M.Sc. (Honours)
Biotechnology
Course Curriculum

Academic Year: 2024-25

W.E.F. March 2024

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.	**MSBO111**	Advanced Biomolecules and Biochemistry	3	0	1	4	**150**
2.	**MSBO112**	Basics of Bioinformatics	3	0	1	4	**150**
3.	**MSBO113**	Plant and Animal Biotechnology	3	0	1	4	**150**
4.	**MSBO114**	Molecular Diagnostics	3	0	1	4	**150**
5.	**MSBO115**	Biostatistics	2	0	0	2	**100**
6.	**MSBO116**	General Microbiology	2	0	0	2	**100**
7.	**MSBO117**	Biopython	2	0	0	2	**100**

8.	**MSBI116**	Internship	2	0	0	2	**50**

Semester- II

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBO211**	Advanced cell and Molecular Biology	3	0	1	4	**150**
2.	**MSBO212**	Research Methodology & IPR	3	0	1	4	**150**
3.	**MSBO213**	Bioprocess Engg. and Technology	3	0	1	4	**150**
4.	**MSBO214**	Advance Immunology and Virology	3	0	1	4	**150**
5.	**MSBO215**	Nano science	2	0	0	2	**100**
6.	**MSBO216**	Drug Discovery	2	0	0	2	**100**
7.	**MSBO217**	Internship	2	0	0	2	**50**

Semester- III

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBO311**	Project proposal preparation	3	0	1	4	**150**
2.	**MSBO312**	Emerging Technology	3	0	1	4	**150**
3.	**MSBO313**	Genetic engineering	3	0	1	4	**150**
4.	**MSBO314**	Advance Immunology and Virology	3	0	1	4	**150**
5.	**MSBO315**	Toxicology	2	0	0	2	**100**
6.	**MSBO316**	AGRICULTURE AND PLANT PATHOGEN INTERACTION	2	0	0	2	**100**
7.	**MSBO317**	Internship	2	0	0	2	**50**

Semester- IV

Sr.No	Course Code	Course Title	*L*	*T*	*P*	C	Marks
Theory Courses							
1.	**MSBO411**	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 MSBO111	COURSE NAME ADVANCED BIOMOLECULES AND BIOCHEMISTRY	SEMESTER I

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	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**

Practicals:

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. Purification and characterization of an enzyme from a recombinant source
6. Experimental verification that absorption at OD_{260} is more for denatured DNA as compared to native double stranded DNA.
7. Reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size.
8. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments)
9. Biophysical methods (Circular Dichroism Spectroscopy, Fluorescence Spectroscopy).
10. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry.

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>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Skill enhancement activities / case study</td><td>15 marks</td></tr>
<tr><td>Presentation/ miscellaneous activities</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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<tr><td>Practical Marks</td><td>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>30 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<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	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 MSBO112	COURSE NAME BASICS OF BIOINFORMATICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
3	1	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 MSBO113	COURSE NAME PLANT & ANIMAL BIOTECHNOLOGY	SEMESTER I

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

Course Prerequisites	Students should have basic knowledge about Plant & Animal Biotechnology
Course Category	Core Professional.
Course focus	Scientific Temperament & Employability
Rationale	Able to gain fundamental knowledge in animal and plant biotechnology and their applications.Understand the molecular techniques required for animal and plant biotechnologyThe students will be technically and critically trained with good practical exposure to perform both the plant and animal culture, which is the at most required in this field of science, skilled candidates are absorbed in well established and commercial tissue culture unitsThis area can be taken up as a micropropagation business with smaller investment by entrepreneurs. learn molecular techniques.
Course Revision/ Approval Date:	06/03/24
Course Objectives (As per Blooms' Taxonomy)	1. **Remember** Able to gain fundamental knowledge in animal and plant biotechnology and their applications. 2. **Apply** Understand the molecular techniques required for animal and plant biotechnology 3. **Analyses** This area can be taken up as a micropropagation business with smaller investment by entrepreneurs. 4. **Create** The students will be technically and critically trained with good practical exposure to perform both the plant and animal culture, which is the at most required in this field of science, skilled candidates are absorbed in well established and commercial tissue culture units 5. **Understand** learn molecular techniques.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Introduction to Animal and Plant Physiology (Plant tissue culture and animal cell culture)	**20%**	**10+4**
Unit 2: Micropropagation and haploid production (Plant genetic manipulation)	**20%**	**10+4**
Unit 3: Protoplast culture and cybrids (Animal reproductive biotechnology and vaccinology)	**20%**	**8+4**
Unit 4: Animal Cell culture and Plant Tissue Culture (Plant and animal genomics)	**20%**	**9+4**
Unit 5: Applied plant and animal biotechnology (Molecular mapping and marker assisted selection)	**20%**	**8+4**

