. National Portal of India. http://www.archive.india.gov.in 6. • National Biodiversity Authority. http://www.nbaindia.org 7. Recombinant DNA SafetyGuidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/ divisions/csurv/geac/annex- • 5.pdf

Evaluation Scheme	Total Marks

Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Skill enhancement activities / case study	15 marks
Presentation/ miscellaneous activities	10 marks
Total	**40 Marks**

Practical Marks	

Attendance	5 marks
Practical Exam	30marks
Viva	5 marks
Journal	5marks
Discipline	5marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	2	-	2	1	1	-
CO2	1	-	2	2	-	-
CO3	-	-	-	1	2	1
CO4	1	3	2	-	2	1
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	-	2	-	2	2	1
CO2	1	2	1	2	-	-
CO3	2	-	-	1	-	1
CO4	1	1	2	-	2	2
CO5	-	1	-	2	-	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM213	COURSE NAME BIOPROCESS ENG &TECH	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Pre-requisites	Basic Understanding of industrially important microorganisms
Course Category	Core.
Course focus	Scientific Temperament & Employability
Rationale	Bioprocess engineering is an ever growing field since it is a combination of natural resources, Science and technology. The basic science provides us with the knowledge about the living organisms such as plants, animals, bacteria and fungi but the bioprocess engineering helps in development of the essential skills required to utilise the living organisms for the betterment of the human beings and the nature itself.
Course Revision/ Approval Date:	06/03/2024
Course Objectives (As per Blooms' Taxonomy)	1. **Remember:** Basics of Microbiology 2. **Apply:** The basic concepts to industrial applications 3. **Analyses:** Integration of science with technology. 4. **Create:** Models of Industrial designs and applications 5. **Understand:** How living organisms can be used for value creation, product manufacturing and societal development.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Bioprocess Engineering: Overview of bioprocess engineering principles, Applications of bioprocess engineering in biotechnology and industrial microbiology, Role of bioprocess engineers in various industries.	**20%**	**9**
Unit 2: Microbial Fermentation: Fundamentals of microbial fermentation, Types of fermentation processes (batch, fed-batch, continuous), Fermentation kinetics and modelling	**20%**	**9**
Unit 3: Bioreactor Design and Operation, Downstream Processing, Process Optimization and Scale-Up	**20%**	**9**
Unit 4: Emerging Trends in Bioprocess Engineering	**20%**	**9**

Practicals:

1. Isolation of industrially important microorganism from soil samples
2. Screening of industrially important microorganism
3. Optimization of suitable conditions for industrially important product
4. Isolation of amylase enzyme producing bacteria and amylase enzyme estimation
5. Immobilization of enzyme
6. Fermentor studies
7. Production of industrially important product by using fermentor

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		Explain, Describe, Discuss, Recall, Locate
CO1 To educate students about the fundamental concepts of bioprocess technology	Remember	
CO2 To know the relevance of microorganisms from industrial context	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To know the importance of design and operations of various industrial fermenters	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To get a knowhow of basic methods involved in production of biobased products	Create	Construct, Develop, Produce

CO5 To meet the challenges of the new and emerging areas of biotechnology industry	Understand	Explain, Describe, outline, Predict, Summarise
Learning Resources		

1.	Textbook: 1. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill. 2. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis. Reference books 1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall. 2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press. 3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York: M. Dekker.
2.	7. Periodicals: Science Daily 8. Journal: Current Science, Biotechnology and Bioprocess Engineering
3	Other Electronic resources: 1) NPTEL 2) SWAYAM 3) UGC - epathshala 4) indiabioscience.org

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Skill enhancement activities / case study	15 marks
Presentation/ miscellaneous activities	10 marks
Total	**40 Marks**

Practical Marks	

Attendance	5 marks
Practical Exam	30 marks
Viva	05 marks
Journal	05 marks
Spotting	5 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	2	-	2	1	1	-
CO2	1	-	2	2	-	-
CO3	-	-	-	1	2	1
CO4	1	3	2	-	2	1
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	-	2	-	2	2	1
CO2	1	2	1	2	-	-
CO3	2	-	-	1	-	1
CO4	1	1	2	-	2	2
CO5	-	1	-	2	-	-

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM214	COURSE NAME ADVANCE IMMUNOLOGY AND VIROLOGY	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	1	0	75	3	1	0	4

Course Pre-requisites	Basic Understanding of Science and Communication.
Course Category	Specialization
Course focus	Employability
Rationale	Immunology seeks to unravel the complexities of the immune system, which is responsible for defending the body against pathogens and maintaining overall health. By studying immunology, we gain insights into how our bodies protect against infections, recognize and eliminate cancer cells, and regulate immune responses.
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	**1. Remember:** To learn about structural features of components of immune system as well as their function **2. Apply:** To gain knowledge on development of the immune system **3. Analyses:** To predict about nature of immune response that develops against bacterial, viral or parasitic infection **4. Create:** To understand the mechanisms by which our body elicits immune response **5. Understand** To understand basic immunological methods involved in research and clinical/applied science

Course Content (Theory)	Weightage	Contact hours
Unit 1: Immunology: fundamental concepts and overview of the immune system, Components of the immune system	**20%**	**9**
Unit 2: Immune responses generated by B and T lymphocytes, Antigen and antibodies interaction	**20%**	**9**
Unit 3: Types: Active and passive immunity, Hypersensitivity (HS) and its types, Auto immunity, Transplantation	**20%**	**9**
Unit 4: Classification, Morphology, size, ultra structure and life cycle of some representative viruses, Cultivation and purification of viruses	**20%**	**9**
Unit 5: Virus-cell interaction, Host cell response to viral infections, Vaccine development and application, Vaccine trials and good clinical practice	**20%**	**9**

Practicals:

1. Identification of various immune cells by morphology – Leishman staining, Giemsa staining. 2.
2. Differential counts.
3. Total counts.
4. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.
5. Haemagglutination Reactions- Blood Grouping – forward and reverse, Rh Typing, Coomb's test, TPHA.
6. Visit to blood bank.
7. Serum electrophoresis.
8. PAGE of serum proteins.
9. ELISA
10. Enrichment of bacterial Phages
11. Plaque assay
12. Phage titre estimation

