Scheme of Teaching

&

Detailed Syllabus

For

Master of Science

M.Sc. (Microbiology)

(Two Year Program)

(w.e.f. Academic Session 2021–22)

Shobhit
Institute of Engineering & Technology
Deemed to-be-University
EDUCATION EMPOWERS

School of Basic & Applied Sciences

Shobhit Institute of Engineering & Technology

(Deemed to-be University)

NH-58, Modipuram, Meerut (U.P.) – 250110

Website: www.shobhituniversity.ac.in

Registrar
Shobhit Institute of Engg. & Tech.
(Deemed to-Be University)
NH-58, Modipuram, Meerut-250110

Program Educational Objectives (PEOs):

PEO1. Explain relationships and apply appropriate terminology relating to the structure, metabolism, genetics, and ecology of prokaryotic microorganisms, eukaryotic microorganisms, and viruses.

PEO2. Explain interactions between opportunistic and pathogenic microorganisms and susceptible hosts in contacts that result in infection and/or disease and apply these interactions to disease symptoms.

PEO3. Explain nonspecific body defences and the immune responses and apply this understanding to the infectious disease process as well as the prevention and control of infectious diseases.

PEO4. Explain principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases.

PEO5. Exhibit strong, independent learning, analytical and problem-solving skills with special emphasis on design, communication, and ability to work in teams.

Program Outcomes (POs):

PO 1. Students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology.

PO 2. Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis.

PO 3. Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.

PO 4. Students will demonstrate engagement in the Microbiology discipline through involvement in research or internship activities, the Microbiology Student Association club (MSA) and outreach or mentoring activities specific to microbiology.

PO 5. Graduates will be able to decide and apply appropriate tools and techniques in microbial manipulation.

PO 6. Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in microbiology practices

PO 7. Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.

PO 8. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

PO 9. Design system, components or processes to meet realistic needs of society, environment, health and safety, and sustainability.

PO 10. Recognize the need for, and an ability to engage in life-long learning.

PO 11. Acquire knowledge of contemporary issues.

PO 12. Graduates will be able to demonstrate knowledge of project and finance management when dealing with Biotechnology Engineering problems.

Program Specific Outcomes (PSOs):

PSO 1. Demonstrate proficiency in basic science and foundation clinical courses.

PSO 2. Demonstrate a working knowledge of advanced microbial techniques and life science for the industrial applications and human welfare.

PSO 3. Demonstrate the application in microbial, biotechnology, and allied industries designing, developing and providing solutions for product/processes/technology development.

SCHEME OF TEACHING – M.Sc. (Microbiology)
FIRST YEAR

SEMESTER-I

Course Code	Course / Title	L	T	P	Credit
MSMB-101	Biochemistry	3	0	0	3
MSMB -102	Microbial Diversity	3	0	0	3
MSMB -103	Biophysical Techniques	4	0	0	4
MSMB -104	Genetics	4	0	0	4
MSMB -105	Cell and Molecular Biology	4	0	0	4
MSMB -151	Biochemistry Lab.	0	0	4	2
MSMB -152	Microbial Diversity Lab.	0	0	4	2
MSMB -153	Biophysical Techniques Lab.	0	0	4	2
Total		**18**	**0**	**12**	**24**

SEMESTER –II

Course Code	Course / Title	L	T	P	Credit
MSMB-201	Genetic Engineering	4	0	0	4
MSMB-202	Immunotechnology	3	0	0	3
MSMB-203	Bioinformatics	3	0	0	3
MSMB -204	Microbial Physiology and Metabolism	4	0	0	4
MSMB-205/ MSMB-206/ MSMB-207	**Elective-I**	4	0	0	4
MSMB-251	Genetic Engineering Lab.	0	0	4	2
MSMB-252	Immunotechnology Lab.	0	0	4	2
MSMB-253	Bioinformatics Lab.	0	0	4	2
Total		**18**	**0**	**12**	**24**

SECOND YEAR

SEMESTER-III

Course Code	Course / Title	L	T	P	Credit
MSMB-301	Industrial and Food Microbiology	4	0	0	4
MSMB-302	Biostatistics	3	0	0	3
MSMB-303	Medical Microbiology	4	0	0	4
MSMB-304	Intellectual Property Rights, Biosafety and Bioethics	3	0	0	3
MSMB-305/ MSMB-306/ MSMB-307	**Elective -II**	4	0	0	4
MSMB-351	Industrial and Food Microbiology Lab.	0	0	4	2
MSMB-353	Medical Microbiology Lab.	0	0	4	2
MSMB-381	Seminar	0	0	4	2
Total		**18**	**0**	**12**	**24**

Semester- IV

Course Code	Course / Title	L	T	P	Credit
MSMB-481	Seminar	0	0	04	2
MSMB-491	Dissertation	0	0	24	12
	Total	**0**	**0**	**28**	**14**

Elective-I – MSMB-205 Agriculture Microbiology
MSMB-206 Virology
MSMB-207 Microbial Technology
Elective-II – MSMB-305Nanobiotechnology
MSMB-306Environmental Microbiology
MSMB-307Vaccines

SEMESTER-I

Course code	**MSMB-101**				
Category	**Applied Sciences**				
Course title	**Biochemistry**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	Theobjectivesofthiscoursearetobilduponundergraduatelevelknowledgeof biochemical principles with specificemphasisondifferentmetabolicpathways.The course shall make the students awareof various disease pathologies within thecontextofeachtopic.				
Outcomes	On completion of this course,studentsshouldbeableto: 1.Gain fundamental knowledgeinbiochemistry; 2.Understandthemolecularbasis of various pathological 3. Conditions from the perspectiveofbiochemicalreactions.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Chemical basis of life:** Miller-Urey experiment, abiotic formation of amino acidoligomers,compositionoflivingmatter;Water–propertiesofwater,essentialrole ofwaterforlifeonearthpH,buffer,maintenanceofbloodpHandpHofgastricjuice,pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionizationand hydrophobicity, emergent properties of biomolecules in water, biomolecularhierarchy,macromolecules,molecularassemblies.				**8 Hrs**
Unit-2	**Proteinstructure-** Structure-function relationships: amino acids – structure and functional groupproperties, peptides and covalent structure of proteins, elucidation of primary andhigher order				**8Hrs**

	structures,Ramachandran plot,evolution ofprotein structure,proteindegradationandintroductiontomolecularpathwayscontrollingproteindegradation,structure-function.	
Unit-3	**Enzyme Kinetics-**Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity andefficiency; enzyme characterization and Michaelis-Menten kinetics; relevance ofenzymes in metabolic regulation, activation, inhibition and covalent modification;single substrate enzymes; concept of catalytic antibodies; catalytic strategies withspecificexamplesofproteases,carbonicanhydrases,restrictionenzymesandnucleosidemonophosphate kinase; regulatory strategies with specific example of hemoglobin;isozymes;roleofcovalentmodificationinenzymaticactivity;zymogens.	**9Hrs**
Unit-4	**Glycobiology-**Sugars-mono,di,andpolysaccharideswithspecificreferencetoglycogen,amyloseand cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids;lipids -structure andpropertiesofimportantmembersofstorageandmembranelipids;lipoproteins.	**8 Hrs**
Unit-5	**Role of Vitamins and cofactors-** Calvincycleandpentosephosphatepathway;glycogenmetabolism,reciprocalcontrolof glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulinin glycogen metabolism; Fatty acid metabolism; protein turnover and amino acidcatabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols withspecific emphasis on cholesterol metabolism and mevalonate pathway.	**9Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	2	3	1	1	1	1	2	2	2	1	1	1	1
CO 2	1	2	2	2	2	1	2	2	2	3	2	2	2	1	2
CO 3	3	1	2	1	2	2	-	1	3	2	-	2	2	2	2
Average	**2.0**	**1.3**	**2.0**	**2.0**	**1.7**	**1.3**	**1.3**	**1.3**	**2.3**	**2.3**	**1.3**	**1.7**	**1.7**	**1.3**	**1.7**

References

1. Stryer,L.(2015).Biochemistry.(8th ed.)NewYork:Freeman.
2. Lehninger, A.L. (2012).Principles ofBiochemistry(6th ed.). NewYork, NY:Worth.
3. Voet, D.,&Voet,J.G.(2016).Biochemistry(5th ed.).Hoboken,NJ: J.Wiley&Sons.