Practicals:

1. Prepare culture media with various supplements for plant tissue culture.
2. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion
3. by PEG (available material).
4. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometric methods
5. Count cells of an animal tissue and check their viability.
6. Prepare culture media with various supplements for plant and animal tissue culture.
7. Prepare single cell suspension from spleen and thymus.
8. Monitor and measure doubling time of animal cells.
9. Perform PCR amplification of 'n' number of genotypes of a species for studying the genetic variation among the individuals of a species using random primers.

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 The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, animal genomics, genetic transformation and molecular breeding animals.	Remember	
CO2 The objectives of this course are to introduce students to the principles, practices and application of plant biotechnology, plant tissue culture, plant and genomics, genetic transformation and molecular breeding of plants.	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Intended to introduce the student to the principles and practical considerations of animal cell and tissue culture	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 Intended to introduce the student to the principles and practical considerations of plant cell and tissue culture	Create	Construct, Develop, Produce
CO5 The objectives of this course are to introduce students to the cell culture technique enables to understand the structure and functions of cells which is programmed by Genetic Engineering tools and techniques for the production of	Understand	Explain, Describe, outline, Predict, Summarise

Learning Resources

1.	Textbook & Reference Book Reference books : 1.Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International. 2. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker. 3. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press. Reference books : 1.Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International. 2. Levine, M. M. (2004). *New Generation Vaccines.* New York: M. Dekker. 3. Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.
2.	Journals & Periodicals 1. ISSCR journals and Cell science. 2. Periodicals: Current scienc
3	Other Electronic resources: NPTL and UGC pathsala

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 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>
<tr><td>Skill enhancement activities / case study</td><td>15 marks</td></tr>
<tr><td>Presentation/ miscellaneous activities</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40Marks</td></tr>
</table>
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Practical Marks	

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

Mapping of PSOs and COs

PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO						
CO 1	1	-	-	-	-	-
CO 2	1	-	-	-	-	-
CO 3	2	3	3	3	2	1
CO 4	2	3	3	2	2	2
CO 5	2	-	1	-	-	-

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

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

COURSE CODE MSBO114	COURSE NAME MOLECULAR DIAGNOSTICS	SEMESTER I

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	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

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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 MSBO116	COURSE NAME BIOSTATISTICS	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
2	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 MSBO117			COURSE NAME GENERAL MICROBIOLOGY		SEMESTER I		
Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	0	0	2	2	0	0	2

Course Pre-requisites	Students should have basic knowledge about Microbiology.
Course Category	Elective
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**

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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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 MSBO118	COURSE NAME BIOPYTHON	SEMESTER I

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

Course Outcomes	1.Develop 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**
3	**Other Electronic resources**: 1) MH Education 2) NPTEL 3) Coursera

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 MSBO211	COURSE NAME ADVANCED CELL AND MOLECULAR BIOLOGY	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	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:	6/03/2024
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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CO2	1	3	2	2	-	-
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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 MSBO212	COURSE NAME RESEARCH METHODOLOGY AND IPR	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	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 MSBO213	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 MSBO214	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. 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 MSBO215	COURSE NAME NANOSCIENCE	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	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**
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
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 MSBO216	COURSE NAME DRUG DISCOVERY	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
2	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	
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 MSBO301	COURSE NAME GENOMICS & ; PROTEOMICS	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	B.Sc in life sciences
Course Category	Core course
Course focus	To understands genes and proteins
Rationale	To understands genes and proteins
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	**1.** To provide introductory knowledge concerning genomics **2.** To introduce various cytogenetic techniques **3.** To provide introductory knowledge in proteomics **4.** To introduce functional genomics **5.** To know Applications of genomics and proteomics .