Instructional Method and Pedagogy:
Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		Explain, Describe, Discuss, Recall, Locate
CO1 To learn about structural features of components of immune system as well as their function	Remember	
CO2 To gain knowledge on development of the immune system	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To predict about nature of immune response that develops against bacterial, viral or parasitic infection	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To understand the mechanisms by which our body elicits	Create	Construct,

immune response **CO5** To understand basic immunological methods involved in research and clinical/applied science	Understand	Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1.	Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
2.	Reference books : 1. Brostoff, J., Seaddin, J.K., Male, D.,& Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub. 2. Murphy, K., Travers, P., Walport, M., & Janeway,C. (2012). Janeway's Immunobiology. New York: GarlandScience. 3. Paul, W.E. (2012). Fundamental Immunology. New York:Raven Press. 4. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodiesin Cell Biology, Biochemistry, and Immunology. London: Academic Press. 5. Parham, P.(2005). The Immune System. New York:Garland Science.
3. 4. 5.	Journals: 1. Journal of Immunology 2. Molecular Immunology 3. Nature Review immunology Periodicals: The scientist Other Electronic resources: h**ttps://www.immunology.org/**

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Skill enhancement activities / case study	15 marks
Presentation/ miscellaneous activities	10 marks
Total	**40 Marks**

Practical Marks	

Attendance	05 marks
Practical Exam	30 marks
Viva	10 marks
Journal	05 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	3	1	2	3	-
CO2	2	2	2	2	-	-
CO3	1	1	-	1	1	-
CO4	-	1	1	-	2	1
CO5	-	-	1	1	-	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	1	-	2	2	3
CO1	2	-	3	2	2	2
CO2	3	1	3	3	3	3
CO3	2	2	1	-	2	2
CO4	3	1	-	-	2	3
CO5	3	1	-	2	2	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM215	COURSE NAME NANOSCIENCE	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
30	0	0	30	2	0	0	2

Course Pre-requisites	Bachelor of Science degree in the necessity
Course Category	Skill Enhancement Elective
Course focus	Employability
Rationale	There is plenty of room at the bottom. Nanomaterials have revolutionized almost all spheres of human activity ranging from health care to chemical and biochemical industries. Nanomaterials exhibit astounding properties and devices based on nanomaterials are highly efficient making the knowledge of the science underlying the function of the nanomaterials inevitable. This has been the rational behind offering the course on "Nanoscience" to the master of science students specializing in either Biotechnology or microbiology
Course initiated/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	1. To equip the students with the knowledge on the Science of nanoworld and to show them that there is indeed plenty of room at the bottom 2. To equip the students with the skill to characterize nanomaterials 3. To make the students understand about the application of nanomaterials in medicine, drug, food and cosmetic industries. 4. To make the students understand about the application of nanomaterials in sensors and artificial implants. 5. To make the students understand about the application of nanomaterials in catalysis, energy sector and to expose the students to the frontiers of nanoscience, including space and marine exploration.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Nanobiotechnology; Concepts, Different formats of nanomaterials and applications	**20%**	**6**
Unit 2: Nano – particles and Nano material Development : Concepts, optimization of nanoparticle properties and development	**20%**	**6**
Unit 3: Methods of characterization of nanomaterials: XRD, XPS, SEM, TEM, XRM; properties of nanomaterials	**20%**	**6**

Unit 4: Applications of nanomaterials: Medicine; drug; food;agriculture; cosmetics; sensors, artificial implants,diagnostics,therapy, nanodevice	**20%**	**6**
Unit 5: Nano – toxicity and Life Cycle Assessment	**20%**	**6**

Instructional Method and Pedagogy:
Classroom lecture, discussion, question and answer method, Case studies, quizzes, presentations, role play, expert lecture (consultant), imaginative approach to view the nanoobjects in action.

Course outcomes:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to:		
CO1: know the science of nanomaterials and their synthesis methods	Cognitive	Understand, apply
CO2: understand the peculiar and unique properties of nanomaterials	Cognitive	Understand, apply
CO3: understand the application of nanomaterials in the fields of medicine, food, drug and cosmetic industries	Cognitive	Understand, apply
CO4: understand the application of nanomaterials in the fields of sensors and artificial implants	Cognitive	Understand, apply
CO5: understand the application of nanomaterials in the fields of catalysis, energy, surveillance and defense; know the frontiers of nanoscience related to space and marine exploration	Cognitive	Understand, apply and create

Learning resources	
1	Reference books: 1. CNR Rao, A Muller, A K Cheetham (Editors), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley-VCH, 2. B Viswanthan, Nanomaterials, Narosa publishing house, New Delhi, 3. Nanomedicine,
2	Journals & Periodicals: ACS Nano, ACS publishers Small, Wiley
3	Other Electronic Resources:

Evaluation Scheme	**Total Marks**	
Theory: Mid semester Marks	20 marks	
Theory: End Semester Marks	40 marks	
Theory: Continuous Evaluation Component Marks	Attendance	05 marks
	MCQs	10 marks

	Open Book Assignment	15 marks
	Open Book Assignment	10 marks
	Total	**40 Marks**
Practical Marks	Attendance	05 marks
	Practical Exam	20 marks
	Viva	10 marks
	Journal	10 marks
	Discipline	05 marks
	Total	**50 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	2
CO2	1	2	3	1	1
CO3	2	-	1	2	2
CO4	1	2	2	3	3
CO5	2	3	1	2	4

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	2
CO2	3	1	2	1	1
CO3	1	2	-	2	1
CO4	2	1	2	3	3
CO5	1	2	3	2	4

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM216	COURSE NAME DRUG DISCOVERY	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
30	0	0	30	2	0	0	2

Course Pre-requisites	Bachelor of Science degree in the necessity
Course Category	Skill Enhancement Elective
Course focus	Employability
Course initiated/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	1 This course will give a broad overview of research and development carried out in industrial setup towards drug discovery. 2 It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening 3 Safety evaluation, bioavailability, clinical trials, and the essentials of patent law will also be discussed. 4 Along the way you will learn about molecular recognition, computer aided drug design, and toxicology as applied to the development of new medicines. 5 This course develops the key themes in the drug discovery and development pipeline and highlights the multidisciplinary nature of the research and development process.