	4. Dobson,C.M.(2003).ProteinFoldingandMisfolding.Nature,426(6968), 884-890.doi:10.1038/nature 02261. 5. Richards,F.M.(1991).TheProteinFoldingProblem.ScientificAmerican,264(1),54-63.doi:10.1038/scientific American 0191-54. 6. 0191-54.

Course code	**MSMB-102**				
Category	**Applied Sciences**				
Course title	**Microbial Diversity**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	Theobjectivesofthiscoursearetobuildknowledgeof prokaryotic and eukaryotic diversity with specificemphasisonmechanisms behind it. The course shall make the students awareof various microbial communities and within thecontextofeachtopic.				
Outcomes	a. Describe common groups of bacteria and archaea in different ecosystems, and their role in biogeochemical key processes in these environments. b. Describe for cultivation-independent methods for studies of the composition of microbial communities and for the function and occurrence of individual groups. c. Describe genomic-based methods to study microbial diversity in nature and for the mechanisms behind it. d. Describe important interactions within microbial communities and between microorganisms and plants and animals. e. Evaluate, synthesize and present scientific studies of genetic and functional microbial diversity in different ecosystems				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Archaea:** Systematics, and occurrence, diversity, characteristic features, significance and potential	**6Hrs**

	applications (eg. biochips, methane generation, ultrafiltation membranes, production of PHB and PHA, desulphurization of coal and crude oil, bioleaching of metals, enzymes, compatible solutes and others) of different groups of archaebacteria (Crenarchaeota, Euarchaeota, Korarchaeota, Nanoarchaeota).	
Unit-2	**Bacteria:** Conventional and molecular systematics, and general discussion on the occurrence, diversity, characteristic features, significance and potential applications of various groups of bacteria according to Bergey's Manual of Systematic Bacteriology.	**6Hrs**
Unit-3	**Fungal Systematics and diversity:** Fungal endophytes of tropical plants and their applications: Endophytic fungi, colonization and adaptation of endophytes. Endophytes as latent pathogens and biocontrol agents. Mycorrhizal fungi: Diversity of endo and ectomycorrhizal fungi. Biology of arbuscularmycorrhizal fungi: signaling, penetration and colonization inside roots, culturing and benefits, recent advances in the field of mycorrhiza.	**6Hrs**
Unit-4	**Agriculturally important toxigenic fungi:** Biodiversity, Chemical and biological characterization of toxic metabolites, toxigenic fungi in sustainable agriculture with special emphasis on biopesticides. Secondary metabolites from fungi: Terpenes, Non-ribosomal peptides, hydrophobins, peptaibols, indole alkaloids, detailed emphasis on polyketides.	**6Hrs**
Unit-5	**Biodiversity of yeast and Algae:**Mycocinogeny and diversity of mycogenic yeast strains, characteristics of mycocins, mode of action, genetic basis of mycocinogeny, important mycocins, applications of antagonistic yeasts. Biotechnological applications of yeasts. Algal diversity from morphology to molecules: Importance of algae in production of algal pigments, biofuels, hydrogen production.	**6Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	1	1	2	1	2	1	1	2	1	1	2	1	2	1
CO 2	2	2	2	2	1	1	-	3	1	3	2	1	1	2	2
CO 3	1	3	3	1	2	2	2	2	3	2	3	3	2	1	2

CO 4	1	2	2	1	-	2	1	1	1	1	-	2	1	1	2
CO 5	3	2	2	2	1	1	3	2	1	1	1	2	2	3	2
Average	**1.8**	**2**	**2**	**1.6**	**1**	**1.6**	**1.4**	**1.8**	**1.6**	**1.6**	**1.4**	**2**	**1.4**	**1.8**	**1.8**

References	1. The Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV by Balows, A., Trüper, H. G., Dworkin, M., Harder, W., Schleifer, K. H. Springer-Verlag, New York; 1992 2. Bacterial Systematics, by Logan, A., Niall A. Logan, Wiley-blackwell; 1994 3. Principles of Microbiology by R.M. Atlas, Mosby publishers, St. Louis; 1995 10 4. Brock Biology of Microorganisms (12th edition) by Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark Benjamin Cummings; 2008. 5. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case Benjamin- Cummings Publishing Company; 2008. 6. Fundamentals of the fungi by Elizabeth Moore, Fourth edition, Benjamin Cummings; Landecker; 1996. 7. Mycotechnology: Present status and future prospects. Edited by Mahendra Rai. I.K., International Publishing House Pvt. Ltd.; 2007. 8. The Yeast Handbook: Biodiversity and Ecophysiology of yeasts by Carlos A. Rosa and Gabor Peter. Springer- Verlag Berlin Heidelberg; 2006. 9. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.

Course code	**MSMB-103**				
Category	**Applied Sciences**				
Course title	**Biophysical Techniques**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course is to teach students to differentiate between the various techniques for measurement of parameters used in biological sciences. The course is designed to teach students the utility of set of experimental methods in biological research in a problem-oriented manner.				

Outcomes	On completion of this course, students should be able to: a. Explain principles of electrophoresis and immunochemical techniques and discuss how these techniques can be used in molecular medicine. b. Explain basic principles for chromatographic separation techniques. c. To familiarize with basic Laboratory techniques and understand the principle of measurements using those techniques.

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Electrophoresis&Blotting:**Agarose and polyacrylamide gel electrophoresis (native and denaturing), Immuno-electrophoresis, Isoelectric Focusing, Capillary electrophoresis. Southern blotting, northern blotting, western blotting, South western blotting.	**8Hrs**
Unit-2	**Chromatography**: Planner chromatography and column chromatography (ion exchange, gel permeation, affinity), GLC and HPLC.	**8 Hrs**
Unit-3	**Spectroscopy and X –ray crystallography**: Principles of colorimetry and UV-Vis spectrophotometry, Mass spectrometry, MALDI, X-Ray Crystallography, SPR.	**8 Hrs**
Unit-4	**Microscopy** -Principle, working, sample preparation and biological applications of different microscopes light microscope (bright field and dark field, phase contrast, polarization, differential interference contrast), electron microscope (TEM, SEM), fluorescence microscope (simple and confocal) and atomic force microscope.	**9Hrs**

Unit-5	**Centrifugation**: Principle, construction, working of centrifugation and concept of RCF, types of instruments and rotors used in centrifugation, types of centrifugations- preparative, differential density gradient centrifugation and analytical ultracentrifuge.	**9Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O 1**	**PS O 2**	**PS O 3**
CO 1	2	1	2	3	1	2	1	1	2	1	2	2	1	2	1
CO 2	3	3	2	1	1	-	1	3	1	2	2	-	1	2	2
CO 3	1	3	3	1	2	3	3	2	3	2	3	3	2	1	2
Average	**2.0**	**2.3**	**2.3**	**1.7**	**1.3**	**1.7**	**1.7**	**2.0**	**2.0**	**1.7**	**2.3**	**1.7**	**1.3**	**1.7**	**1.7**

References

1. Wilson, K. and Walker, J. 1994. Principles and Techniques Practical Biochemistry, Cambridge University Press, Cambridge.
2. Willard, H.H., Meritt, L.L., Dean, J.A. and Settle, F.A. 1986. Instrumental method of analysis (7th eds.). Wadsworth Pub. Co., USA.
3. Rana, S.V.S. 2006 and 07. Biotechniques– Theory and Practice (2nd eds.). Rastogi Publications.
4. Chatwal, G.R. and Anand, S.K. 2008. Instrumental methods of chemical analysis (5th eds.). Himalaya Publishing House.
5. Skoog, D.A., Holler, F.J. and Crouch, S.R. 2007. Instrumental analysis. Brooks/Cole Cengage Learning.
6. Upadhayay, A. and Upadhayay, K. 2008. Biophysical chemistry (4th eds.). Himalaya Publishing House.

Course code	**MSMB -104**				
Category	**Applied Sciences**				
Course title	**Genetics**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	

Pre-requisites (if any)	Nil
Objectives	The objectives of this course are to takestudents through basics of genetics andclassical genetics covering prokaryotic/phage genetics to yeast and highereukaryotic domains. On covering allclassicalconceptsofMendeliangeneticsacrossthelife-forms,studentswill be exposed to concepts of populationgenetics, quantitative geneticsencompassingcomplextraits,clinicalgeneticsandgenetic sofevolution.
Outcomes	Onsuccessfulcompletionofthiscourse,studentwillbeable: 1. Describefundamentalmolecular principlesofgenetics; 2. Understand relationship betweenphenotypeandgenotypeinhumangenetictraits; 3. Describethebasicsofgeneticmapping; 4. Understandhowgeneexpressionisregulated.

