

Academic Council Meeting No. and Date : 4 / June 14, 2022

Agenda Number : 2

Resolution Number : 4.6 & 4.14



**Vidya Prasarak Mandal's
B. N. Bandodkar College of
Science (Autonomous), Thane**



**Syllabus for
Programme : Bachelor of Science
Specific Programme : Microbiology**

[S.Y.B.Sc. Microbiology]

**Revised under Autonomy
From academic year 2022 - 2023**

This page is intentionally left blank

PREAMBLE

Microbiology is one of the most promising branches of modern biology. It is developing with fast pace and generating interest in many young scientists engaged in interdisciplinary research.

With the objective of exposing preliminary learners to many related field and applications of basic microbiology concepts the attempt has been made to build the syllabus of S.Y. B.Sc. Microbiology. In addition to imparting knowledge of basic skill set, deliberate efforts are being made to help learners apply the scientific knowledge in his/her day-to-day life, by engaging the learners in interesting laboratory experimentation with real-time experience.

Continuing the Choice Based Credit System (CBCS) implemented by the esteemed University from the academic year 2017-2018, the existing syllabus of S.Y. B.Sc. Microbiology is restructured according to the CBCS pattern for its implementation from 2022-23 under the autonomous status of VPM's B. N. Bandodkar College of Science. While earlier revision of the syllabus took care of balancing both the basic techniques and some of the advance techniques in Microbiology, the present revision is related to restructuring of syllabus under autonomy updating it with a few more changes.

With the basic knowledge of microbiology concepts and techniques learnt in FYBSC, for upskilling students they are exposed to different biomolecules like proteins, enzymes and DNA. The advance analytical techniques used for detailed understanding of individual biomolecules have been incorporated in the same units for better correlation of technical understanding. Various applied fields like Food microbiology, Dairy microbiology have also been included. An attempt has been made to introduce students to immunology, diagnostics and biostatistics as well.

Learning fundamental processes of genetics, progressively students are also getting exposed to basic techniques of recombinant DNA technology. Interesting practicals related to these topics would add up to the learner's knowledge through experiential learning.

Eligibility:ClearedF.Y.B.Sc.withMicrobiology asoneofthesubjects

Duration:3years

ModeofConduct:LaboratoryPracticals/Offlinelectures/Onlinelectures

ProgramSpecific Outcome:

At the end of the program Students would be able to:

- Study and identify various microbial cultures
- Analyse the role in their natural niche.
- Apply knowledge to make positive use of microbial systems for betterment of community and for sustainable development.

VPM's B.N. Bandodkar College of Science (Autonomous), Thane
S.Y.B.Sc.
(Microbiology) Structure of
Programme

CourseCode	CourseTitle	No. of lectures	Credits
BNBUSMB3T1	Biomolecules, Bio-analytics and Microbial taxonomy	45	2
BNBUSMB3T2	Applied Environmental Microbiology	45	2
BNBUSMB3T3	Microbial Genetics	45	2
BNBUSMB3P3	Section I (Practicals Based on Units I, II and III of BNBUSMB3T1)	45	1
	Section II (Practicals Based on Units I, II and III of BNBUSMB3T2)	45	1
	Section III (Practicals Based on Units I, II and III of BNBUSMB3T3)	45	1
Total		270	9

CourseCode	CourseTitle	No. of lectures	Credits
BNBUSMB4T1	Bioenergetics, Enzymology and Protein Analysis	45	2
BNBUSMB4T2	Industrial Technology, Food and Dairy Microbiology	45	2
BNBUSMB4T3	Immunology, clinical microbiology and basic biostatistics	45	2
BNBUSMB4P4	Section I (Practicals Based on Units I, II and III of BNBUSMB4T1)	45	1
	Section II (Practicals Based on Units I, II and III of BNBUSMB4T2)	45	1
	Section III (Practicals Based on Units I, II and III of BNBUSMB4T3)	45	1
Total		270	9

SemesterIII

Course CodeBNBUSM B3T1	CourseTitle Biomolecules,Bio-analyticsandMicrobialtaxonomy	Credits 2	No. oflectur es 45
LearningOutcomes: Learnerwillbeableto • Understandstructureandchemistryofnucleic acid • Carryoutestimationofbiomolecules • Performagarosegelelectrophoresisandbasicchromatography • Knowthesignificanceofmodern toolsof microbialtaxonomy			
Unit I:Nucleic acidstructure andchemistry	1.1 NucleicAcidStructure a. Properties of DNA b. Structural features of DNA c. Properties of RNA d. Structural features of RNA 1.2 Nucleicacidchemistry a. Denaturationofdouble helicalDNA andRNA b. Nucleicacidfromdifferentsspeciescanformhybrids c. Nucleotidesandnucleicacidsundergononenzymatictransformations d. DNAmethylation 1.3 OtherFunctionsofnucleotides 1.4 DNAsupercoilingand linkingnumber 1.5 Structuresofchromosomesofeukaryoticcell	15	