Course Content	Weightage	Contact hours	Pedagogy
Unit 1: Introduction to Drug Discovery and Development (In Silico and In Vivo Models)	20%	06	Power point, Power point + Video, Chalk & Board, Students' seminar, Quiz etc
Unit 2: Molecular Dynamics simulation	20%	06	Power point, Power point + Video, Chalk & Board, Students' seminar, Quiz etc
Unit 3: Combinatorial Chemistry Analysis and design of combinatorial libraries	20%	06	Power point, Power point + Video, Chalk & Board, Students' seminar, Quiz etc
Unit 4: Drug Designing & The identification of novel drug targets	20%	06	Power point, Power point + Video, Chalk & Board, Students' seminar, Quiz etc
Unit 5: In Vivo Drug Validation	20%	06	Power point, Power point + Video, Chalk & Board, Students' seminar, Quiz etc

Learning Resources	
1.	Textbook: 1. Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1 st edition 2006. 2. Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012. 3. An introduction to medicinal chemistry. G. L. Patrick. 5 th Edition Oxford UK, Oxford University Press, 2013.
2.	Reference books 1. Krogsgaard-Larsen et al. Textbook of Drug Design and Discovery. 4th Edition. CRC Press. 2. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell. 3. Nally, J. D. (2006) GMP for Pharmaceuticals. 6th edition. CRC Press 4. Brody, T. (2016) Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines. Academic Press.
3.	Journal: 1. Drug Discovery Today. 2. Natures Review Drug Discovery. 3. Drug, Discovery, Development and Therapy.
4.	Periodicals: 1. SLAS Discovery. 2. Marine Drugs.
5.	Other Electronic resources: NCBI, ENSEMBL, VISTA, UCSC etc

Evaluation Scheme		**Total Marks 50**
Mid semester Marks	20	
End Semester Marks	40	
Continuous Evaluation Marks	Attendance	5 marks
	Quiz	10 marks
	Skill enhancement activities / case study	15 marks
	Presentation/ miscellaneous activities	10 marks

Course Outcomes	1. On completion of this course, students should be able to understand the basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.
	2. Demonstrate an understanding of the steps involved in the drug discovery and design process.
	3. Demonstrate an awareness of the important contributions the different discipline areas make to the drug discovery and development process
	4. Critically analyse biological pathways for their potential as drug targets for a given disease.
	5. Demonstrate the ability to use evidence-based approaches to guide decision making during the drug discovery and development process.
Additional Information to enhance learning	Any site visit required or expert talk required on specific topics.

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	3	1	2	3	-
CO2	2	2	2	2	-	-
CO3	1	1	-	1	1	-
CO4	-	1	1	-	2	1
CO5	-	-	1	1	-	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	1	-	2	2	3
CO1	2	-	3	2	2	2
CO2	3	1	3	3	3	3
CO3	2	2	1	-	2	2
CO4	3	1	-	-	2	3
CO5	3	1	-	2	2	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM301			COURSE NAME MEDICAL MICROBIOLOGY			SEMESTER III	
Teaching Scheme (Hours)				**Teaching Credit**			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	0	0	45	3	0	0	3

Course Prerequisites	Students should have basic knowledge about Microbiology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	To gain an understanding of mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora..
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	**1. Remember** Concepts of basic Microbiology **2. Apply** understanding pathogenic microorganisms **3. Analyses** the mechanisms by which they cause disease in the human body **4. Create** an understanding how interactions network develops **5. Understand** applications both scientific and industrial

Course Content (Theory)	**Weightage**	**Contact hours**
Unit 1: Theory: Infection: types of infection, sources of infection, reservoirs and vehicles of infection, predisposing factors. Host-parasite relationship governing the infection and establishment of disease, factors affecting virulence. Normal microflora of the human body: normal flora of skin, respiratory, gastrointestinal, genital tract, role of resident flora, concept of probiotics. Mode of spread of infection; Respiratory, skin, wound & burn infection, venereal infections, alimentary tract infection, blood borne infection and nosocomial infection.	**20%**	**9**