S. No.	**Unit details**	**Time Allotted**
Unit-1	History of Genetics, Mitosis and Meiosis, Cell Cycle regulation, Mendel's laws of Inheritance, Codominance, Lethal Gene Linkage- types of linkage and estimation of linkage	**8 Hrs**
Unit-2	Ultrastructureofcellandcellorganellesandtheirfunctions, Cytoplasmic inheritance, Chromosome structure, morphology, number and types-karyotype and ideogram, Structure of chromosomal aberrations.	**9Hrs**
Unit-3	Mutations-Germinal and Somatic Mutations, Types of mutations, Molecular bases of mutation, Methods of inducing mutation and C/B technique, quantitative traits-qualitative traits and differences between them.	**8Hrs**
Unit-4	Multiple factor hypothesis, Alleles, Multiple alleles in Plants, Types of gene action	**7 Hrs**

Unit-5	Regulation of gene expression, DNA and its structure, function, types, mode of replication and repair, lac operon and fine structure of gene: Classification of gene.	**8Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
CO 1	2	1	2	2	1	2	2	1	2	1	2	2	1	2	1
CO 2	2	2	2	1	1	-	1	-	1	2	2	2	1	2	2
CO 3	2	2	2	-	2	3	3	2	3	2	2	3	2	1	2
CO 4	1	3	3	1	2	3	3	2	3	2	3	3	2	1	2
Average	**1.8**	**2.0**	**2.3**	**1.0**	**1.5**	**2.0**	**2.3**	**1.3**	**2.3**	**1.8**	**2.3**	**2.5**	**1.5**	**1.5**	**1.8**

References	1. Hartl,D.L.,&Jones,E.W.(1998).Genetics:PrinciplesandAnalysis.Sudbury,MA:JonesandBartlett. 2. Pierce,B.A.(2005).Genetics:aConceptualApproach.NewYork:W.H.Freeman. 3. Tamarin,R.H.,&Leavitt,R.W.(1991).PrinciplesofGenetics. Dubuque,IA:Wm.C.Brown.Smith,J.M.(1998).*EvolutionaryGenetics*.Oxford:OxfordUniversityPress

Course code	**MSMB -105**				
Category	**Applied Sciences**				
Course title	**Cell and Molecular Biology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are tosensitize the students to the fact thataswegodownthescaleofmagnitudefromcellstoorganellestomolecules,the understanding of various biologicalprocessesbecomesdeeperandinclusive.				
Outcomes	Studentshouldbeequippedtounderstandthree fundamental aspects in biologicalphenomenon: a) what to seek; b) how toseek;c)whytoseek?				
S. No.	**Unit details**				**Time**

		Allotted
Unit-1	**Cell organelles-** Internal organization of the cell - cell membranes: structure of cell membranesand concepts related to compartmentalization in eukaryotic cells; intracellularorganelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes,ribosomes,cellularcytoskeleton,mitochondria, chloroplastsandcellenergetics;nuclearcompartment:nucleus ,nucleolusandchromosomes.	**8 Hrs**
Unit-2	**Cellularsignalling,transportandtrafficking**-Molecular mechanisms of membrane transport, nuclear transport, transport acrossmitochondriaandchloroplasts;intracellularvesiculartrafickingfromendoplasmicreticulumthroughGolgiapparatustolysosomes/cellexterior.	**8 Hrs**
Unit-3	**Cellular Processes-**Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; celldifferentiation: stem cells, their differentiation into different cell types and organizationinto specialized tissues; cell-cell interactions; cell receptors and trans-membranesignalling;cellmotilityandmigration;celldeath:differentmodesofcelldeathandtheirregulation.	**9 Hrs**
Unit-4	**Manipulating and studying cells-** Isolationofcellsandbasicsofcellculture;observingcellsunderamicroscope,differenttypesofmicroscopy;analyzingandmanipulatingDNA,RNAandproteins.	**8 Hrs**
Unit-5	**Genome instability and cell transformation-** Mutations,proto-oncogenes,oncogenesandtumoursuppressorgenes,physical,chemicaland biological mutagens; types of mutations;transpositions- transposable genetic elements in prokaryotes and eukaryotes, role oftransposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure,functionandmechanismofaction.	**8 Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	2	2	1	2	2	1	2	1	2	2	1	2	1
Average	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**1**

References	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 CellBiology*(8th Ed.). NewYork: W.H. Freeman. 3. Krebs,J.E.,Lewin,B.,Kilpatrick,S.T.,&Goldstein,E.S.(2014).*Lewin'sGenesXI*.Burlington,MA:Jones&BartlettLearning. 4. Cooper,G.M.,&Hausman,R.E.(2013).*TheCell:aMolecularApproach*(6th Ed.).Washington:ASM;Sunderland. 5. Hardin, J., Bertoni,G., Kleinsmith,L. J.,&Becker,W. M.(2012). *Becker's WorldoftheCell*.Boston(8th Ed.).BenjaminCummings. 6. Watson,J.D.(2008).*MolecularBiologyoftheGene*(5th d.).MenloPark,CA:Benjamin/Cummings.

Course code	**MSMB-151**				
Category	**Applied Sciences**				
Course title	**Biochemistry Lab.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	
Pre-requisites (if any)	Nil				
Objectives	Theobjectiveofthislaboratorycourseistointroducestudentstoexperimentsinbiochemistry.Thecourseisdesignedto teach students the utility of set ofexperimentalmethodsinbiochemistryinaproblemorientedmanner.				
Outcomes	On completion of this course, studentsshouldbeableto: 1. Toelaborateconceptsofbiochemistrywitheasytorunexperiments; 2. To familiarize with basic				

	laboratoryinstrumentsandunderstandandtheprinciple of measurements usingthoseinstrumentswithexperimentsinbiochemistry.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
CO 1	2	1	2	1	1	2	1	1	2	1	2	3	1	2	1
CO 2	3	2	2	1	1	1	1	-	-	2	2	2	2	2	2
Average	**2.5**	**1.5**	**2**	**1**	**1**	**1.5**	**1**	**0.5**	**1**	**1.5**	**2**	**2.5**	**1.5**	**2**	**1.5**

Experiment details

1. Preparingvariousstocksolutionsandworkingsolutionsthatwillbeneededfort hecourse
2. TopreparеanAcetic-NaAcetateBufferandvalidatetheHenderson-Hasselbachequation.
3. TodetermineanunknownproteinconcentrationbyplottingastandardgraphofBSA usingUV-VisSpectrophotometerandvalidatingtheBeer-Lambert'sLaw.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar aminoacidsbythinlayerchromatography.
5. Purification and characterization of an enzyme from a recombinant source(suchasAlkalinePhosphataseorLactateDehydrogenaseoranyenzym eoftheinstitution'schoice).

a) Preparationofcell-freelysates
b) AmmoniumSulfateprecipitation
c) Ion-exchangeChromatography
d) GelFiltration
e) AffinityChromatography
f) Dialysisofthepurifiedproteinsolutionagainst60%glycerolasademonstr ationofstoragemethod
g) Generating a Purification Table (protein concentration, amount of totalprotein; Computing specific activity of the enzyme preparation at eachstageofpurification)
h) AssessingpurityofsamplesfromeachstepofpurificationbySDS-PAGEGelElectrophoresis
i) EnzymeKineticParameters:Km,VmaxandKcat.

Course	**MSMB-152**

code					
Category	**Applied Sciences**				
Course title	**Microbial Diversity Lab.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	
Pre-requisites (if any)	Nil				
Objectives	Theobjectiveofthislaboratorycourseis to provide practical skills on basicmicrobiologicaltechniques				
Outcomes	Studentsshouldbeableto: 1. Isolate,characterizeandidentifycommonbacterialorganisms; 2. Determinebacterialloadofdifferentsamples; 3. Performantimicrobialsensitivitytests; 4. Preservebacterialcultures.				