Unit II Bio-analytics	Estimation of Biomolecules: 2.1 Macromolecular composition of a microbial cell 2.2 Methods of elemental analysis: Carbon, Nitrogen and Phosphorus 2.3 Quantitative Estimation of Biomolecules Proteins: Biuret, Lowry & Bradford methods (Comparative analysis) Carbohydrates: DNSA method Lipids: Soxhlet method DNA: DPA method RNA: by Orcinol method Basic separation methods: 2.4 Chromatography: Principles of Chromatography A. Planar Chromatography: Paper Chromatography & Thin-Layer Chromatography B. Column Chromatography Types of Chromatography: (principle & working) 1. Adsorption Chromatography 2. Gas-Liquid Chromatography (GLC) 3. Gel Permeation Chromatography 4. Ion Exchange Chromatography 5. Affinity Chromatography 6. High Performance Liquid Chromatography 2.5 Agarose Gel Electrophoresis Ninhydrin, Anthrone	15
--	---	---------------------------------------

Unit III Microbial taxonomy	3.1 Introduction to Microbial Classification and Taxonomy: Systems of Classification: Phenetic, Phylogenetic, Genotypic, Numerical Taxonomy; 3.2 Taxonomic Ranks: Species, Genus, Family, Order, Class, Phylum, Domain 3.3 Techniques for determining Microbial taxonomy and Phylogeny: Morphological, physiological, metabolic and ecological characteristics Genetic Analysis, Molecular characteristics: Nucleic acid base composition, Nucleic acid Hybridization, nucleic acid and amino acid sequencing, Fingerprinting 3.4 Concept of 'uncultured bacterial diversity; attempt to culture the 'yet uncultured bacteria'; Multilocus sequence analysis, Fatty acid analysis	15
---	--	------------------

CourseCode BNBUSMB3T2	CourseTitle AppliedEnvironmentalMicrobiology	Credits 2	No. oflectur es 45
LearningOutcomes: Learner willbeableto • Demonstratethepresenceofair microflora andrelateitto airquality • Illustratevariousbiogeochemicalcycles • Performwateranalysis • Justifytheuseofmicrobes asbiofertilizers andbiopesticides			
Unit I:Air&Soi l Microbiology Air Microbiology	1.1Airmicrobiology - ImportantAirbornePathogensandImportantToxinsrel easedby Airbornebacteria - Aerosols,NatureofBioaerosols,Aeromicrobiologicalpa thway - Microbial survivalin the air - Extramuraland Intramuralaeromicrobiology(Overview) - BioaerosolControl - Airsamplingmethodsanddevices 1.2SoilMicrobiology - Compositionandtypesofsoil,texturaltriangle - Typesofsoilmicroorganismsandtheiractivities - Methodsofstudyingsoilmicroorganisms:Sampling,C ulturalmethods,Physiologicalmethods, Immunologicalmethods,Nucleicacidbasedmethods, Radioisotopetechniques - Biogeochemicalcycles: Carbon,Nitrogen,Phosphorus,Sulfur - Soil Microbiome(Introduction) Iron cycle,	15	

Unit II: Fresh Water & Sewage Microbiology	2.1 Fresh Water Microbiology a. Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes, marshes and bogs and marine environment b. Potable water definition, Purification of raw water c. Bacteriological standards of potable water Maharashtra pollution control board (MPCB), Central pollution control board (CPCB), Bureau of Indian standards (BIS) World health Organization (WHO) d. Waterborne Infections e. Indicator organisms: Indicators of faecal pollution f. Bacteriological analysis of water for potability: Presumptive (Multiple tube fermentation -MPN), Confirmed, Completed)	15
	2.2 Sewage and Waste Water Microbiology a. Wastewater analysis: Physico-chemical parameters: pH, temperature, TS, COD, BOD, Toxicity b. Industrial water pollutants c. Ecological effects (Biomagnification and Eutrophication) and health hazards d. Removal of Pathogens by Sewage treatment Processes, Oxidation Ponds and Septic tanks, Sludge Processing, Disposal of treated wastewater and biosolids Waste water treatment, Nature of waste water	