Unit 2: Infection mechanism Theory: Infections caused by Gram positive cocci and Gram-negative cocci: Source of infection, Pathogenicity, Epidemiology & Lab diagnosis of *Staphylococcus, Streptococcus and Neisseria* (meningitis, gonorrhea). Infections caused by Gram negative bacteria of family Enterobacteriaceae: Source of infection, Pathogenicity, Epidemiology & Lab diagnosis of *E.coli, Klebsiella, Proteus, Pseudomonas, Shigella dysenteriae and Salmonella typhi*. Infection caused by Gram Positive bacilli: Source of infection, Pathogenicity, Epidemiology & Lab diagnosis of *Corynebacterium diphtheriae, Bacillus anthracis,Clostrodium tetani, Vibrio cholerae*. Disease caused by acid-fast bacteria and intracellular bacteria: Source of infection, Pathogenicity, Epidemiology & Lab diagnosis of Mycobacterium tuberculosis, *Mycobacterium leprae, Rickettsia and Chlamydia*.	**20%**	**9**
Unit 3: Pathogenic Micro-organism: Theory: Morphology, pathogenesis, immune response, diagnosis and prevention of- Pox viruses (Variola, Vaccinia, Small pox) Herpes Simplex type I and type II, Picorna viruses (Entero viruses and Polio viruses). Paramyxo viruses (Rubella virus and Para influenza viruses), Orthomyxo viruses (Measles & Mumps viruses). Hepatitis viruses (Type A, B, C, D, E), Arbo viruses (Alpha virus and Flavi viruses), Rhabdo viruses (Rabies virus). Oncogenic viruses, HIV virus.	**20%**	**9**
Unit 4: Infection Life cycle Theory: Important protozoal diseases: Route of entry, Life Cycles, Immunity, disease produced, diagnosis & prophylaxis of *Plasmodium vivax, P. falciparum, P. malariae (Malaria), Entamoeba histolytica & Entamoeba coli (amoebiasis*), Route of entry, Life Cycles, Immunity, disease produced, diagnosis & prophylaxis of *Leishmania, Trypanosoma and Toxoplasma*. Fungal infections: description & classification of pathogenic fungi, Infection caused by dermatophytes (*Microsporum, Trichophyton & Epidermatophyton*) Definition, Causative agent, Source of infection, Epidemiology, Symptomatology & Diagnosis of Candidiasis, Aspergillosis and Histoplasmosis.	**20%**	**9**
Unit 5: Antimicrobial agents Theory: Antimicrobial agents: Histroy, Antibiotics, Antifungal and Antivirals (common drugs, their spectrum and mode of action). Methodologies for testing of antibacterial, antifungal, and antiviral drugs (in vivo and in vitro infectivity models), mechanism drug resistance. Preclinical development: Safety profile of drugs (Pyrogenecity, Toxicity –hepato, -nephro, -cardio and neurotoxicity), Toxicological evaluation of drug (LD50, Acute, subacute and chronic toxicity), Mutagenecity (Ames test, micronucleus test) and Carcinogenicity. Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials –Objectives, Conduct of trials, Outcome of trials	**20%**	**9**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practicalexercises are designed to understand the theory as taught in the classroom. Hands on in practicalsession.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1 To understand the basic principles of medical microbiology and infectious disease.	Remember	Explain, Describe, Discuss, Recall, Locate
CO2 To gain an understanding of mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To provide the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.	Create	Construct, Develop, Produce
CO5 To explain the methods of microorganisms control, e.g. chemotherapy	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources	
1.	Textbook & Reference Book 1. Medical Microbiology; Jawetz, Melnick, & Adelberg's, Fifth edition, MacGrow Hills 2. Medical Bacteriology, Medical Mycology and AIDS; N.C.Dey, T.K. Dey and D. Sinha, New Central Book Ajency (P) Ltd. 3. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B Lippincott Company, USA 5. 4. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi. 5. Principles of Therapeutics, Burn J. H., Blackwell Scientific Pub. O. Ltd. Oxford. 6. Principles of Drug Action, The Basis of Pharmacology, Goldstein A., Aronow L., and Kalman S. M., Harper international edition New York. Mannfred A. Holliger, (2008), Introduction to pharmacology, 3rd Ed., CRC Press

2. 3	7. Journals & Periodicals 8. JBC, 9. Science, 10. Plos biology 11. Periodicals: current science 12. Other Electronic resources: 1) MH Education 2) NPTEL

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	30 marks
Theory: End Semester Marks	50 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 05 marks Skill enhancement activities / case study: 05 marks Presentation/ miscellaneous activities: 05 marks **Total: 20 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 30 marks Viva: 10 marks Journal: 5 marks **Total: 50 Marks**

Mapping of PSOs and COs

PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM302			COURSE NAME EMERGING TECHNOLOGIES			SEMESTER III	
Teaching Scheme (Hours)				**Teaching Credit**			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	0	0	45	3	0	0	3

Course Prerequisites	Students should have basic knowledge about Microbiology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences.
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	1. **Remember** Concepts of new technologies 2. **Apply** understanding Experimental approches 3. **Analyses** appreciate current-day research tool-kit. 4. **Create** an understanding how interactions network develops 5. **Understand** applications both scientific and industrial

Course Content (Theory)	Weightage	Contact hours
Unit 1: Microscopy Theory: **Optical microscopy methods** Basic Microscopy: Light Microscopy: lenses and microscopes, resolution: Rayleigh's Approach,Darkfield;PhaseContrast;DifferentialInterferenceContrast;fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent, fluorescence microscope; optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture; CCD cameras; back illumination, binning; recording colour; three CCD elements with dichroic beams platters, boosting the signal. **Advanced Microscopy:** Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers &solid-state, primary beam splitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; BeyondtheDiffractionLimit:StimulatedEmissionDepletion(STED),Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM)	**20%**	**9**
Unit 2: Mass spectroscopy Theory: **Mass spectroscopy** Ionization techniques; mass analysers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phosphor proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.	**20%**	**9**
Unit 3: System & Structural Biology Theory: **Systems biology** High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modelling and designing testable predictions. **Structural biology** X-ray diffraction methods, solution &solid-state NMR, cryo-electron microscopy, small angle X-ray scattering, atomic force microscopy.	**20%**	**9**

Unit 4: CRISPR technology Theory: **CRISPR-CAS** History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for in vivo genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.	**20%**	**9**
Unit 5: NANOBODIES Theory: Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.	**20%**	**9**
Practicals: • Hand on use of ELISA • Demonstration of GC • Demonstration of HPLC • Hands on use of fluorescent microscope • Demonstration of AAS • Demonstration of RT-PCR • Demonstration of Fermentation		

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.

Course outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		Explain, Describe, Discuss, Recall, Locate
CO1 This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences.	Remember	
CO2 The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Understanding the need for Technologies	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 Understanding the advanced technologies.	Create	Construct,
		Develop, Produce

CO5 Applications of Emerging Technologies		Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources

1. **Textbook & Reference Books**

1. Campbell, I.D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J.(2009). Physical Biology of the Cell. New York: Garland Science.
4. Nelson, P.C., Radosavljević, M.,&Bromberg, S.(2004). Biological Physics: Energy, Information, Life. New York: W.H.Freeman.
5. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1),993-1016.doi:10.1146/annurev.biochem.77.061906.092014.
6. Mohanraju, P.,Makarova, K. S., Zetsche, B., Zhang, F.,Koonin, E. V.,& Oost, J. V. (2016).Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). doi:10.1126/science.aad5147.
7. Lander, E.(2016).The Heroes of CRISPR. Cell, 164(1-2), 18-28.doi:10.1016/j.cell.2015.12.041.
8. Ledford, H.(2016).TheUnsungHeroesofCRISPR.Nature,535(7612),342-344. doi:10.1038/535342a.
9. Jinek,M., Chylinski, K., Fonfara,I., Hauer,M.,Doudna,J.A., &Charpentier,E. (2012). A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity. Science, 337(6096), 816-821.doi:10.1126/science.1225829.
10. Hamers-Casterman,C.,Atarhouch,T.,Muyldermans,S.,Robinson,G.,Hammers, C. Songa, E. B., Hammers, R. (1993). Naturally Occurring Antibodies Devoid of Light Chains. Nature, 363(6428), 446-448.doi:10.1038/363446a0.
11. Sidhu, S. S., & Koide, S. (2007). Phage Display for Engineering and Analysing Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
12. Steyaert, J., & Kobilka, B. K.(2011). Nanobody Stabilization of G Protein-Coupled Receptor Conformational States. Current Opinionin Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
13. Vincke, C., & Muyldermans, S. (2012). Introduction to Heavy Chain Antibodies and Derived Nanobodies. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779- 968-6_2.
14. Verheesen, P.,& Laeremans, T.(2012). Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation. Single Domain Antibodies, 81-104.doi:10.1007/978-1-61779-968-6_6.
15. Li,J.,Xia,L.,Su,Y.,Liu,H.,Xia,X.,Lu,Q.Reheman,K.(2012).Molecular Imprint of Enzyme Active Site by Camel Nanobodies. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721.doi:10.1074/jbc.m111.336370.
16. Sohier,J.,Laurent,C.,Chevigné,A.,Pardon,E.,Srinivasan,V.,Wernery,U.Galleni, M. (2013). Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody. Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.
17. Chakravarty, R., Goel, S., & Cai, W.(2014). Nanobody: The "Magic Bullet" for Molecular Imaging?Theranostics,4(4),386-398.doi:10.7150/thno.8006.

2.	Journals & Periodicals 1. JBC, 2. Science, 3. Plos biology 4. Periodicals: current science
3	Other Electronic resources: 1) MH Education 2) NPTEL

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	30 marks
Theory: End Semester Marks	50 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 05 marks Skill enhancement activities / case study: 05 marks Presentation/ miscellaneous activities: 05 marks **Total: 20 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 30 marks Viva: 10 marks Journal: 5 marks **Total: 50 Marks**

Mapping of PSOs and COs

PO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM303	COURSE NAME INDUSTRIAL & FOOD MICROBIOLOGY	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	2	0	45	3	2	0	5

Course Prerequisites	Students should have basic knowledge about Microbiology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	The course will introduce Basic aspects and scope of food microbiology. Intrinsic and extrinsic factors that affect microbial growth in foods.
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	1. **Remember:** provide in-depth knowledge about food microbiology 2. **Apply** understanding Experimental approaches 3. **Analyses** microbial production of industrial products 4. **Crea**te an understanding how interactions network develops 5. Understand applications both scientific and industrial

Course Content (Theory)	Weightage	Contact hours
Unit 1: The Trajectory of Food Microbiology 1. Introduction to Food Microbiology - Part I: Bacteria 2. Introduction to Food Microbiology - Part II: Yeast, Mold and Virus	**20%**	**9**
Unit 2: Microorganisms and Food Materials Microbial growth and its Quantification Factors affecting growth and survival of microorganisms in Foods Role of Predictive Microbiology	**20%**	**9**
Unit 3: Microbiology of Food Commodities • Overview of Spoilage • Microbial spoilage of Fruits and Fruit juices • Microbial spoilage of Vegetables • Microbial spoilage of Cereals and Bakery Foods • Microbiology of Meat, Poultry, Sea foods • Microbial spoilage of Canned Foods	**20%**	**9**

Unit 4: Microbiology of Food Preservation • Physical methods-Thermal Processing • Physical methods: Part II: Non-Thermal Processing • Chemical Methods • Natural Antimicrobial Compounds • Emergency Methods of Food Preservation • Combination Methods of Preservation • Biotechnology in Food Preservation.	**20%**	**9**
Unit 5: Microbial Process Strategies & Dairy Waste management 1. Single Cell Protein and Industrial Alcohol 2. Organic Food-Citric, lactic and Vinegar 3. Industrial Enzymes and Vitamin 4. Bacteriocins and Antibiotics 5. Fermented Foods 6. Treatment and Disposal of Waste Water and Effluents	**20%**	**9**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:	Remember	Explain, Describe, Discuss, Recall, Locate
CO1 To provide in-depth knowledge to students on different aspects of microbial growth and associated spoilage in foods..		
CO2 To Demonstrate students on principles, different preservation methods of food and mode of action of various preservation methods on microbes.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To Acquaint students with types of fermentation processes and microbial production of industrial products.	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To acquaint students with Diary aste and its management.	Create	Construct, Develop, Produce
CO5 To acquaint students with experimental strategies used in food Microbiology, processing and preservation.	Understand	Explain, Describe, outline, Predict, Summarise
Learning Resources		

1.	**Textbook & Reference Books** **1.** Frazier,W.C. and Westhoff, D. C. 2004. Food Microbiology. 3rd McGraw Hill, New Delhi. **2.** Jay, J. M. 1992. Modern Food Microbiology. 4th Van Nostrand Reinhold, New York, USA. **3.** Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Enfield: Science Publ., USA. **4.** Ray, B. 2004. Fundamental Food Microbiology 3rd, CRC Press, Washington D.C. USA. **5.** Waites, M. J. 2001. Industrial Microbiology: An Introduction. Blackwell Science, London.
2.	Journals & Periodicals 1. JBC, 2. Science, 3. Plos biology 4. Periodicals: current science
3	Other Electronic resources: 1) MH Education 2) NPTEL

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	30 marks
Theory: End Semester Marks	50 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 05 marks Skill enhancement activities / case study: 05 marks Presentation/ miscellaneous activities: 05 marks **Total: 20 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 30 marks Viva: 10 marks Journal: 5 marks **Total: 50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of POs and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM304			COURSE NAME ENVIRONMENTAL MICROBIOLOGY			SEMESTER III	
Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	30	2	0	0	2

Course Prerequisites	Students should have basic knowledge about Microbiology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	The course will introduce major groups of microorganisms- tools in biotechnology and their most important environmental applications.
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	**1. Remember: e**nvironmental applications of biotechnology **2. Apply** understanding Experimental approaches **3. Analyses** environmental problems **4. Create** an understanding how interactions network develops **5. Understand** applications both scientific and industrial

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to environment Pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology	**20%**	**9**