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	2	1	3	2	1	1	2	1	1	2	1	1	1
CO 2	2	1	1	2	2	-	1	-	2	3	1	1	2	-	2
CO 3	3	1	2	2	2	2	2	3	3	2	2	2	2	2	-
CO 4	2	2	3	1	2	2	1	1	2	2	1	2	1	2	2
Average	**2.0**	**1.5**	**2.0**	**1.5**	**2.3**	**1.5**	**1.3**	**1.3**	**2.3**	**2.0**	**1.3**	**1.8**	**1.5**	**1.3**	**1.3**

Experiment details

1. Sterilization,disinfectionandsafetyinmicrobiologicallaboratory.
2. Preparationofmediaforcultivationofbacteria.
3. Isolationofbacteriainpureculturebystreakplatemethod.
4. Studyofcolonyandgrowthcharacteristicsofsomecommonbacteria:
5. *Bacillus,E.coli,Staphylococcus,Streptococcus,etc.*
6. PreparationofbacterialsmearandGram'sstaining.
7. Enumerationofbacteria:standardplatecount.
8. Antimicrobialsensitivitytestanddemonstrationofdrugresistance.
9. Maintenanceofstockcultures:slants,stabsandglycerolstockcultures
10. Determinationofphenolco-efficientofantimicrobialagents.
11. DeterminationofMinimumInhibitoryConcentration(MIC)

Course code	**MSMB -153**				
Category	**Applied Sciences**				
Course title	**Biophysical Techniques Lab**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	
Pre-requisites (if any)	Nil				
Objectives	Theobjectiveofthislaboratorycourseistointroducestudentsto experimentsinBiophysical techniques.Thecourseisdesignedto teach students the utility of set ofexperimentalmethodsinaproblemorientedmanner.				
Outcomes	On completion of this course, studentsshouldbeableto: 1. Toelaborateconceptsofbiophysicaltechniqieswitheasyt orunexperiments; 2. To familiarize with basic laboratoryinstrumentsandunderstandandthepr inciple of measurements usingthoseinstrumentswithexperimentsinbioc hemistry, microbiology and bimolecules.				

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O 1**	**PS O 2**	**PS O 3**
CO 1	1	2	2	1	3	2	1	1	2	2	1	2	1	1	1
CO 2	2	1	1	3	2	-	1	-	2	3	1	1	2	-	2
Average	**1.5**	**1.5**	**1.5**	**2**	**2.5**	**1**	**1**	**0.5**	**2**	**2.5**	**1**	**1.5**	**1.5**	**0.5**	**1.5**

Experiment details

1. ExperimentalverificationthatabsorptionatOD$_{260}$ismorefordenaturedDNA ascomparedtonativedoublestrandedDNA.reversalofthesamefollowingDNA renaturation.KineticsofDNArenaturationasafunctionofDNAsize.
2. IdentificationofanunknownsampleasDNA,RNAorproteinusingavailable laboratorytools.(OptionalExperiments)
3. Biophysicalmethods(CircularDichroismSpectroscopy,FluorescenceSpectroscopy).
4. DeterminationofmassofsmallmoleculesandfragmentationpatternsbyMas sSpectrometry.
5. As per syllabus

SEMESTER-II

Course code	**MSMB -201**				
Category	**Applied Sciences**				
Course title	**Genetic Engineering**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.				
Outcomes	On completion of this course,studentsshouldbeableto: 1.Endowed with strong theoretical knowledge of this technology. 2.Acquainted with tools of RDT like enzymes, vectors and hosts. 3.Apply RDT in different domains of life science, medical, agriculture, forensic and allied fields for the welfare of living beings.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction and tools for genetic engineering:**Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase;	**6 Hrs**

	cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.	
Unit-2	**Different types of vectors:**Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia*vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	**7Hrs**
Unit-3	**Different types of PCR techniques:** Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.	**7Hrs**
Unit-4	**Gene manipulation and protein-DNA interaction:** Insertion of foreign DNA into host cells; transformation, electroporation,	**7Hrs**

	transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNasefootprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
Unit-5	**Gene silencingand genome editing technologies:** Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies(*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics- gene replacement; gene targeting; creation of transgenic and knock-outmice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.	**13Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	1	1	3	2	1	1	2	1	2	2	1	1	1
CO 2	1	1	1	2	-	1	2	1	2	3	1	-	2	1	2
CO 3	2	1	2	1	2	2	2	3	1	2	2	2	2	2	-
Average	**1.3**	**1.3**	**1.3**	**1.3**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**2.0**	**1.7**	**1.3**	**1.7**	**1.3**	**1.0**

References

1. Old, R. W., Primrose, S. B., &Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene,

	Promega, Novagen, New England Biolab etc.

Course code	**MSMB -202**				
Category	**Applied Sciences**				
Course title	**Immunotechnology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.				
Outcomes	On completion of this course, students should be able to: 1. Evaluate usefulness of immunologyin different pharmaceutical companies; 2. Identify proper research lab working in area of their own interests; 3. Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Immunology: fundamental concepts and overview of the immune system:**Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major				**5 Hrs**

	Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.	
Unit-2	**Immune responses generated by B and T lymphocytes:**Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.	**8Hrs**
Unit-3	**Antigen-antibody interactions:** Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand – receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.	**6Hrs**
Unit-4	**Vaccinology:** Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic	**8Hrs**

	vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.	
Unit-5	**Clinical immunology:** Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immunesystem, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.	**8Hrs**
Unit-6	**Immunogenetics:** Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.	**5Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	1	1	3	2	1	1	2	1	2	2	1	1	1
CO 2	1	1	1	2	-	1	2	1	2	3	1	-	2	1	2
CO 3	2	1	2	1	2	2	2	3	1	2	2	2	2	2	-
Average	**1.3**	**1.3**	**1.3**	**1.3**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**2.0**	**1.7**	**1.3**	**1.7**	**1.3**	**1.0**

References

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., &Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies

	in Cell Biology, Biochemistry, and Immunology. London: Academic Press. 6. Parham, P. (2005). The Immune System. New York: Garland Science.

Course code	**MSMB -203**				
Category	**Applied Sciences**				
Course title	**Bioinformatics**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to provide theory and practical experience of theuse of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.				
Outcomes	On completion of this course,studentsshouldbeableto: 1. Develop an understanding of basic theory of these computational tools; 2. Gain working knowledge of these computational tools and methods; 3. Appreciate their relevance for investigating specific contemporary biological questions; 4. Critically analyse and interpret results of their study.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Bioinformatics basics:**Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid				**5 Hrs**

	databases; Structural databases; Biological XML DTD'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.	
Unit-2	**DNA sequence analysis:**DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.	**5Hrs**
Unit-3	**Multiple sequence analysis:** Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.	**5Hrs**
Unit-4	**Protein modelling:** Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.	**5Hrs**
Unit-5	**Protein structure prediction and virtual library:** Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology	**6Hrs**

	modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design;Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.	

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	1	1	3	2	1	1	2	1	2	2	1	1	1
CO 2	1	1	1	2	-	1	2	1	2	3	1	-	2	1	2
CO 3	2	1	2	1	2	2	2	3	1	2	2	2	2	2	-
CO 4	2	1	2	1	2	2	2	3	1	2	2	2	2	2	-
Average	**1.5**	**1.3**	**1.5**	**1.3**	**1.8**	**1.8**	**1.8**	**2.0**	**1.5**	**2.0**	**1.8**	**1.5**	**1.8**	**1.5**	**0.8**

References	1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press. 2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience. 4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell. 5. Bourne, P. E., &Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss. 6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

Course code	**MSMB -204**				
Category	**Applied Sciences**				
Course title	**Microbial Physiology and Metabolism**				
Scheme and	**CR**	**L**	**T**	**P**	