Unit III Biofertiliser, Biopesticide, Bio remediation Soil and Geo Microbiology	3.1 Biofertilizers: Soil & Plant Microbial communities 3.2 Microbes as Sustainable Biofertilizers: Need & Advantages of Biofertilizer Over Chemical 3.3 Introduction to types of Biofertilizers: Non-symbiotic & Symbiotic Nitrogen fixation, Phosphate Solubilizing Microorganisms, potassium mobilization, Green Manuring, Cyanobacterial inoculants, Azolla, Frankia induced nodulation, Mycorrhizal Fungi 3.4 Methods of application of Biofertilizers 3.5 Biopesticides: Introduction; Types of Biological Control (Classical, inoculation, Inundation), Examples each of Bacterial, Viral, Fungal and Protozoal biopesticide, Concept of Biofungicide and Bioherbicide 3.6 Bioremediation, Bioaugmentation, Biotransformation, Xenobiotics, Recalcitrant xenobiotics, Biomagnification 3.7 Factors affecting bioremediation & Types of Bioremediation (<i>in-situ</i>, <i>ex-situ</i>) 3.8 Applications of Bioremediation - hydrocarbons, (Oil spills) Pesticides and herbicides, Heavy metals (Uranium) contaminated soil and wasteland, Ground Water; Genetically modified microbes in bioremediation 3.9 Advantages and limitations Mass production, constraints in biofertilizer technology and biofertilizer strains develop Basic requirement for establishment of biopesticide, technical aspect, major biopesticides produced and used in India, Biopesticide formulations	15
---	--	----

Course Code BNBUSMB3T3	Course Title Basic genetics and Recombinant DNA technology	Credits 2	No. of lectures 45
Learning Outcomes: Learners will be able to: - Understand the molecular mechanisms of DNA replication - Differentiate between DNA replication in prokaryotes and eukaryotes - Explain basic terminologies related to microbial genetics. - Know the significance and components of basic PCR			

Unit I Reproduction Basics of Microbiology	1.1 Evolutionary importance of DNA as genetic material 1.2 DNA replication in prokaryotes and eukaryotes- 1.3 Semi-conservative DNA replication: the Meselson and Stahl Experiment, 1.4 Role of different proteins and enzymes in DNA replication: Initiator proteins, Helicases, Primase, SSBPs, DNA Gyrase, DNA Ligase 1.5 Semi-discontinuous Replication: The Okazaki experiment 1.6 Bidirectional Replication of circular DNA molecules, pulse chase experiment 1.7 Molecular model of DNA Replication in <i>E. coli</i>: Initiation, elongation and termination of replication 1.8 DNA polymerases and their role 1.9 Rolling circle replication 1.10 DNA replication in Eukaryotes: Replicons, Initiation of replication, replication enzymes, Replicating the ends of chromosomes, telomerase: action and significance	15
Unit II Transcription Physical and chemical agent for microbial control	2.1 Central Dogma: An Overview, Transcription process, Transcription in bacteria – • Initiation of transcription at promoters, • elongation of an RNA chain, • termination of an RNA chain 2.2 Transcription in Eukaryotes - Eukaryotic RNA polymerase, 2.3 Transcription of protein-coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self Splicing of Introns, RNA editing 2.4 Genetic code - Nature of genetic code and characteristics of genetic code. 2.5 classes of RNA and its significance	15
Unit III Basic Recombinant DNA Technology Basic rDNA technology	3.1 Introduction 3.2 Model organisms: prokaryotic, eukaryotic 3.3 Chemical Synthesis of DNA. 3.4 Restriction endonucleases, DNA Ligase 3.5 <i>E. coli</i>: preferred host for cloning 3.4 Vector: pBR322, design, advantages and drawbacks 3.5 Polymerase Chain Reaction: General Principle, 3.6 Components of a Typical PCR Reaction; Basic Experimental Design	15

and bioinformatics		
-----------------------	--	--

ourseCode BNBUSMB3P3	CourseTitle PracticalBasedonBNBUSMB3T1,B NBUSMB3T2&BNBUSMB3T3	Credits 3	No. oflectur es
	SectionI		
Practical1	PracticalsBasedonUnit IofBNBUSMB3T1		
a.	IsolationofgenomicDNA from <i>E.coli</i>		
Practical2	PracticalsBasedonUnit IIofBNBUSMB3T1		
a.	Estimationof Proteinby Biuretmetho		