Unit 2: Bioremediation: Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ).	**20%**	**9**
Unit 3: Role of microorganisms in bioremediation: Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration Phyto stabilization)	**20%**	**9**
Unit 4: Biotechnology and agriculture: Bioinsecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, Pseudomonas fluorescens); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.	**20%**	**9**
Unit 5: Biofuels: Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.	**20%**	**9**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practicalexercises are designed to understand the theory as taught in the classroom. Hands on in practicalsession.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1 This course aims to introduce fundamentals of Environmental Biotechnology. .	Remember	Explain, Describe, Discuss, Recall, Locate
CO2 The course will introduce major groups of microorganisms- tools in biotechnology and their most important environmental applications.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To acquire an awareness of and sensitivity to the total environment and its allied problems.	Create	Construct, Develop, Produce
CO5 To understand how biotechnology can useful to solve environmental problems	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources

1. **Textbook & Reference Books**

1. 1 G.M. Evans and J.C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.
2. B. Ritmann and P.L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.
3. P. K. Mohapatra (2006) Textbook of Environmental Biotechnology, IK International
4. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic Concepts and Applications, I K International Publishing House
5. Hans-Joachim Jördening, Josef Winter (2005) Environmental Biotechnology: Concept and applications. Wiley VCH
6. A. K. Chatterji (2010) Introduction to Environmental Biotechnology PHI Learning Limited New Delhi
7. T. Srinivas (2008) Environmental Biotechnology, New Age International
8. PK Gupta (2005) Elements of Biotechnology
9. Lawrence K. Wang, Volodymyr Ivanov, Joo-Hwa Tay, Yung-Tse Hung (2010) Environmental Biotechnology, Humana Press
10. S. K. Agarwal (2005) Advanced Environmental Biotechnology APH Publishing Corporation New Delhi

2.	Journals & Periodicals 1. JBC, 2. Science, 3. Plos biology 4. Periodicals: current science
3	Other Electronic resources: 1) MH Education 2) NPTEL

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	30 marks
Theory: End Semester Marks	50 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	05 marks
Skill enhancement activities / case study	05 marks
Presentation/ miscellaneous activities	05 marks
Total	**20 Marks**

Practical Marks	

Attendance	05 marks
Practical Exam	30 marks
Viva	10 marks
Journal	5 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM305	COURSE NAME MICROBIAL PHYSIOLOGY AND METABOLISM	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	0	0	45	3	0	0	3

Course Prerequisites	Students should have basic knowledge about Microbiology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	The course will provide information on sources of energy and its utilization by microorganisms.
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	1. **Remember:** To understand microbial metabolism mechanism 2. **Apply** understanding Experimental approaches 3. **Analyses** microbial production of industrial products 4. **Create** an understanding how interactions network develops 5. **Understand** applications both scientific and industrial

Course Content (Theory)	Weightage	Contact hours
Unit 1: **Microbial growth, measurement of microbial growth and effect o temperature on growth** Definitions of growth and generation time measurement of microbial growth, and specific growth rate, Batch an Continuous culture, Phases and types of growth curve and its industria application, Microbial growth in response to temperature, pH, solute an water activity, oxygen, pressure and radiation. Autotrophy - Concept, factor for, types of autotrophs, mechanisms	**20%**	**9**

Unit 2: Microbial transport and nutrition Classification of bacteria based on nutrients, Membranes of microorganisms Ion channels, Passive and facilitated diffusion, Primary and secondary activ transport, concept of uniport, symport and antiport, Group translocation an Iron uptake, Photosynthetic pigments and apparatus in bacteria, Mode o nutrition in purple sulphur bacteria, non-sulphur bacteria and green sulphu bacteria, Utilization of light energy by halobacterium. Bio-signalling Molecular mechanisms, signalling in bacteria- The two-component signallin mechanism in bacterial chemotaxis. Microbial stress responses**.**	**20%**	**9**
Unit 3: Photosynthesis and metabolism Photosynthesis: Oxygenic and an oxygenic microorganisms, structure of chloroplast, light reaction, photolysi of water and photophosphorylation, C3 and C4 pathway of carbon fixation Nutritional classification of microorganisms, Energy generation i cyanobacteria, green bacteria, purple sulphur bacteria and chemolithotrops Lipid biosynthesis: Biosynthesis of lipids and fatty acids, triglycerol an phospholipids and their regulation. Lipid Metabolism: Degradation of Lipids oxidation of unsaturated, saturated, even and odd chain fatty acids, keton bodies. Metabolism of nitrogenous compounds: Transamination, oxidativ deamination, decarboxylation, urea cycle. General biosynthetic pathways o amino acids, biosynthesis of purines and pyrimidines and their regulation	**20%**	**9**
Unit 4: Microbial energetics and nitrogen fixation Concept of aerobic respiration, anaerobic respiration and fermentation Central metabolic pathways: EMP pathway, ED pathway, PP pathway, an TCA cycle. Anaplerotic reactions, gluconeogenesis, glyoxylate cycle Mitochondrial and bacterial electron transport. Oxidation-reduction potentia and energetic of electron transport. Fermentations: alcohol fermentation Pasteur effect, lactate and butyrate fermentation, Fermentation balances branched versus linear fermentation pathways. Nitrogen Fixation Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrat reduction, biological nitrogen fixation. Nitrogen fixers and mechanism o nitrogen fixation.	**20%**	**9**
Unit 5: Secondary Metabolism Fungal and bacterial secondary metabolism: Secondary metabolites an regulation of secondary metabolism. Antibiotics: Definition, Discovery classification, structure and mode of action. Biosynthesis of secondar metabolites -beta-lactum antibiotics, patulin, Aflatoxin, ergot alkaloids Fungal toxins: Types of toxins, aromatic and phenolic toxins, terpenoi toxins, polysaccharides and glycoproteins. Bacterial toxins: Exo an endotoxins, enterotoxins. Pigments: Melanin, carotenoids. Fungal hormones Sirenin (Allomyces) Sterols (Achlya). Trisporic acid (Ascomycetes), peptid hormones (Basidiomycetes). Bioluminescence in microorganisms Mechanism and significance.	**20%**	**9**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		Explain, Describe, Discuss, Recall, Locate
CO1 To get the basic idea of the conditions affecting microbial growth.	Remember	
CO2 To understand the mechanism of transport through the microbial cell membrane	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To understand microbial metabolism mechaism	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To gain knowledge of microbial energetics and nitrogen fixation.	Create	Construct, Develop, Produce
CO5 To know microbial secondary metabolism and products	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources

1.	**Textbook & Reference Books** ● Kim B.H. and Gadd G.M. 2008. Bacterial physiology and metabolism. Cambridge University Press, Cambridge. ● Gilbert H.F. 2000. Basic concepts in biochemistry: A student's survival guide. Second Edition. Mc-Graw-Hill Companies, health professions Division, New York. ● Madigan M.T., Martinko J.M., Stahl D.A. and Calrk D.P. 2012. Brock Biology of Microorganisms. 13th ed. Pearson Education Inc. ● Gottschalk G. (1986). *Bacterial Metabolism*. 2nd edition. Springer Verlag. Lehninger A. (1982). *Biochemistry*. Worth Publ.
2.	Journals & Periodicals 1. JBC, Annals of Microbiology 2. Science, 3. Plos biology 4. Periodicals: current science
3	Other Electronic resources: 1) MH Education 2) NPTEL

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>30 marks</td></tr>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>05 marks</td></tr>
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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO	1					
CO1	2	-	2	1	2	-
CO2	1	2	2	2	-	-
CO3	1	-	-	3	2	1
CO4	2	3	2	-	1	2
CO5	2	1	2	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	1	-	2	2	1
CO2	-	1	1	2	-	1
CO3	2	-	-	1	2	1
CO4	2	1	2	2	2	2
CO5	-	1	-	2	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM306	COURSE NAME AGRICULTURAL MICROBIOLOGY AND PLANT-PATHOGEN INTERACTIONS	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
3	2	0	45	3	2	0	3

Course Prerequisites	Students should have basic knowledge about Microbiology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	The course will introduce Plant-pathogen interaction mechanism process involving pathogen- and plant-derived molecules.
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	**Remember:** To understand the epidemiology of plant pathogen interaction **Apply** understanding Experimental approaches **Analyses** To introduce Agricultural microbiology and its scope **Create** an understanding how interactions network develops **Understand** applications both scientific and industrial

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Agriculture Microbiology Concepts and scope of agricultural microbiology, importance of microorganisms in agriculture, influence of microorganisms in plant growth, modern concepts of microbial inoculants in agriculture. Interaction of soil microorganisms with plants: Rhizosphere and phylloplane microorganisms. Mass culturing and quality control of microbial inoculants-mother culture, shake culture and brief account of large-scale production of biofertilizers, types of carrier materials, packing, storage, bench life and transportation of biofertilizers. ISI standards and quality testing at different levels. Methods of biofertilizer application- seed inoculation, soil amendment and nursery application.	**20%**	**9**

Unit 2: Microbes & Bio-fertilizers Symbiotic and non-symbiotic nitrogen fixation, mechanisms of nitrogen fixation and importance. Brief account of production and application of Rhizobium inoculant; strain selection and mass culturing. Brief account of production and utility of Azotobacter, Az spirillum, cyanobacteria, Azolla, Frankia. Salient features and significance of strains and application of these organisms. Phosphate-solubilizing microorganisms-importance, culturing and applications of these microorganisms in agriculture. Vermi composting, Mycorrhizae: types, Mass production and application of mycorrhizae. Mushroom cultivation.	**20%**	**9**
Unit 3: Phytopathology Introduction and historical milestones, significance of plant diseases, types of plant diseases, basic procedure of plant disease diagnosis, parasitism, pathogenicity and plant disease development, disease cycle, infection cycle and plant disease triangle Levels of plant- pathogen interaction: Perpetration, host recognition, role of host exudates, entry by plant pathogens through natural openings and wounds, direct penetration, process of pathogenesis, infection and establishment of pathogens in the host tissues.	**20%**	**9**
Unit 4: Pathogenesis & Défense Mechanism in Plants Role of pathogen enzymes in pathogenesis- production of different enzymes and action of pathogen enzymes on host tissues and significance of these enzymes in disease development. Role of phytotoxins in plant pathogenesis-types of toxins produced by plant pathogens, effect of toxins on disease development. Role of plant growth regulators in plant pathogenesis. Defense mechanisms in plants: Structural and biochemical defense mechanisms role of elicitors, receptors and suppressors in disease development, molecular mechanisms in expression of plant disease resistance. Epidemiology of plant diseases: Effect of environmental factors on disease development; Dissemination of plant pathogens; Disease forecasting and its Significance, Seed Pathology: Importance of seed-borne diseases and seed health testing methods.	**20%**	**9**

Unit 5: Plant Disease Management Cultural methods-exclusion, eradication, crop rotation and sanitation. Inspection and certification, quarantine regulations. Physical methods-soil solarization, hot water treatment, mulching and other methods. Chemical control of plant diseases-preparation and use of different chemicals, types of chemicals used in plant disease management; application of chemicals to soil, seeds, plant and store house problems and remedies for fungicidal resistance. Biological control of plant disease selection, testing and use of antagonistic microorganisms and their metabolites, application methodology and significance. Breeding for disease resistance, systemic acquired resistance; protoplast, cell, tissue culture and somaclonal variation for disease resistance, biotechnological approaches in obtaining disease resistance plants, induced resistance, transgenic plants for plant disease management. Integrated disease management practices. Brief account of some important plant diseases (with one example for each group with description of pathogen, symptoms and management)- rots, damping-offs, downy mildews, white rust, powdery mildews, smuts, rusts, wilts, leaf spots, anthracnose, galls, ergots, bacterial diseases, viral diseases, phytoplasmal diseases, nematode diseases, protozoal diseases, viroid diseases, non-parasitic diseases and post-harvest diseases	**20%**	**9**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in the classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:	Remember	Explain, Describe, Discuss, Recall, Locate
CO1 To introduce Agricultural microbiology and its scope.		
CO2 To demonstrate the use of non-pathogenic/symbiotic microbes as biofertilizers	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 To understand the epidemiology of plant pathogen interaction	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 To get insights of plant pathogen and defence mechanism in plants	Create	Construct, Develop, Produce
CO5 To get acquainted with management of plant diseases	Understand	Explain, Describe, outline, Predict, Summarise
Learning Resources		