Course Content (Theory)	Weightage	Contact hours
Unit 1: Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis	**20%**	**09**
Unit 2: Theory: Cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping. Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.	**20%**	**09**
Unit 3: Theory: Identification and classification of organisms using molecular markers-16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence	**20%**	**09**

Unit 4: Theory: Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases. Transcriptome analysis for identification and functional annotation of gene	**20%**	**09**
Unit 5: Theory:Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.	**20%**	**09**

Practicals:

1. Isolation of genomic DNA of bacteria
2. Protein extraction
3. Protein purification
4. Quantification of extracted proteinNative PAGE
5. SDS-PAGE
6. Use of SNP databases at NCBI and other sites
7. Use of OMIM database
8. Detection of Open Reading Frames using ORF Finder

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,
CO1 Fundamentals of genomics and proteomics	Apply	Discuss, Recall, Locate
CO2 How genomes are mapped and introduction to various genome sequencing projects	Analyses and Evaluation	Apply, Practice, Interpret, Select, Correlate
CO3 Using various molecular markers for identification and Comparison of genomes	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4 Transcriptomics and metabolomics	Analyses and Evaluation	Construct, Develop,

CO5 The applications of Genomics and Proteomics	Understand	Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook 1. Ruthvik Chadwick (2015) Genomics and Society Ethical, Legal, Cultural and Socioeconomic Implications 2. Nawin C. Mishra, Günter Blobel (2011) Introduction to Proteomics Principles and Applications 3. Richard Twyman (2004) Principles of Proteomics 4. N Saraswathy, P Ramalingam (2011) Concepts and Techniques in Genomics and Proteomics
2	Reference books: 1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub. 2. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press. 3. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
3	Journal: 1. Current Science, 2. Indian Journal of Biotechnology and other international biotechnology journals 3. BMC Genomics 4. Proteomics 5. Journal of proteomics
5	Periodicals: 1. Science Daily 2. Everyman's Science
6	Other Electronic resources: 1) MH Education 2) NPTEL 3) SWAYAM

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks

<table>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Article Review</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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</td></tr>
<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 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	0	0	2	0	0	0
CO2	1	2	0	0	2	0
CO3	1	0	2	2	0	1
CO4	0	1	2	0	0	2
CO5	0	0	0	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	1	0	1	3	0
CO2	3	1	2	1	2	0
CO3	2	0	2	0	0	0
CO4	1	0	1	2	1	1
CO5	1	1	0	0	0	0

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

COURSE CODE MSBO302	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: **NANOBODIES** 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	Compare,

	Evaluation	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 MSBO303	COURSE NAME COMPUTATIONAL BIOLOGY	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 computer system, software etc.
Course Category	Core
Course focus	Computational biology
Rationale	To understand use of computational biology
Course Revision/ Approval Date:	20/03/2020
Course Objectives (As per Blooms' Taxonomy)	1 The objective of this course is to provide students with theory essentials to aid computer technology. 3 The objective of this course is to provide students with theory essentials to aid for metabolomics courses. 4 The objective of this course is to provide students with theory essentials to aid for drug design program. 5 This course will pave a way for technological insite.