b.	Estimation of sugars by DNSA method	
c.	Estimation of DNA by DPA method	
d.	Estimation of RNA by Orcinol method	
e.	Separation of Amino acids by Paper Chromatography	
f.	TLC of sugars	
g.	Demonstration of Size exclusion Chromatography	
h.	Demonstration of AGE	
Practical 3	Practicals Based on Unit III of BNBUSMB3T1	
a.	Isolation and identification of bacteria isolated from different ecosystems	
b.	Study of bacterial diversity using dilute cultivation media	
c.	Demonstration : Analysis of phylogenetic tree	
	Section II	
Practical 4	Practicals Based on Unit I of BNBUSMB3T1	
a.	Gravity sedimentation method for Air microflora analysis	
b.	Determination of Soil pH and Soil moisture content	
c.	Study of soil ecosystem by contact slide method	
d.	Enrichment and isolation of microorganisms from soil: a. Nitrifying bacteria (in liquid medium) qualitative detection; b. Ureolytic bacteria (Broth and Agar), c. Cellulolytic bacteria (liquid medium qualitative detection) and isolation	
e.	Isolation of Phosphate solubilizing bacteria	
Practical 5	Practicals Based on Unit II of BNBUSMB3T2	
a.	Winogradsky's column	
b.	Routine analysis of water: a. Standard Plate Count	
	b. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test c. Rapid Detection of <i>E. coli</i> by MUG Technique (Demonstration)	
c.	Wastewater analysis: a. Study of microbial flora in raw and treated sewage b. Determination of BOD and COD of wastewater	
Practical 6	Practicals Based on Unit III of BNBUSMB3T2	
a.	Isolation of Blue Green Algae from Water samples	

b.	Isolation of <i>Azospirillum</i>	
c.	Isolating Chromium tolerant organisms	
	Section III	
Practical 7	Practicals Based on Unit I and II of BNBUSMB3T3	
a.	Reagent preparation for molecular biology techniques	
Practical 8	Practicals Based on Unit III of BNBUSMB3T3	
a.	Restriction digestion of lambda phage/any plasmid DNA	
b.	Ligation reaction using <i>EcoRI</i> digested λ DNA fragment	
c.	Isolation and visualization of plasmid DNA	
	Estimation of total sugar by Anthrone method (Demo), Estimation of reducing method by Fehling's method, Extraction of lipid by Soxhlet method, Enumeration of microorganisms in air and study of its load after fumigation, Study of air microflora and determination of sedimentation rate, Determination of total solids in wastewater	

SemesterIV

CourseCode BNBUSMB4T1	CourseTitle Bioenergetics,EnzymologyandProteinAnalysis	Credits 2	No. oflectur es 45
LearningOutcomes: Learners willbeableto: - Understandbasicaspectsofbioenergeticsandmetabolism - Comprehendthebasicprinciplesofenzymology - Enlist the mechanisms underlying the enzymatic reactions and - Know differentmethods used for proteinpurificationand separation			
Unit I:Introduction toMetabolism &Bioenergetics	1.1 Introductiontometabolism,Metabolicpathway 1.2 Organicreactionmechanisms 1.3 Experimentalapproachesto studymetabolism 1.4 ThermodynamicsofPhosphatecompounds 1.5 Oxidation-reductionreactions 1.6 Thermodynamicsoflife	15	
Unit II:EnzymeKineti cs	2.1 History,Definition,ClassificationandNomenclatureofenzymes 2.2 ChemicalNature, PropertiesofEnzymes, 2.3 MechanismofEnzymeAction, 2.4 Michaelis-Mentenequationandit'sderivation;LineweaverBurkplot 2.5 OverviewofCoenzyme: a. Coenzymes:Differenttypesandreactionscatalyzedbycoenzymes (in tabularform) b. Nicotinicacid:structure,occurrence&biochemicalfunction 2.6 EnzymeKinetics: a. Saturationkinetics b. Effectoftemperature andpH c. EffectofInhibitors-Reversibleandirreversible,competitive,Non-competitive and uncompetitiveinhibitors 2.7 Multi-substratereactions-Ordered,Randomandpingpong reactions 2.8 Allostericeffectsinenzymecatalyzedreactions-Koshland-NemethyandFilmermodel&Monod,WymanandChangeux Model	15	