Credits	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	This course enables the students to provide basic knowledge about catabolism, anabolism, regulation of metabolism and pathway analysis. It also gives understanding of how enzymes and metabolites in living system work to produce energy and synthesizing different biomolecules.				
Outcomes	On completion of this course,studentsshouldbeableto: 1. Understand the microbial growth in different physiological conditions. 2. Learn the phenomenon of nutrient utilization of microbes. 3. Comprehend the concept of microbial respiration and their metabolism.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Microbial Growth and Movement:** Mathematical nature and expression of microbial growth. Generation time. Synchronous growth. Bacterial growth in batch and continuous cultures, chemostats and turbidostats. Note on cell death (necrosis Vs apoptosis). E.coli chemotaxis system, structural organization of bacterial sensors for chemotaxis, mechanism of chemotaxis regulation	**12Hrs**
Unit-2	**Central pathways of carbohydrate metabolism:** Metabolic pathways in aerobic heterotrophs: Pyruvate formation (Embden-Meyerhof pathway (EMP) /glycolytic pathways, Pentose phosphate pathway (PPP) /hexose monophosphate shunt, Entner-Doudoroff pathway). Metabolic pathways utilizing pyruvate (TCA cycle, glyoxylate cycle).	**12 Hrs**
Unit-3	**Energy production:** Substrate level and oxidative phosphorylation. Electron Transport Chain. Note on transport system: Iron transport and phosphotransferase system.	**12 Hrs**
Unit-4	**Microbial synthesis I:** Microbial synthesis of purine and pyrimidine bases in RNA and DNA. Microbial synthesis of Glutamate family (Glutamine, Arginine	**12 Hrs**

	and Proline) and Aspartate family (Asparagine, Methionine, Threonine, Isoleucine and Lysine) and Histidine	
Unit-5	**Microbial synthesis II:** Microbial synthesis of Aromatic family (Tryptophan, Phenylalanine and Tyrosine), Serine family (Glycine and Cysteine) and Pyruvate family (Alanine, Valine and Leucine). Biosynthesis of phospholipid (Phosphatidylethanolamine, Phosphatidylgycerol and cardiolipin).	**12 Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	1	3	2	1	1	2	1	2	3	1	2	1
CO 2	2	1	1	2	2	1	2	1	2	-	1	-	2	1	2
CO 3	2	1	2	1	1	2	2	3	1	2	2	2	2	2	-
Average	**1.7**	**1.3**	**1.7**	**1.3**	**2.0**	**1.7**	**1.7**	**1.7**	**1.7**	**1.0**	**1.7**	**1.7**	**1.7**	**1.7**	**1.0**

References	1. The Microbial world‖ by Stanier, Ingraham, Wheelis and Painter. McMillan Educational Ltd., London. 2. Microbial Physiology by Moat and Foster , Wiley. 3. Essentials of Bacterial Physiology byUmbreit. 4. Bacterial Physiology and Metabolism by Skokatch.

Course code	**MSMB -205**				
Category	**Applied Sciences**				
Course title	**Agriculture Microbiology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	The course aims to provide fundamental knowledge about cytology and physiology of microorganisms, with emphasis to their role in nature and their use in agricultural biotechnology, in relation to soil fertility, organic matter degradation, and microbial interactions with plants and other biotic and abiotic components of soil ecosystem.				
Outcomes	On completion of this course,studentsshouldbeableto: 1. Understand the microorganisms of soil and nutrient cycle. 2. Learn about the role of enzymes and toxins in pathogenesis. 3. Understand about the physical and chemical control of plant diseases. 4. Learn about Biofertilizers & Mycorrhizae.				

S. No.	Unit details	Time Allotted
Unit-1	Microorganisms of soil. Rhizosphere and phyllosphere microflora. Brief account of Microbial interactions: antagonism, symbiosis, mutualism, commensalisms, synergism and parasitism. Nutrient cycle: Carbon cycle , nitrogen cycle, phosphorous cycle and sulphur cycle.	**4Hrs**
Unit-2	Role of enzymes and toxins in pathogenesis. Fungal diseases of plants: Rusts of wheat, linseeds; late blight of potato; red rot of sugarcane. Bacterial diseases of plants: Citrus canker, blight of rice. Viral diseases of plants: Leaf curl of Papaya, vein clearing of lady's finger.	**10 Hrs**
Unit-3	Physical and chemical control of plant diseases. Bacterial control of insect pests: Bacillus thuringiensis as bacterial insecticide. Viral control of insect pests: Nuclear polyhedrosisvisuses (NPV) and cytoplasmic polyhedrosis viruses (CPV). Fungal control of insect pests: *Entomopathogenic* fungi : *Metarhiniumanisopliae, Beauveriabassiana, Verticilliumlecani, Hirsutellathompsoni*	**9 Hrs**
Unit-4	**Storage fungi:** Categories of storage fungi, conditions during storage in relation to damage of seeds, harmful effects. Mycotoxins and their effect on human being. General idea about quarantine. Production of biogas and alcohol from agricultural wastes.	**12 Hrs**
Unit-5	**Biofertilizers:** Types, production and application. Mycorrhizae: Types and their application in agriculture and forestry. Vermicomposting. Reclamation of waste agricultural land by microorganisms.	**6 Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	1	1	3	2	1	1	2	1	2	2	1	1	1
CO 2	1	2	1	2	2	1	2	1	2	3	1	-	2	1	2
CO 3	2	1	-	1	1	-	2	2	1	2	1	2	2	2	2
CO 4	2	1	2	1	2	2	2	2	1	2	2	2	2	2	1
Average	**1.5**	**1.5**	**1.0**	**1.3**	**2.0**	**1.3**	**1.8**	**1.5**	**1.5**	**2.0**	**1.5**	**1.5**	**1.8**	**1.5**	**1.5**

1. Soil Microbiology by Prof. N.S. Subba Rao (2000), Fourth edition, Oxford and IBH Publishing Co. Pvt, Ltd., New

References	Delhi 2. Introduction to soil microbiology. Alexander M. (1977) John Wiley & Sons, Inc., New York. 3. Modern Soil Microbiology, Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Marcel Dekker INC, New York

Course code	**MSMB -206**				
Category	**Applied Sciences**				
Course title	**Virology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	This course is designed to introduce the structure of viruses, provide knowledge on fundamentals of virology; Develop understanding of infection processes at the molecular level; introduce a concept of biosafety against infection or genetic modification.				
Outcomes	On completion of this course,studentsshouldbeableto: 1. Understand basic concepts in the field of Virology.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**General Virology:** Brief outline on discovery of viruses. Nomenclature and classification of plant, animal and bacterial viruses. Distinctive properties of viruses; morphology & ultrastructure of virus. Virus related agents (viroids, prions).	**6 Hrs**
Unit-2	**General Methods of Diagnosis and Serology:** Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures. Primary &secondary cell cultures. Monolayer cell cultures; cell strains, cell lines and transgenic systems. Serological methods – haemagglutination& HAI; complement fixation; immunofluorescence methods, ELISA and radioimmunoassays. **Assay of viruses –** physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron	**8Hrs**

	microscopy). Infective assay (plaque method, end point method).	
Unit-3	**Bacterial Viruses:** Bacteriophage: structural organization and life cycle. Bacteriophage typing - application in bacterial genetics. Brief details on M13, Mu, T3, T4 and Lambda P1.	**8Hrs**
Unit-4	**Plant Viruses:** Effects of viruses on histology, physiology and cytology of plants. Common viral diseases of plants; paddy, cotton, tomato and sugarcane. Common plant viruses: TMV, Cauliflower Mosaic Virus and Potato Virus X. transmission of plant viruses through vectors and without vectors. Control measures - virus-free planting material; vector control.	**6Hrs**
Unit-5	**Animal Viruses:** Epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA Viruses - Picorna, Ortho myxo, Paramyxo, Toga, Rhabdo, Rota, HIV - Oncogenic viruses. DNA viruses; Pox, Herpes, Adeno, SV 40, Hepatitis virus. Interferons, and antiviral drugs.	**8Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	1	1	3	2	1	1	2	1	2	2	1	1	1
Average	**1**	**2**	**1**	**1**	**3**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**1**

References

1. Conrat HF, Kimball PC and Levy JA. (1992). Virology. IIIrd edition. Prentice Hall, Englewood Cliff, New Jersey.
2. Dimmock NJ, Primrose SB. (2007) Introduction to Modern Virology VIth edition. Blackwell Scientific Publications, Oxford
3. Flint, S.J., Enquist, L.W., Krung, R. Racaniello, VR. And Skalka, A.M. (2015). Principles of Virology, Molecular Biology, pathogenesis and control, ASM Press, Washinton D.C.
4. Maloy SR, Cronan Jr. JE, Freifelder D. (1998). Microbial genetics. Jones and Bartlett publishers.

Course code	**MSMB -207**				
Category	**Applied Sciences**				
Course title	**Microbial Technology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	

Pre-requisites (if any)	Nil	
Objectives	The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.	
Outcomes	On completion of this course,studentsshouldbeableto: 1. Develop deeper understanding of the microbial technology and its applications.	
S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction to microbial technology:**Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (e.g., engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/ strains and their applications; Strain improvement to increase yield of selected molecules, e.g., antibiotics, enzymes, biofuels.	**8 Hrs**
Unit-2	**Environmental applications of microbial technology:**Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.	**6 Hrs**
Unit-3	**Pharmaceutical applications of microbial technology:**Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and	**8 Hrs**

	introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).	
Unit-4	**Food applications of microbial technology:** Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution *etc.*).	**7 Hrs**
Unit-5	**Advances in microbial technology:** Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (e.g., protease, antibiotic) etc.	**8 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	3	1	1	3	2	1	3	2	1	2	1	2	1	1
Average	**1**	**3**	**1**	**1**	**3**	**2**	**1**	**3**	**2**	**1**	**2**	**1**	**2**	**1**	**1**

References

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). Comprehensive Biotechnology. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet. (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied

	microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology,(f) Current opinion in Microbiology, (g) Biotechnology Advances,(h) Genome Research)

Course code	**MSMB-251**				
Category	**Applied Sciences**				
Course title	**Genetic Engineering Lab.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to provide students with experimental knowledge of molecular biology and genetic engineering.				
Outcomes	On completion of this course, studentsshouldbeableto: 1. Gain hands- on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages ingenetic engineering as well as in research laboratories conducting fundamental research.				