Course Content (Theory)	Weightage	Contact hours
Unit 1 and 2: Introduction to computational biology basics and biological databases and pairwise and multiple sequence alignments. Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases. Local alignment, Global alignment, Scoring matrices-PAM, BLOSUM, Gapsand penalties, Dotplots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA.Building Profiles, Profile based functional identification.	**40%**	**20**
Unit 3 : Genome analysis Organization And Structure Of Genome:Eukaryotic Genome (Nucleosomes, Histones, Chromatids, Centomeres, Telomeres), C Value Paradox. Repetitvie Content Of Eukaryotic Genomes, Chromatin Modification And Genome Expression. Histone Modification (Acetylation, Deacetylation, Phosphorylation). Nucleosome Re-modeling. Genome Silencing B Y DNA Methylation. Imprinting, Prokaryote Genomes (Organiza-tion Of Genes, Operons). Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement.Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.	**15%**	**5**
Unit 4: Structure visualization Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.	**15%**	**10**

Unit 5 and 6: Molecular modeling and Structure-based drug development Significance and need, force field methods, energy, buried and exposed residues; sidechains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions.Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high through put screenings.	**15%**	**08**
Unit 7: Ligand-based drug development Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.	**15%**	**02**

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** Develop an understanding of the basic theory of these computational tools; **CO2** Develop required database extraction, integration, coding for computational tools and methods necessary for all Omics; **CO3** Create hypothesis for investigating specific contemporary biological questions	Understand, Remember& apply Understand, Remember& apply Apply	Explain, Describe, Discuss, Recall, Locate Apply, Practice, Interpret, Select, Correlate Compare, Classify, Select,

CO4 Critically analyze and interpret results of their study with respect to whole systems. **CO5** Provide help to experiment with or develop appropriate tools;	Apply Understand, Remember& apply	Investigate Construct, Develop, Produce Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook: 1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 2. Bourne, P.E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss. *3.* Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
2	Reference books : 1. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education. 2. Oprea, T. (2005). C*hemo informatics in Drug Discovery,* Volume 23. Wiley Online Library. 3. Gasteiger, J.& Engel, T. (2003), *Chemo informatics: a Textbook*, Wiley Online Library.
3	Journal: Bioinformatics and Biology Insights
5	Periodicals: BMC Bioinformatics
6	OtherElectronicresources: https://iop.vast.ac.vn/theor/conferences/smp/1st/kaminuma/SWISSPROT/index.html

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

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

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

COURSE CODE MSBO304	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

COURSE CODE MSBO305	COURSE NAME MOLECULAR DIAGNOSTICS	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	Bachelor Degree in Life sciences
Course Category	**Professional Core Professional**
Course focus	
Rationale	
Course Revision/ Approval Date:	14/03/2020
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: Genome biology in health, disease, resolution, detection & analysis Theory: DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs. PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOFMS; Bioinformatics data acquisition & analysis.	**20%**	**10**
Unit 2: Diagnostic metabolomics Theory: Metabolite profile for biomarker detection of the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms.	**20%**	**10**
Unit 3: Detection and identity of microbial diseases and inherited diseases Theory: Direct detection and identification of pathogenicorganisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics. Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.	**20%**	**10**
Unit 4: Molecular oncology Theory: Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.	**20%**	**10**
Unit 5: Quality assurance and control Theory: Quality oversight; regulations and approved testing.	**20%**	**05**

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	Blooms' Taxonomy Sub

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

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks

<table>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Article Review</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
</table>
</td></tr>
<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
</table>
</td></tr>
</table>

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 MSBO306	COURSE NAME PROJECT PROPOSAL PREPARATION	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	Bachelor Degree in Life sciences
Course Category	**Professional Core Professional**
Course focus	
Rationale	
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	1 To help students organize ideas, material and objectives for their d 2 The purpose of this course is to prepare the students to present thei importance to their fellow classmates and teachers. 3 To understand how the papers are refereed 4 To know how papers published 5 To learn skills required for power point and poster presentations.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven.	**20%**	**06**
Unit 2: Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.	**20%**	**06**
Unit 3: Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, etc. Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation	**20%**	**06**