Unit III: Protein Analysis Analytical techniques	3.1 Purification of proteins: a. Recognizing the protein of interest b. Criteria for protein purification: Solubility, Size, Charge, and Binding Affinity 3.2 Electrophoresis of proteins: a. SDS-PAGE	15
---	--	------------------

	b. Native Gels, Gradient gels, Isoelectric focusing gels c. 2D PAGE d. Cellulose acetate electrophoresis e. Detection, estimation, recovery of proteins in gels 3.3 Basic principle of sedimentation: a. RCF and sedimentation concepts b. Sedimentation rate or velocity c. Sedimentation equilibrium d. Svedberg units 3.4 Construction, working of centrifuge types: a. Types of centrifuges b. Types of rotors c. Care and maintenance of centrifuges 3.5 Preparative centrifugation: a. Differential centrifugation, b. Density gradient centrifugation Applications of preparative centrifuge	
--	---	--

Course Code BNBUSM B4T2	Course Title Industrial Technology, Food and Dairy Microbiology	Credits 2	No. of lectures 45
Learning Outcomes: Learners will be able to: • Name different components of basic fermenter with their functional significance • Compare different methods of food preservation • Demonstrate the presence of different spoilage causing organisms • Explain various methods used in analysis of milk			
Unit I Industrial Technology Host defense and public health	1.1 An introduction to fermentation processes 1.2 The range of fermentation processes 1.3 The Component parts of a fermentation process 1.4 Screening methods: Primary and secondary screening High throughput screening methods 1.5 Strain improvement: selection of induced mutants synthesizing improved levels of primary metabolites; The isolation of induced mutants producing improved yields of secondary metabolites; The improvement of strains by modifying properties other than the yield of product 1.6 Preservation of cultures and Quality control of preserved stock 1.7 Types of fermentations: Surface and Submerged; Batch and Continuous, Aerobic and anaerobic	15	
Unit II Food Microbiology	2.1 Microbes as food, overview of fermented foods 2.2 Microbial growth and food spoilage 2.3 Controlling food spoilage: a. Homeostasis and hurdle technology b. Naturally occurring antimicrobials: lysozyme, lactoferrin and other Fe binding proteins, avidin, spices and essential oils, onions and garlic, isothiocyanates, phenolic compounds c. Antimicrobial chemicals: organic acids, nitrites, Para-benzoic acid, sodium chloride, phosphates, sulfites d. Biopreservation: controlled acidification, bacteriocins, probiotics, prebiotics and symbiotics 2.4 Physical methods of food preservation: drying, freeze-drying, cold storage, heat treatment: concept of TDP and TDT 2.5 Preservation by irradiation: UV and ionizing radiations	15	

	2.6 Food Control Enforcement & Control Agency: International agencies (FDA, USDA), FSSAI [website], Introduction to HACCP Important Microorganisms in Food Microbiology: Spoilage causing microorganisms, Food-borne illness associated Microorganisms	
Unit III Dairy Microbiology	3.1 Microbiology of raw milk, spoilage causing organisms, sources of contamination of milk, important pathogenic microbes 3.2 Microbial quality of raw milk 3.3 Milk analysis: Grading, platform tests, Dye reduction test, DMC, SPC, LPC, Coliform count, Thermophilic count, Psychrophilic count 3.4 Rapid detection of milk borne pathogens (Nucleic acid based assays, Immunological based assays, Biosensors) 3.5 Products: Cheese, Butter, Yoghurt (types, manufacturing process outline, Defects) 3.6 Microbiological Quality and Safety Aspects of Traditional Dairy Products	15

Course Code BNBUSMB4T3	Course Title Immunology, clinical microbiology and basic biostatistics	Credits 2	No. of lectures 45
Learning Outcomes: Learners will be able to: - Explain role of lymphoid cells, organs, immunoglobulin - Explain conventional, rapid and advance methods used in isolation and identification of bacteria from clinical sample - Represent data with statistical tools			
Unit I: Immunology Nanotechnology, Biofilms and biosensors with application	1.1 Classification of immune components of innate immunity & acquired immunity 1.2 Cells of immune system: Hematopoiesis, lymphocytes, monocytes & macrophages, granulocytes, mast cells, dendritic cells & NK cells 1.3 Lymphoid organs : primary and secondary 1.4 Concept of local immunity and herd immunity 1.5 Basic concept of antigen and epitope, types of antigen 1.6 Basic structure, classes and function of immunoglobulin		15