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	1	2	1	1	2	2	1	1	-	1	2	1	2	2	1
Average	**1**	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**-**	**1**	**2**	**1**	**2**	**2**	**1**

Experiment details

1. Concept of lac-operon:
   a) Lactose induction of B-galactosidase.
   b) Glucose Repression.
   c) Diauxic growth curve of E.coli
2. UV mutagenesis to isolate amino acid auxotroph
3. Phage titre with epsilon phage/M13
4. Genetic Transfer-Conjugation, gene mapping
5. Plasmid DNA isolation and DNA quantitation
6. Restriction Enzyme digestion of plasmid DNA
7. Agarose gel electrophoresis
8. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
9. Vector and Insert Ligation
10. Preparation of competent cells
11. Transformation of E.coli with standard plasmids, Calculation of transformation

efficiency

12. Confirmation of the insert by Colony PCR and Restriction mapping
13. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in E.coli, SDS-PAGE analysis
14. Purification of His-Tagged protein on Ni-NTA columns

a) Random Primer labeling

b) Southern hybridization.

Course code	**MSMB-252**			
Category	**Applied Sciences**			
Course title	**Immunotechnology Lab.**			
Scheme and Credits	**CR**	**L**	**T**	**P**
	2	0	0	4
Pre-requisites (if any)	Nil			
Objectives	The objectives of this laboratory course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen andantibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.			
Outcomes	On completion of this course, students should be able to: 1.Evaluate usefulness of immunology in different pharmaceutical companies 2.Identify proper research lab working in area of their owninterests; 3.Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection (viral or bacterial) by looking at cytokine profile.			

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	2	1	3	2	2	1	2	1	2	3	1	2	1

CO 2	2	1	1	3	3	1	2	1	-	1	1	1	2	1	2
CO 3	2	1	2	1	-	2	-	3	1	2	2	2	2	2	1
Average	**2.0**	**1.3**	**1.7**	**1.7**	**2.0**	**1.7**	**1.3**	**1.7**	**1.0**	**1.3**	**1.7**	**2.0**	**1.7**	**1.7**	**1.3**

Experiment details

1. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from serum or IgY from chicken egg.
6. SDS-PAGE, Immunoblotting, Dot blot assays.
7. Blood smear identification of leucocytes by Giemsa stain.
8. Separation of leucocytes by dextran method.
9. Demonstration of Phagocytosis of latex beads and their cryopreservation.
10. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.
11. Demonstration of ELISPOT.
12. Demonstration of FACS.

Course code	**MSMB-253**				
Category	**Applied Sciences**				
Course title	**Bioinformatics Lab.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	
Pre-requisites (if any)	Nil				
Objectives	The aim of this course is to provide practical training in bioinformatics methods including accessing major public sequence databases, use of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.				
Outcomes	On completion of this course, studentsshouldbeableto: 1. Describe contents and properties of most important bioinformatics databases; 2. Perform text- and sequence-based searches and analyze and discuss results in light of molecular biological knowledge;				

	3. Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming; 4. Predict secondary and tertiary structures of protein sequences.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	3	2	2	1	2	1	2	3	1	2	1
CO 2	2	1	1	3	3	1	2	1	-	1	1	1	2	1	2
CO 3	2	1	2	1	-	2	-	3	1	2	2	2	2	2	1
CO 4	2	1	2	1	-	2	-	3	1	2	2	2	2	2	1
Average	**2.0**	**1.3**	**1.8**	**1.5**	**1.5**	**1.8**	**1.0**	**2.0**	**1.0**	**1.5**	**1.8**	**2.0**	**1.8**	**1.8**	**1.3**

Experiment details

1. Using NCBI and Uniprot web resources
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.
4. Similarity searches using tools like BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Phylogenetic analysis of protein and nucleotide sequences.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Using RNA structure prediction tools.
9. Use of various primer designing and restriction site prediction tools.
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).
11. Construction and study of protein structures using Deepview/PyMol.
12. Homology modelling of proteins.
13. Use of tools for mutation and analysis of the energy minimization of protein structures.
14. Use of miRNA prediction, designing and target prediction tools.

SEMESTER-III

Course code	**MSMB -301**				
Category	**Applied Sciences**				
Course title	**Industrial and Food Microbiology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of the course is to understandthe basics of industrial and food microbiology processes.				
Outcomes	On completion of this course,studentsshouldbeableto: 1.Learn about the different types of fermentation processes, equipments used and microbiological processes involved. 2. Gain knowledge of significance and activities of microorganisms in food. 3.Gain knowledge about microbiology of milk and fermented products. 4. Know the microbial quality control and quality schemes used in food industries.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction to industrial microbiology:**Sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and recent developments in fermentation technology.				**6Hrs**
Unit-2	**Downstream processing of microbial products:** Filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying (lyophilization and spray drying), and crystallization **Fermentation economics:**Basic objective for successful economically viable fermentation process, cost break down for well-established fermentation processes, market potential of the products, cost aspects of various stages in the processes development including effluent				**8Hrs**

	treatment	
Unit-3	**Production aspects:** Microbial strains, substrates, strain improvement, flow diagrams, product optimization, and applications of industrial alcohol (ethanol and butanol), amino acids (lysine, phenylalanine, tryptophan), antibiotics (cephalosporins, tetracyclines, polyenes), enzymes and immobilized enzymes, SCP, microbial polyesters, biosurfactants, and recombinant products (insulin, somatostatin, thaumatin).	**8Hrs**
Unit-4	**Microbiology of foods:** Vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.	**6Hrs**
Unit-5	**Microbial spoilage of foods** **Food preservation:** Chemical, physical and biological methods. **Fermentation processes:** Production of milk and milk products, plant based products, fish products, meat products and food beverages. **Food-borne diseases**	**8 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	2	1	3	2	2	1	2	1	2	3	1	2	1
CO 2	2	1	1	3	3	1	2	2	1	1	1	1	2	1	2
CO 3	1	2	2	1	1	2	1	2	1	2	2	2	2	2	2
CO 4	2	1	2	1	1	2	1	3	1	2	2	2	2	2	1
Average	**1.8**	**1.5**	**1.8**	**1.5**	**2.0**	**1.8**	**1.5**	**2.0**	**1.3**	**1.5**	**1.8**	**2.0**	**1.8**	**1.8**	**1.5**

References

1. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger& A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.
2. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker &S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.
3. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA., 2007.
4. Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
5. Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989
6. Industrial Microbiology: An Introduction by Waites,

	Morgan, Rockey&Highton, Blackwell Science, 2001.

Course code	**MSMB -302**				
Category	**Applied Sciences**				
Course title	**Biostatistics**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objective of this course is to give conceptual exposure of essential contents of statistics to students.				
Outcomes	On completion of this course,studentsshouldbeableto: 1.Learn data collection, organization, summarization and analysis. 2.Demonstrate skills in drawing inferences about a body of data when only a part of the data is observed. 3. Demonstrate skills in interpreting and communicating the results of statistical analysis, orally and in writing. 4. Apply basic statistical concepts commonly used in Health and Medical Sciences.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Measures of central tendency and dispersion:**Basic terms, measures of central tendency and dispersion: Population, sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation.				**7 Hrs**
Unit-2	**Probability and distributions:** Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples bernoulli, binomial, poisson and normal distributions.				**5 Hrs**

Unit-3	**Methods of sampling:** Methods of sampling: Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.	**4 Hrs**
Unit-4	**Hypothesis testing:** Hypothesis testing: Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Introduction to analysis of variance.	**8 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	2	1	3	2	2	1	2	1	2	-	1	2	1
CO 2	3	1	1	2	3	1	2	2	1	1	1	1	2	-	2
CO 3	1	3	2	1	-	2	1	2	-	2	2	2	1	2	2
CO 4	2	1	2	1	1	2	1	2	1	2	2	2	2	2	1
Average	**2.0**	**1.8**	**1.8**	**1.3**	**1.8**	**1.8**	**1.5**	**1.8**	**1.0**	**1.5**	**1.8**	**1.3**	**1.5**	**1.5**	**1.5**

References	1. Methods in Biostatistics: For Medical Students and Research Workers, 7th Edition, Mahajan BK. 2. Understanding Biostatistics, Kallen A, 2011. 3. Fundamentals of Biostatistics 7th Edition, Rosner B, 2010.