Unit 4: Poster Presentation: Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic	**20%**	**06**
Unit 5: Oral Presentation: At the end of their project, a presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.	**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
Afer successful completion of the above course, students will be able to:	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate
CO1 Formulate a scientific question		
CO2 Present scientific approach to solve the problem	Apply	Apply, Practice, Interpret, Select, Correlate
CO3 Interpret, discuss and communicate scientific results in written form	Evaoluate	Compare, Classify, Select, Investigate
CO4 Gain experience in writing a scientific proposaldiagnostics strategy.	Apply	Construct, Develop, Produce
CO5 Learn how to present and explain their research findings to the audience effectively	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources

1	Textbook 1. Nicholas Rowe (2017) Academic & Scientific Poster Presentation : A Modern Comprehensive Guide 2. Kelly Coleman,Kathleen Petelinsek (2014) Choose It! Finding the Right Research Topic 3. Ralph Berry (2000) The Research Project: How to write it 4. Alexei Kapterev (2011) Presentation secrets, Do What You Never Thought Possible with Your Presentations, John Wiley & Sons 5. Writing Scientific Research Articles (2nd Edition) By Margaret Cargill, Patrick O'Connor (2013) 6. Scientific Writing: Easy When You Know How By Jennifer Peat, Elizabeth Elliott, Louise Baur, Victoria Keena (2013) 7. How to Write a Paper (5th Edition) Edited by George M. Hall (2012) 8. How to Write a Great Research Paper By Book Builders, Beverly Chin, (2004) 9. Research Papers for Dummies By Geraldine Woods (2002) 10. Nicholas Rowe (2017) Academic & Scientific Poster Presentation : A Modern Comprehensive Guide 11. Kelly Coleman,Kathleen Petelinsek (2014) Choose It! Finding the Right Research Topic 12. Ralph Berry (2000) The Research Project: How to write it 13. Alexei Kapterev (2011) Presentation secrets, Do What You Never Thought Possible with Your Presentations, John Wiley & Sons 14. Writing Scientific Research Articles (2nd Edition) By Margaret Cargill, Patrick O'Connor (2013) 15. Scientific Writing: Easy When You Know How By Jennifer Peat, Elizabeth Elliott, Louise Baur, Victoria Keena (2013) 16. How to Write a Paper (5th Edition) Edited by George M. Hall (2012) 17. How to Write a Great Research Paper By Book Builders, Beverly Chin, (2004) 18. Research Papers for Dummies By Geraldine Woods (2002)

2	Other Electronic resources 1. Springer® Journal author tutorials now with interactive courses: Free online course and tutorial. 2. Elsevier® Researcher Academy Researcher Academy provides free access to countless e-learning resources designed to support researchers on every step of their research journey. 3. Wiley Author Webinars 4. Writing Scientific Papers Scitable by Nature Education 5. How to Write a World Class Paper From title to references From submission to revision 6. Duke Graduate School Scientific Writing Resource 7. Writing scientific papers: 8 Improving the English 8. How to write a Great Research Paper, and Get it Accepted by a Good Journal. 9. How to Publish Without Perishing: Finding the Time to Write 10. Article Introductions: More Important Than You Thought! 11. 5 Tips for Writing Better Science Papers 12. What Makes a Good Abstract? 13. Biotechnology news 14. Science Daily 15. Nature News 16. Science News 17. Retraction watch (Information about Scientific Misconduct) 18. COPE: Publishing ethics (Website contains information about publication ethics and practical resources)
3	
5	
6	

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**

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

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

COURSE CODE MSBO308	COURSE NAME VACCINES	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	10+2+B.Sc. Life science/Biotechnology
Course Category	Elective
Course focus	Employability
Rationale	Vaccines are among the most effective public health interventions for preventing infectious diseases. The course rationale highlights that this course aims to educate students about the importance of vaccines in reducing morbidity and mortality worldwide.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	1 This course will provide students with an overview of current developments in different areas of vaccines. 2 Describe the basic principles of vaccination 3 Explain how the public are less tolerant of the risks 4 Describe the importance of post marketing vaccine safety surveillance 5 Identify some vaccines that have been associated with adverse vaccine reactions.