Unit II: Clinical Microbiology Scientific writing, research methodology and biostatistics	2.2 Phases of Diagnostic cycle 2.3 Clinical microbiology: Specimen Collection and handling 2.3 Approaches to Pathogen identification Conventional Approach 2.4 Rapid Techniques for pathogen identification 2.5 Other pathogens identified by conventional or rapid diagnostics 2.6 Point-of-care Rapid Diagnostics	15
Unit III: Basic biostatistics Biofertiliser, biopesticide, bioremediation	3.1 Introduction to biostatistics: a. Statistics, Biostatistics, Applications and uses of Biostatistics b. Data: Types of data (Qualitative/Quantitative, Primary/Secondary, Univariable/Bivariable/Multivariable. Raw data/Derived data) c. Population, Sampling, Sample, Random sample, Characteristic (Measurable/ Non-measurable) 3.2 Frequency distribution a. Types of frequency distribution (Simple/Grouped) b. Terms associated with grouped frequency distribution (Class interval, class limit, class boundaries, class mark, class width, class frequency, cumulative frequency) 3.3 Graphical representation of data: a. Graphical representation of ungrouped data: Line graph, Bar diagram (simple), pie chart b. Graphical representation of grouped data: histogram (equal class intervals), frequency polygon 3.4 Central tendency: a. Characteristics of central tendency b. Measures of central tendency: mean, median, mode (Ungrouped data, grouped data) 3.5 Measures of variation: Absolute and relative measure of dispersion For grouped and ungrouped data: Standard deviation 3.6 Significance of Statistics in Epidemiology 3.7 Epidemiological techniques and markers	15

CourseCode BNBUSMB4P4	CourseTitle Practicals Based on BNBUSMB4T1,BNBUSMB4T2& BNBUSMB4T3	Credits 3	No. oflectu res
	SectionI		
Practical1	PracticalsBasedonUnit IofBNBUSMB4T1		
a.	ProblemsbasedonbioenergeticstocalculateKeq,Gibbsenergy, Enthalpy		
b.	Radioisotopeshalf-lifecalculations		
Practical2	PracticalsBasedonUnit IIofBNBUSMB4T1		
a.	Effectoftemperature,pH,enzymeconcentration,substrate concentrationandinhibitors onInvertase activity		
Practical3	PracticalsBasedonUnit IIIofBNBUSMB4T1		
a.	Proteinprecipitationusingammoniumsulphate		
b.	Desaltingusingdialysismethod		
c.	DemonstrationofAffinitychromatography		
d.	DemonstrationofIonexchangechromatography		
e.	ElectrophoresisofproteinsbySDS-PAGE		
f.	Isolation of chloroplast using sucrose density gradient centrifugation		
	SectionII		
Practical4	PracticalsBasedonUnit IofBNBUSMB4T2		
a.	Productionofamylasebysolidstateandsubmerged fermentation		
Practical5	PracticalsBasedonUnit IIofBNBUSMB4T2		
a.	IsolationoforganismscausingFoodSpoilage		
b.	DeterminationofMICof salt/sugar		
c.	DeterminationofTDPandTDT		
Practical6	PracticalsBasedonUnit IIIofBNBUSMB4T2		
a.	Dyereductiontest: 1) MBRT 2) RRT		
b.	MicrobiologicalQualityAnalysisoflocaldairyproduct 1. Coliformcount 2. Thermophiliccount 3) Psychrophiliccount 4) Fecalstreptococcicount 5) Yeastandmoldcount		
	SectionIII		
Practical7	PracticalsBased onUnit IofBNBUSMB4T3		

a.	Separation of PBMNCs using Ficoll Hypaque	
b.	Field's staining of Blood film	
Practical8	PracticalsBasedonUnit IIofBNBUSMB4T3	
a.	IsolationoforganismsonXLD, CLEDandCetrimideagar	
b.	Biochemicaltest: a. Triplesugarironslant b. Catalase c. Oxidase d. Lysinedecarboxylase e. Oxidative-FermentativeTest	
c.	DemonstrationofPCR	
Practical9	PracticalsBasedonUnit IIIofBNBUSMB4T3	
a.	Representingdataobtainedfromaselfstudystatisticallyongraph paperandusingMS-Excel: Linegraph,Bar diagram,Piechart	
b.	Solvingproblemsbased onmeasures of central tendencyusing MS-Excel.	
c.	Solvingproblems basedon measuresof dispersionusing MS-Excel.	
	Isolation of amylase, protease, lipase producers, Extracellular production of invertase from yeast, Sizing Yeast cells, centrifuge machine	