Course code	**MSMB -303**				
Category	**Applied Sciences**				
Course title	**Medical Microbiology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	To introduce basic principles and application relevance of clinical disease. It covers all biology of bacteria, viruses and other pathogens related with infectious diseases in humans.				
Outcomes	On completion of this course,studentsshouldbeableto:				

	1. Gain information about the concepts of medical microbiology and gain knowledge on medically important micro-organisms. 2. Gain knowledge of morphology, cultural characteristics, biochemical tests, epidemiology, laboratory diagnosis etc of bacterial pathogens. 3. Gain knowledge on Water borne infections caused by bacteria, Nosocomial infections. 4. Gain knowledge on various chemotherapeutic agents and their mode of action including alternatives of antibiotics and Alternative and Complimentary medicine.

S. No.	Unit details	Time Allotted
Unit-1	**Human pathogens, Infection and Transmission:** Human pathogens: Normal microbial flora of human body and its significance, tissue tropism. Emerging andreemerging pathogens: Viral, bacterial, protozoan and fungal pathogens. Infection and transmission: Entry of pathogen into human host – portals of entry. Virulence factors and their role in breaching host defense, mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts. G protein signaling-Establishment, spreading, tissue damage and anti-phagocytic factors; Evasion of host defense, non-specific host defense, toxigenesisbacterial toxins and its types, Quorum sensing in Staphylococcus pyogenes. Modes of transmission and factors influencing. Communicable diseases; Nosocomial and community infections and their control.	**6 Hrs**
Unit-2	**Bacterial and Protozoan diseases:** Study of diseases caused by pathogenic bacteria: pathogenicity, laboratory diagnosis, epidemiology and control	**10 Hrs**

	measures– *Streptococcus Staphylococcus, Shigellla, Salmonella, Neisseria, Corynebacterium, Vibrio, Yersinia, Haemophilus, Mycobacterium. Spirochetes-Trepornema ,Chlamydiae, Mycoplasma*. Protozoan diseases-malaria, leishmaiasis and filariasis.	
Unit-3	**Fungal diseases:**Aetiology, clinical symptoms, laboratory diagnosis and treatment of superficial infections (dermatomycoses): Epidermophyton, Microsporum and Trichophyton; Madura foot; Subcutaneous mycoses: Sporotrichosis and Systemicmycosis: Blastomycosis, Coccodiodomysis, Candidiasis, Opportunistic mycoses: Aspergillosis.	**10 Hrs**
Unit-4	**Viral diseases:**Etiology, clinical symptoms, laboratory diagnosis and treatment: Pox virus, Herpes virus (HSV I & II) Varicella-zoster, Adenovirus, Picorna virus, Orthomyxoviruses (influenza), Paramyxoviruses (Mumps and Measles), Rhabdoviruses, Hepatitis viruses (HAV, HBV HCV, HDV), H1N1, Oncogenic viruses (HPV, epstein-barr virus, CMV), HIV, Arboviruses (Dengue, Encephalitis, chikungunya, rubella). Prion infection- Mad Cow, CJD, Kuru.	**8 Hrs**
Unit-5	**Antimicrobial agents:**Classification of antimicrobial agents, Mechanism of drug action – antibacterial (Bacteriostatic and bactericidal) antifungal and antiprotozoans. Methods of testing drug sensitivity (in vitro and in vivo), antibiotic assay in body fluids. Mechanism of drug resistance and dissemination of multi drug resistance. Probiotics as therapeutic agents. Brief account of vaccines (conventional and recombinant) and immunization schedules; Passive prophylactic measures; Interferons. **Diagnostic Microbiology:**Principles and applications of immuno and molecular diagnostic methods: RID, RIE, Agglutination test; CFT, RIA, ELISA, PCR, DNA finger printing.	**8 Hrs**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	3	1	3	2	1	1	2	1	2	2	1	2	1
CO 2	-	1	1	2	3	1	2	-	1	1	1	1	2	2	2
CO 3	1	1	2	1	2	2	1	2	1	2	2	-	1	2	1
CO 4	2	1	-	1	1	2	1	2	1	-	2	2	2	2	1
Average	**1.3**	**1.3**	**1.5**	**1.3**	**2.3**	**1.8**	**1.3**	**1.3**	**1.3**	**1.0**	**1.8**	**1.3**	**1.5**	**2.0**	**1.3**

References	1. Microbiology by Lansing M. Prescott and John P. Harley and Donald Klein; Ed. 6th; McGraw-Hill Science, 2004. 2. Allen and William M Janda and Paul C Schreckenberger and Washington C Winn; Ed. 6th; Lippincott Williams & Wilkins, 2005. 3. Essentials of diagnostic microbiology by Lisa Anne Shimeld and Anne T. Rodgers; Delmar Publishers, 1999. 4. Medical Microbiology by Geo. Brooks and Karen C. Carroll and Janet Butel and Stephen Morse; Ed. 24th; McGraw-Hill Medical, 2007.

Course code	**MSMB -304**				
Category	**Applied Sciences**				
Course title	**Intellectual Property Rights, Biosafety and Bioethics**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are: • To provide basic knowledge on intellectual property rights and their implications in biological research and product development; • To become familiar with India's IPR Policy; • To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products; • To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.				

Outcomes	On completion of this course,studentsshouldbeableto: • Understand the rationale for and against IPR and especially patents; • Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations; • Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents; • Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, • national and international regulations; • Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction to IPR:** Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.	**5 Hrs**
Unit-2	**Agreements and Treaties:** History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments	**8 Hrs**
Unit-3	**Concept of biosafety:**Biorisk, Hazardous characteristics of the agent, Laboratory procedures, Good lab practices, Principles of biosafety, Biosafety levels to personnel, environment and	**8 Hrs**

	community	
Unit-4	**Biosafety guidelines:** Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Cartagena Protocol.	**6 Hrs**
Unit-5	**Perceptions of ethical biotechnology:** Morality, Legality and ethics, Principles of bioethics, Ethical conflicts in biotechnology, , Social and ethical implications of biological weapons, Ethical limits of biotechnology	**6 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	3	1	3	2	1	1	2	1	2	2	1	2	1
CO 2	-	1	1	2	3	1	2	-	1	1	1	1	2	2	2
CO 3	1	1	2	1	2	2	1	2	1	2	2	-	1	2	1
CO 4	2	1	-	1	1	2	1	2	1	-	2	2	2	2	1
CO 5	-	1	1	2	3	1	2	-	1	1	1	1	2	2	2
CO 6	1	1	2	1	2	2	1	2	1	2	2	-	1	2	1
Average	**1.0**	**1.2**	**1.5**	**1.3**	**2.3**	**1.7**	**1.3**	**1.2**	**1.2**	**1.2**	**1.7**	**1.0**	**1.5**	**2.0**	**1.3**

References

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy.New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoIComplete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
3. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
4. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences-Case Studies of Policy Challenges from New Technologies, MIT Press

Course code	**MSMB -305**				
Category	**Applied Sciences**				
Course title	**Nanobiotechnology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	

Pre-requisites (if any)	Nil	
Objectives	The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination of thetop-down approach of microelectronics and micromechanics with the bottom- up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fieldsand technologies. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.	
Outcomes	On completion of this course,studentsshouldbeableto: • describe basic science behind the properties of materials at nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.	
S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction to nanobiotechnology:**Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.	**5 Hrs**
Unit-2	**Nano – films:**Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.	**5 Hrs**
Unit-3	**Nano – particles:**Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.	**5 Hrs**
Unit-4	**Applicationsof nano – particles:** Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in	**5 Hrs**

	cancer therapy, nanodevices for biosensor development.	
Unit-5	**Nano – materials:** Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates. **Nano – toxicity:** Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.	**10 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	1	2	1	1	2	1	2	1	3	2	2	2	2	1
Average	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**2**	**2**	**1**

References	1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA 2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss 3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press 4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); ElsevierRecent review papers in the area of Nanomedicine.