Course Content (Theory)	Weightage	Contact hours
Unit 1: **Fundamentals of immune system** Overview of Immune system; Human Immune system: Effectors of immune system; Innate & Adaptive Immunity; Activation of the Innate Immunity; Adaptive Immunity;T and B cells in adaptive immunity;Immune response in infection;.Correlates of protection.	**20%**	**06**

Unit 2: **Immune response to infection** Protective immune response in bacterial; viral and parasitic infections;Primary and Secondary immune responses during infection; Antigen presentation and Role of Antigen presenting cells: Dendritic cells in immune response; Innate immune response; Humoral (antibody mediated)responses;Cell mediated responses:role ofCD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells.	**20%**	**06**
Unit 3: **Immune response to vaccination** Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators.	**20%**	**06**
Unit 4: **Vaccine types & design** History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine.	**20%**	**06**
Unit 5: **Vaccine technologies** New Vaccine Technologies;Rationally designed Vaccines;DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).	**20%**	**06**

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 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:	Understand,	Explain, Describe,

CO1 Understand fundamental concepts Of human immune system and basic immunology	Remember& apply	Discuss, Recall, Locate
CO2 Differentiate and understand immune responses in relation to infection and vaccination;	Understand, Remember& apply	Apply, Practice, Interpret, Select, Correlate
CO3 Understand requirement and designing of different types of vaccines	Analyses	Compare, Classify, Select, Investigate
CO4 Understand the importance of conventional and emerging vaccine technologies.	Understand, Remember	Construct, Develop, Produce
CO5 To understand importance of vaccine designing and development during pandemic	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1	Textbook:Vaccines for Biodefense and Emerging and Neglected Diseases 1st Edition, by Alan D.T. Barrett (Author), Lawrence R. Stanberry (Author)
2	Reference books : *1.* Janeway, C. A., Travers,P.,Walport, M., & Shlomchik, M. J.(2005). *Immuno Biology:* *the Immune System in Health and Disease*. USA: Garland Science Pub. 2. Kindt, T.J., Osborne, B. A., Goldsby,R. A., & Kuby,J.(2013). *Kuby Immunology*. New York: W.H.Freeman. 3. Kaufmann, S. H. (2004).*Novel VaccinationStrategies*.Weinheim:Wiley-VCH.
3	Journal : Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.
5	Periodicals: https://www.cdc.gov/vaccines/pubs/pinkbook/index.html
6	Other Electronic resources: https://www.hhs.gov/vaccines/about/resources/smart-vaccine-tool/index.html

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

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

COURSE CODE MSBO308	COURSE NAME DRUG DISCOVERY AND DEVELOPMENT	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	10+2 examination in science
Course Category	Discipline specific elective
Course focus	Employability
Rationale	The course rationale acknowledges that drug discovery and development are critical in addressing global health challenges, including infectious diseases, cancer, neurodegenerative disorders, and other prevalent health conditions.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	1 This course will give a broad overview of research and developmen setup towards drug discovery. 2 It will present drug development as a process involving target se computer-based methods and combinatorial chemistry/high-throughp 3 Safety evaluation, bioavailability, clinical trials, and the essentials c discussed. 4 Along the way you will learn about molecular recognition, comput toxicology as applied to the development of new medicines. 5 This course develops the key themes in the drug discovery and highlights the multidisciplinary nature of the research and developme

Course Content (Theory)	Weightage	Contact hours
UUnit 1: Target identification and molecular modelling: Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three dimensional structures and physicochemical properties of drugs and receptors; Modelling drug/ receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.	**20%**	**06**
Unit 2: Lead optimization: Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a Function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, etc.; Bioanalytical assay development in support of in vitro and in vivo studies (LC/MS/MS, GC/MS and ELISA).	**20%**	**06**
Unit 3: Preclinical development: Principles of drug absorption, drug metabolism and distribution - intestinal absorption, Metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/ PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.	**20%**	**06**
Unit 4: Drug Manufacturing: Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.	**20%**	**06**