References:SE MESTER-III

BNBUSMB3T1:Biomolecules,BioanalyticsandMicrobial taxonomy

BooksandReferences:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
1.	LehningerPrinciplesof Biochemistry	NelsonandCox	WHFreeman	4 th	2004
2.	Laboratory Manual inBiochemistry	J.Jayaraman	New AgeInternati onal Publishers		2003
3.	A handbook of OrganicAnalysis:qualitative and quantitative	HansThacherClarke	CBS publishers&dist ributors , NewDelhi	4 th	2007
4.	BiochemicalMethods	S. Sadashivam & A.Manickam	New AgeInternati onal Publishers	3 rd	2018
5.	BiochemistryLaboratory: ModernTheory& Techniques	RodneyBoyer	PearsonEd ucation,Inc	2 nd	2012
6.	MolecularCloning	Sambrook& Russel	Cold Springharbor laboratorypress	3 rd	2001
7.	Prescott,Harley&Klein's Microbiology	Willey,Sherwood &Woolverton	McGraw-Hill	7 th	2008
8.	Microbiology-Anevolving science	JoanL.Slonczewski andJohnW.Foster	W.WNorton Company,NY	4 th	2017

BNBUSMB3T2:AppliedEnvironmentalMicrobiology

BooksandReferences:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
1.	Environmental Microbiology	RainaM.Maier,IanL. Pepper & Charles P.Gerba	AcademicPress	2 nd	2010
2.	Introductionto Environmental Microbiology	Barbara Kolwzan,Waldemar Adamiak	OficinaWydawnicza PolitechnikiWroclawski ej,Wroclaw	-	-
3.	SoilMicrobiology	N.SSubbaRao	Oxfordand IBH PublishingCo.PvtLtd	4 th	2000

Books and References:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
4.	Microbiology- Anevolving science	Joan L. Slonczewski and John W. Foster	W. W. Norton Company, NY	4 th	
5.	Prescott, Harley & Klein's Microbiology	Willey, Sherwood & Woolverton	McGraw-Hill	7 th	2008
6.	Fundamentals of Microbiology	Frobisher, Hinsdill, Crabtree, Goodheart	Saunders College Publishing	9 th	1974
7.	Biotechnology	BD Singh	Kalyani Publishers	4 th	2010
8.	A text book of Biotechnology	RC Dubey	S. Chand	4 th	2006
9.	https://blog.bitsathy.ac.in/an-overview-of-biofertilizers-in-sustainable-agriculture/				
10.	https://www.researchgate.net/publication/335065992_Microbial_Biofertilizers_Types_and_Application				
11.	https://www.researchgate.net/publication/335065992_Microbial_Biofertilizers_Types_and_Application				

BNBUSMB3T3: Basic genetics and Recombinant DNA technology

Books and References:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
1.	Molecular biology	David Freifelder	Jones & Bartlett Publishers	2 nd	1987
2.	iGenetics: A Molecular Approach	Peter Russel	Benjamin Cummings	3 rd	2010
3.	Molecular Biology	Robert Weaver	McGraw Hill inter national edition.	3 rd	2005
4.	Molecular Cloning A laboratory manual (Volume 1)	Sambrook, Russell	CSHL press	3 rd	2001

SEMESTER-IV

BNBUSMB4T1: Bioenergetics, Enzymology and Protein Analysis

Books and References:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
1.	Fundamentals of Biochemistry	D.Voet and J. Voet	Publisher Wileyplus	5 th	2011
2.	Biochemistry	Satyanarayana and Chakrapani	Books and allied pvt ltd.	3 rd	2006
3.	Lehninger Principles of Biochemistry	Nelson and Cox	W.H. Freeman	4 th	2004
4.	Outlines of Biochemistry	E.E. Conn & P.K. Stumpf, G. Bruening, R.N. Doi.	John Wiley and sons	5 th	1999
5.	Biochemistry	Lubert Stryer	W.H. Freeman and Company	5 th	2002
6.	Principle and techniques of Biochemistry and Molecular Biology	Wilson and Walkar	Cambridge University Press	7 th	2010

BNBUSMB4T2: Industrial Technology, Food and Dairy Microbiology

Books and References:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
1.	Industrial Microbiology	Casida L.E.,	New Age International (P) Ltd, Publishers, New Delhi.	Reprint	2009
2.	Principles of Fermentation Technology	Stanbury P. F., Whitaker A. & Hall S.J.,	Aditya Books Pvt. Ltd, New Delhi	2 nd	1997
3.	Dairy microbiology	K.C. Mahanta.	Omson Publication	1 st	1984
4.	Food Microbiology	Adam and Moss	New Age International Ltd.	3 rd	2008
5.	Milk and milk products	Eckles	Tata McGraw Hill Publishing company Ltd.	4 th	1986
6.	Outlines of dairy technology	Sukumar De	Oxford University Press	13 th	1980