Course code	**MSMB -306**				
Category	**Applied Sciences**				
Course title	**Environmental Microbiology**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	To know and understand the role of microbes in biogeochemical processes different ecosystems. The students will the basic microbiological principles, the methods in microbial ecology and their theoretical and practical use.				
Outcomes	On completion of this course,studentsshouldbeableto: 1. Understand the concepts related to aquatic microbiology. 2. Gain knowledge on environmental pollution,				

	bioremediation and role ofmicrobes 3. Understand the basics of soil microbiology and xenobiotics. 4. Gain knowledge on biodeterioration and microbial waste treatment methods.	
S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction to Microbial Ecology:** Evolution of Life on Earth; History and scope of ecology, Concept of autecology, synecology, population, community, biome. Ecological succession. Microorganism in aquatic Environment: major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes. Biofilms, Production in lakes, rivers, estuaries and wetlands. Nutrient dynamics in lakes, rivers, estuaries and wetlands.	**8Hrs**
Unit-2	**Aquatic Microbiology:** Fresh and marine ecosystem (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystem; upwelling, eutrophication; food chain in aquatic ecosystems. Role of methanotrophs in ecosystem. Potability of water, microbial assessment of water, water purification. Ground water types and their contamination. Biofilm. Waste treatment: Sewage and effluent treatment; Primary, secondary and tertiary treatment, Solid waste treatment. Solid wastes as sources of energy and food.	**7Hrs**
Unit-3	**Aerobiology:** Airspora in different layers of the atmosphere, bioaerosol, assessment of air quality using air sampler based principles of sedimentation, impaction, impingement, suction and filtration. Brief account of transmission of airborne microbes, indoor and outdoor microbial quality. Allergy: Causes and tests for detection of allergy. Endotoxin in air and its hazards. Molecular methods for air quality assessment. Historical development of space microbiology, Life detection	**8 Hrs**

	methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic and heterotrophic)	
Unit-4	**Role of microbes in degradation:** Biodegradation of xenobiotic – hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Biosorption/ bioaccumulation of heavy metal. Bioremediation of soil, air and water: various methods, advantages and disadvantages. Bioleaching of iron, copper, gold and uranium.	**8 Hrs**
Unit-5	**Global environmental problems:** Ozone depletion, UV-B, greenhouse effect and acid rain, their impact and biotechnological approaches for management. . Containment of acid mine drainage applying biomining [with reference to copper extraction from low grade ores].	**6Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	3	1	3	2	1	1	2	1	2	2	1	2	1
CO 2	2	1	-	1	1	2	1	2	1	-	2	2	2	2	1
CO 3	-	1	1	2	3	1	2	-	1	1	1	1	2	2	2
CO 4	1	1	2	1	2	2	1	2	1	2	2	-	1	2	1
Average	**1.3**	**1.3**	**1.5**	**1.3**	**2.0**	**1.8**	**1.3**	**1.3**	**1.3**	**1.0**	**1.8**	**1.3**	**1.5**	**2.0**	**1.3**

References	1. Alan Scragg (2005), Environmental Biotechnology, Second Edition, Oxford University Press. 2. J., Pichtel (2005), Waste Management Practices: Municipal, Hazardous and Industrial, Taylor and Francis. 3. B.C. Bhattacharya & Ritu Banerjee (2007) EnvironmentalBiotechnology, Oxford Press. 4. Shree Nath Singh (2011), Microbial Degradation of Xenobiotics,Springer Science & Business Media.

Course code	**MSMB -307**				
Category	**Applied Sciences**				
Course title	**Vaccines**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Nil				
Objectives	This course will provide students with an overview of current developments in different areas of vaccines.				
Outcomes	On completion of this course, students should be able to:				

	• Understand fundamental concepts of human immune system and basic immunology; • Differentiate and understand immune responses in relation to infection and vaccination; • Understand requirement and designing of different types of vaccines; • Understand importance of conventional and new emerging vaccine technologies.	
S. No.	**Unit details**	**Time Allotted**
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.	**6 Hrs**
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 of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells.	**9 Hrs**
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 in vaccination; Oral immunization and Mucosal Immunity.	**8 Hrs**
Unit-4	**Vaccine types & design:** History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration:	**3 Hrs**

	parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine.	
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).	**4 Hrs**

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	3	1	3	2	1	1	2	1	2	2	1	2	1
CO 2	2	1	1	1	1	-	1	2	1	1	2	2	2	2	1
CO 3	1	1	1	2	3	1	2	-	1	1	1	1	2	-	2
CO 4	1	1	2	1	2	2	1	2	1	2	2	2	1	2	1
Average	**1.5**	**1.3**	**1.8**	**1.3**	**2.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.8**	**1.8**	**1.5**	**1.5**	**1.3**

References	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 Vaccination Strategies. Weinheim: Wiley-VCH. 4. Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.Nature; Wiley-Liss

Course code	**MSMB-351**				
Category	**Applied Sciences**				
Course title	**Industrial and Food Microbiology Lab.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to provide hands-on training in basics of industrial and food microbiology processes.				
Outcomes	On completion of this course, studentsshouldbeableto: 1. Acquaints with various industrial and food				

	products, their production techniques and prevention of spoilage. This course is supplemented by fermentation knowledge from another paper in the same semester. Student get trained to undertake a job in food and industries dealing with fermentation. Besides this, this course is coupled to an industrial visit also.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	3	1	3	2	1	1	2	1	2	2	1	2	1
Average	**2**	**2**	**3**	**1**	**3**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**1**

Experiment details

1. To determine the specific growth rate and generation time of a bacterium during submerged fermentations.
2. To compare glucoamy;ase production by parent and mutant of thermphilic fungus Thermomucorindicae under submerged and SSF conditions.
3. To grow yeast (S. cerevisiae) and fungus (Rhizopus sp.) in artificial medium and to calculate the yield and productivity of the biomass produced.
4. To make wine from different juices by fermentation.
5. To compare glucoamylase production of free and immobilized sporangiospores of Thermomucorindicae.
6. To study microbiology of vegetables, fruits, milk and milk products.
7. To test the quality of milk.
8. To demonstrate production of curd and cheese.
9. To study production of wine from grape juice.
10. Restriction digestion analysis by agarose gel electrophoresis.
11. Restriction digestion analysis by polyacrylamide gel electrophoresis.
12. Isolation of plasmid DNA from minicultures.

Course code	**MSMB-353**
Category	**Applied Sciences**
Course title	**Medical Microbiology Lab.**
Scheme and Credits	**C** / **P**: 2 / **L**: 0 / **T**: 0 / **P**: 4
Pre-requisites (if any)	Nil
Objectives	The objectives of this course are to provide hands-on training in basic experiments of Medical Microbiology.
Outcomes	On completion of this course, students

	should be able to: 1. Learn opportunities in the basic principles of medical microbiology and infectious disease. 2. Understand pathogenic microorganisms and the mechanisms by which they cause disease in the human body. 3. Develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases. 4. Understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	3	1	3	2	1	1	2	1	2	2	1	2	2
CO 2	2	3	1	1	1	2	1	2	1	2	-	2	1	2	1
CO 3	2	1	1	2	3	1	-	2	1	1	1	2	2	1	2
CO 4	1	1	2	1	2	2	1	2	1	2	2	2	1	2	1
Average	**1.8**	**1.8**	**1.8**	**1.3**	**2.3**	**1.8**	**0.8**	**1.8**	**1.3**	**1.5**	**1.3**	**2.0**	**1.3**	**1.8**	**1.5**

Experiment details

1. Slide Agglutination Test: RID
2. Tube AgglutinationTest: (WIDAL Test)
3. VDRL Test for syphilis
4. Study of Malaria Life Cycle and malarial testing
5. Blood Agar Preparation and detection of Blood Microorganisms.
6. Study of normal microflora of skin
7. Testing of antimicrobial activity of the skin on bacteria.
8. Study of microbial flora of the infected wounds
9. Primary screening of enteric pathogen from gastro intestinal tract.
10. Primary screening of pathogen from urinary tract.

Course code	**MSMB-381**				
Category	**Applied Sciences**				
Course title	**Seminar**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	2	0	0	4	

SEMESTER-IV

Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
MSMB-481	Seminar	0	0	04	2
MSMB-491	Dissertation	0	0	24	12
	Total	**0**	**0**	**28**	**14**