Unit 5: Clinical trial design: Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation. **Unit 6: Fundamentals of regulatory affairs and bioethics:** Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label vs. off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance To current ethical guidelines, Ethical Committees and their setup, Animal Ethical issues and compliance.	**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 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.	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate
CO2 Demonstrate an understanding of the steps involved in the drug discovery and design process.	Remember	Apply, Practice, Interpret, Select, Correlate
CO3 Demonstrate an awareness of the important contributions the different discipline areas make to the drug discovery and development process	Remember	Compare, Classify, Select, Investigate
CO4 Critically analyse biological pathways for their potential as drug targets for a given disease..	Analyses	Construct, Develop, Produce
CO5 Demonstrate the ability to use evidence-based approaches to guide decision making during the drug discovery and development process.	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

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 **6.** Krogsgaard-Larsen et al. Textbook of Drug Design and Discovery. 4th Edition. CRC Press. **7.** Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell. **8.** Nally, J. D. (2006) GMP for Pharmaceuticals. 6th edition. CRC Press **9.** Brody, T. (2016) Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines. Academic Press.
3	Journal :Drug Discovery Today. 9. Natures Review Drug Discovery. 10. Drug, Discovery, Development and Therapy.
5	Periodicals: **1.** SLAS Discovery. **2.** Marine Drugs.
6	Other Electronic resources: NCBI, ENSEMBL, VISTA, UCSC etc

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

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

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

COURSE CODE MSBO308	COURSE NAME DRUG DISCOVERY AND DEVELOPMENT	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	10+2 examination in science
Course Category	Discipline specific elective
Course focus	Employability
Rationale	The course rationale acknowledges that drug discovery and development are critical in addressing global health challenges, including infectious diseases, cancer, neurodegenerative disorders, and other prevalent health conditions.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	1 This course will give a broad overview of research and developmen setup towards drug discovery. 2 It will present drug development as a process involving target se computer-based methods and combinatorial chemistry/high-throughp 3 Safety evaluation, bioavailability, clinical trials, and the essentials c discussed. 4 Along the way you will learn about molecular recognition, comput toxicology as applied to the development of new medicines. 5 This course develops the key themes in the drug discovery and highlights the multidisciplinary nature of the research and developme

Course Content (Theory)	Weightage	Contact hours
Unit 1: Target identification and molecular modelling: Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three dimensional structures and physicochemical properties of drugs and receptors; Modelling drug/ receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.	**20%**	**06**
Unit 2: Lead optimization: Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a Function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, etc.; Bioanalytical assay development in support of in vitro and in vivo studies (LC/MS/MS, GC/MS and ELISA).	**20%**	**06**
Unit 3: Preclinical development: Principles of drug absorption, drug metabolism and distribution - intestinal absorption, Metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/ PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.	**20%**	**06**
Unit 4: Drug Manufacturing: Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.	**20%**	**06**

Unit 5: Clinical trial design: Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation.	**20%**	**06**
Unit 6: Fundamentals of regulatory affairs and bioethics: Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label vs. off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance To current ethical guidelines, Ethical Committees and their setup, Animal Ethical issues and compliance.		

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 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.	Understand, Remember& apply	Explain, Describe, Discuss, Recall, Locate
CO2 Demonstrate an understanding of the steps involved in the drug discovery and design process.	Remember	Apply, Practice, Interpret, Select, Correlate
CO3 Demonstrate an awareness of the important contributions the different discipline areas make to the drug discovery and development process.	Remember	Compare, Classify, Select, Investigate
CO4 Critically analyse biological pathways for their potential as drug targets for a given disease.	Analyses	Construct, Develop, Produce
CO5 Demonstrate the ability to use evidence-based approaches to guide decision making during the drug discovery and development process.	Understand, Remember& apply	Explain, Describe, outline, Predict, Summarize

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

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

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

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