BNBUSMB4T3: Immunology, Clinical Microbiology and biostatistics

Books and References:					
Sr.No.	Title	Author/s	Publisher	Edition	Year
1.	Immunology essential and fundamental	S. Pathak, U Palan	Capital Publishing Company	2 nd	2005
2.	Immunology	Kindt, Goldsby, Osborne	W. H. Freeman and Co.	6th	2007
3.	Microbiology: An Evolving Science	Slonczewski and Foster	Norton & Company, Inc	4th	2016
4.	Koneman's color atlas and textbook of diagnostic microbiology	Elmer W. Koneman	Lippincott Williams & Wilkins	6th	2006
5.	Introduction to Biostatistics	Dr. Pranab Kumar Banerjee	S. Chand Publishing	Revised edition	2007
6.	Microbiology	Michael J. Pelczar, C.S. Chan, , Noel R. Krieg	TATA McGraw - Hill	5 th	1995

Evaluation Scheme

Internals:

Class test	Assignment/ Study tour with report/Journal Movie club presentation/Presentation of mini-research project work/volunteering for Department fest/poster making/exhibition/ Departmental contribution/ case study presentation/Review writing	Attendance, Active Participation and Leadership Qualities	Total
20M	10 M	10M	40M

Internal Examination: Based on Unit 1 /Unit 2/Unit 3

Duration: 40 mins

Total

Marks: 20

No. of Questions: 15

Q.1	Answer the following choosing the correct alternative.								10
	1	Based on Unit I/II/III							
	a		b		c		D		
	2	Based on Unit I/II/III							
	a		b		c		D		
	3	Based on Unit I/II/III							
	a		b		c		D		
	4	Based on Unit I/II/III							
	a		b		c		D		
	5	Based on Unit I/II/III							
	a		b		c		D		
	6	Based on Unit I/II/III							
	a		b		c		D		
	7	Based on Unit I/II/III							
	a		b		c		D		
	8	Based on Unit I/II/III							
	a		b		c		D		
	9	Based on Unit I/II/III							
	a		b		c		D		
	10	Based on Unit I/II/III							
	a		b		c		D		

Q.2	Answer the following choosing the correct alternative.	10
------------	---	-----------

	1	BasedonUnitI/II/III						
	a		b		c		D	
	2	Basedon UnitI/II/III						
	a		b		c		D	
	3	BasedonUnitI/II/III						
	a		b		c		D	
	4	BasedonUnitI/II/III						
	a		b		c		D	
	5	BasedonUnitI/II/III						
	a		b		c		D	

TheoryExamination: SuggestedFormatof Questionpaper

Duration: 2Hours

TotalMarks:60

- Allquestionsarecompulsory

Q.1	Answer anytwo ofthefollowing						16
	a	BasedonUnitI					
	b	BasedonUnitI					
	c	BasedonUnitI					
Q.2	Answer anytwo ofthe following						16
	a	BasedonUnitII					
	b	BasedonUnitII					
	c	BasedonUnitII					
Q.3	Answer anytwo ofthefollowing						16
	a	BasedonUnitIII					
	b	BasedonUnitIII					
	c	BasedonUnitIII					
Q.4	Answer anysix ofthefollowing						06
	a	Basedon UnitI/II/III					
	b	BasedonUnitI/II/III					

	c	BasedonUnitI/II/III	
	d	BasedonUnitI/II/III	
	e	BasedonUnitI/II/III	
	f	BasedonUnitI/II/III	
	g	BasedonUnitI/II/III	
	h	BasedonUnitI/II/III	
	i	Basedon UnitI/II/III	
	Answer <i>anytwo</i> ofthefollowing		06
	a	BasedonUnitI/II/III	
	b	BasedonUnitI/II/III	
	c	BasedonUnitI/II/III	

Marks Distribution and Passing Criterion for Each Semester

Theory					Practical		
CourseCode	Internal	Minmarksforpassing	TheoryExamination	Minmarksforpassing	CourseCode	PracticalExamination	Minmarksforpassing
BNBUSMB3T1	40	16	60	24	BNBUSMB3P3	150	60
BNBUSMB3T2	40	16	60	24			
BNBUSMB3T3	40	16	60	24			

Theory					Practical		
CourseCode	Internal	Minmarksforpassing	TheoryExamination	Minmarksforpassing	CourseCode	PracticalExamination	Minmarksforpassing
BNBUSMB4T1	40	16	60	24	BNBUSMB4P4	150	60
BNBUSMB4T2	40	16	60	24			
BNBUSMB4T3	40	16	60	24			

~ * ~ * ~ * ~ * ~ * ~