1.	**Textbook & Reference Books** • Agrios, G. 2005. Plant Pathology, 5th edition, Reed Elsevier India Private Limited, New Delhi, India Limited, New Delhi, India. • Mehrotra, R.S.1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi. • Purohit, S.S. 2003. Agricultural Biotechnology, 2nd edition, Agrobios Publisher, Jodhpur, India. • Rangaswami, G and Bagyarai, D.J.2005. Agricultural Microbiology, 2nd edition, Prentice-Hall of India Private Limited, New Delhi. • Agarwal, V.K and Sinclair, J.B. 1987. Principles of Seed Pathology, CBS Publishers, Delhi. • Srivastava, H.N. 2001. Plant Pathology, Pradeep Publications, Jalandhar. Dhingra, O.D and Sinclair, J.B. 1985. Basic Plant Pathology Methods, CBS Publishers, Delhi. • Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to Foliar Attack), Bioscientific Publishers. • Carlile, M.G., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK. • Gow, N.A.R and Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London. • Rao, N.S.S. 1993. Biofertilizers In Agriculture and Forestry, 3rd edition, Oxford & IBH Publishing Pvt. Ltd, New Delhi. Nene, Y.L and Thapliyal, P.N. 1971. Fungicides In Plant Disease Control, 2nd edition, Oxford & IBH Publishing Co., New Delhi.
2.	Journals & Periodicals 1. Indian Journal of Applied Microbiology 2. Plant Pathology 3. Annual Review of Phytopathology 4. Plant Disease journal 5. Journal of Plant Diseases and Protection 6. Hamamouch et al. 2013. The interaction of the novel 30C02 cyst nematode effector protein with a plant β-1,3-endoglucanase may suppress host defence to promote parasitism. J Exp Bot 63:3683-3696 7. Plant Growth-Promoting Rhizobacteria: Context, Mechanisms of Action, and Roadmap to Commercialization of Biostimulants for Sustainable Agriculture 8. deJonge 2011. How filamentous pathogens co-opt plants: the ins and outs of fungal effectors. Curr Opin Plant Biol 14: 1–7 9. Mechanisms and applications of plant growth promoting rhizobacteria: Current perspective.
3	Other Electronic resources: 1) MH Education 2) NPTEL

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Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	2	1	1	-
CO2	1	3	2	2	-	-
CO3	1	-	-	1	2	1
CO4	2	3	2	-	2	2
CO5	2	1	-	1	-	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	2	-	2	2	1
CO2	-	1	1	2	-	-
CO3	2	-	-	1	2	1
CO4	2	1	2	3	2	2
CO5	-	1	-	2	-	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSIM308	COURSE NAME BIOENTREPRENEURSHIP	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
4	4	0	8	4	2	0	6

Course Pre-requisites	Students should contain basic knowledge about entrepreneurship.
Course Category	Core
Course focus	Employability
Rationale	Bioentrepreneurship is at the intersection of science and business. This course aims to bridge the gap between scientific knowledge and commercial applications, equipping students with the skills to translate innovative research and discoveries into successful biotech ventures.
Course Revision/ Approval Date:	14th March 2019
Course Objectives **(As per Blooms' Taxonomy)**	**1** To get knowledge about concepts of entrepreneurship **2** To gain knowledge on identifying a winning business opportunity **3** To apply their knowledge on gathering funds and launching a busi **4** To grow and nurture the organization and harvest the rewards. **5** To gain knowledge on for technology management and transfer

Course Content (Theory)	Weightage	Contact hours
Unit 1: **Theory: Innovation and entrepreneurship in bio-business** Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision	**20%**	**06**
Unit 2: **Theory: Bio markets - business strategy and marketing** Negotiating road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.	**20%**	**06**
Unit 3: **Theory: Finance and accounting:** Business plan preparation including statutory and legal requirements, Business feasibility study,financial management issues of procurement capital and management costs, Collaborations & partnership, Information technology.	**20%**	**06**
Unit 4: **Theory: Technology management:** Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies	**20%**	**06**
Unit 5: **Theory: Entrepreneurship Development programs**: Entrepreneurship development programs of public and private agencies (MSME, DBT,BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies. Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP)	**20%**	**06**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments Practical exercises are designed to understand the theory as taught in classroom. Hands on in practical session.

Course Outcomes:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1 Gain entrepreneurial skills, understand the various operations involved in venture creation	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate
CO2 Identify scope for entrepreneurship in biosciences	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Utilize the schemes promoted through knowledge centres and various agencies	Evaoluate	Compare, Classify, Select, Investigate
CO4 Build up a strong network within the industry.	Apply	Construct, Develop, Produce
CO5 Develop and refine strategy in today's fast-changing, dynamic markets	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: 1. Adams, D.J.,& Sparrow,J.C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences.Bloxham: Scion.
2	Reference books : 2. Shimasaki, C. D.(2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies.Amsterdam:Elsevier.AcademicPress is an imprint of Elsevier. 30 3. Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge. 4. Jordan, J. F.(2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press. 5. Desai, V.(2009).The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub.House
3	Journal : Bioentrepreneur-Nature, Journal of Bioentrepreneurship
5	Periodicals: Harward Buisness Review, Entrepreneur
6	Other Electronic resources: 1. https://online.stanford.edu/courses/xmse100-introduction-innovation-and-entrepreneurship 2. https://ocw.mit.edu/courses/entrepreneurship/

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Article Review	10 marks
Total	**40 Marks**

Practical Marks	

Attendance	05 marks
Practical Exam	20 marks
Viva	10 marks
Journal	10 marks
Discipline	05 marks
Total	**50 Marks**

Mapping of PSOs and COs

PO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO						
CO1	1	-	-	-	2	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	1
CO4	-	3	-	-	-	2
CO5	-	-	1	-	1	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Mapping of PO and COs

PO	PO1	PO2	PO3	PO4	PO5	PO6
CO						
CO1	3	1	-	1	2	-
CO2	1	-	-	-	2	-
CO3	-	-	-	-	-	-
CO4	-		-	2	-	-
CO5	-	1	-	1	-	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None