K. J. SOMAIYA COLLEGE OF SCIENCE AND COMMERCE, VIDYAVIHAR, MUMBAI- 400 077

AUTONOMOUS- AFFILIATED TO UNIVERSITY OF MUMBAI

Scheme of Course Structure (Faculty of Science) 2019-2020

Syllabus for S.Y.B.Sc.

Program: B.Sc.

Course: Microbiology

(Choice based Credit System with effect from

the academic year 2019–2020)

Preamble

To the common man, Microbiology means the study of invisible mini wonders that only cause disease. In reality, the vast majority of microorganisms co-exist alongside us without causing any harm. On the contrary, many of them are required for our survival. Microbiology is a study of this microscopic world. It is a research oriented subject and plays a pivotal role in our daily lives.

After introducing the basics of Microbiology in Semester I and Semester II, syllabus progresses to include the topics of Immunology, Genetics, Biochemistry, Virology, Taxonomy, Dairy and Food Microbiology, basic and advanced Instrumentation in Semester III and Semester IV.

Semester V and Semester VI while focusing on the depth and applications of the above topics will also include new topics of Population genetics, Emerging infectious diseases, Bioinformatics, Biostatistics, Advanced Virology and basic Nanotechnology.

As mentioned in the syllabus, all the three courses of theory and practicals are compulsory for B.Sc. Microbiology students (Semester III and IV). Choice is offered between Module III and Module IV in Course III in both Semester III and Semester IV.

The syllabi for the three year undergraduate programme are designed to enable the students to understand and select an area of their interest to pursue further studies for post -graduation

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Course outcome: After the successful completion of the three courses, the learner should be able to

1) Explain and analyse concepts of Immunology, Genetics, Biochemistry, Taxonomy, Epidemiology and Bioinstrumentation.
2) Understand advanced concepts in chromatography/ microscopy.

Semester III	Course Number	Course Title	Course code	Credits	Hours	Periods (50 min)	Unit/ Module	Lectures (50 MINUTES)	Examination		
									Internal Marks	External Marks	Total Marks
THEORY											
Core courses											
	I	Medical Microbiology	19US3MBI	2	30	36	1	12	40	60	100
							2	12			
							3	12			
	II	Genetics, Virology and Taxonomy	19US3MB2	2	30	36	1	12	40	60	100
							2	12			

							3	12			
	III	Bioinstrumentation	19US3MB3	2	30	36	1	12	40	60	100
							2	12			
							3	12			
PRACTICALS											
CORE COURSES											
		Medical Microbiology	19US3MBP	1	10	12				50	50
		Genetics, Virology and Taxonomy		1	10	12				50	50
		Bioinstrumentation		1	10	12				50	50

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Course – I

COURSE TITLE: Medical Microbiology

COURSE CODE: 19US3MB1

[CREDITS - 02]

Course Specific Outcome: To enable the learner to:

1. Grasp the concept of the host-parasite interactions, virulence properties of pathogens and host immune response.
2. Be aware of fundamentals of infections, pathogenesis, and epidemiology.
3. To provide the glimpses of the strategies available to control and to treat diseases, choices of antibacterial agents.

Module	TITLE AND CONTENT	NO OF LECTURES
1	**Module: I : Pathogenicity of micro-organism**	12
	Learning objectives: Learner should be able to : 1) Understand the outcome of host parasite relationship 2) Identify the type of infectious process 3) Discern the concept of virulence and pathogenicity 4) Determine the virulence experimentally 5) Perceive the overview of bacterial pathogenesis 6) Cognise adherence factors and types of toxins **Learning outcomes** : By the end of this course learner will be : 1)Apprized of various factors associated with host parasite relationship 2) Comprehend the mechanism of infections 3)Determine ID_{50} and LD_{50} 4)Differentiate exotoxins and endotoxins	
	1.1) Host parasite relationship : a) Introduction to virulence	03

	b) Outcome of host parasite relationship c) Mathematical expression of infection d) Various types of infection e) Concept of LD50 and ID50 f) Determination of LD50 and ID50	
	1.2) Overview of bacterial pathogenesis	O2
	1.3) Bacterial adherence factors – Fimbriae, glycocalyx, pili, S-layer, slime layer, teichoic and lipo-teichoic acid	O2
	1.4) Virulence factors: Enzymes: hyaluronidase, collagenase, streptokinase, coagulase, hemolysin.	O2
	1.5) Toxigenicity : a. Exotoxins: neurotoxin, b. Enterotoxin, c. Cytotoxin d. Endotoxins: Chief characteristics.	O3
2	**Module: II : Epidemiology** 12 **Learning objectives**: Learner should be able to : 1) Understand the frequency of a disease 2) Measure frequency of a disease 3) Apprehend the course of an infectious disease 4) Infer epidemic curves **Learning outcomes**: By the end of this course students will be able to: 1) Classify the disease based on its frequency 2) Calculate morbidity and mortality rate of an infection 3) Effective implementation pertaining to spread of a disease	
	2.1) Epidemiology of infectious disease : include a case study in practical	O1
	2.2) Epidemiology terminology.	O1
	2.3) Measuring frequency- The epidemiologist's tools	O2
	2.4) Infectious disease cycle	O2
	2.5) Recognition of a infectious disease in a population in an epidemic	O1

	2.6) Virulence and mode of transmission 2.7) Emerging and re-emerging infectious diseases and pathogens 2.8) Control of epidemics 2.9) Nosocomial infections 2.10) Global travel and health considerations	01 01 01 01 01
3	**Module : III: Chemotherapy** **12** **Learning objectives** : To enable the learner to : 1) Comprehend the characteristics of antimicrobial drugs 2) Describe antibacterial susceptibility tests 3) Understand the salient features of various antibiotic group 4) Understand the drug resistance mechanism **Learning outcomes** : By the end of this course students will be able to: 1) interpret if the action of drugs is static or cidal 2) Perform MIC and MLC test 3) Interpret the drug and its target site 4) Explore the mechanism of drug resistance in a community	
	3.1) Basics: a) History and development of Chemotherapy b) General properties of antimicrobial agents c) Attributes of an ideal antimicrobial agent 3.2) Determining the level of antimicrobial activity : a) Dilution susceptibility test b) Disc diffusion test 3.3) Principal groups of Antibacterial agents, Mechanism of Action, bacteriostatic or bacteriocidal, narrow or broad spectrum, side effects, one example for each of the following. : a) Cell wall synthesis inhibition b) Protein synthesis inhibition c) Nucleic acid inhibition	03 02 05

	d) Cell membrane disruption e) Metabolic antagonism 3.5) Concept of drug resistance	 O2

References:

Module I & Module II:

1) Prescott, Harley and Klein. (2008). *Microbiology.* 7th edition McGraw Hill international edition.

Module III:

1) Ananthanarayan and Paniker. (2009). *Textbook of Microbiology.* 8th Edition. Universal Press

Evaluation Pattern: Theory

For course I

External Evaluation – Semester End Examination (60 M) - Duration : 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III	30	20

Internal Evaluation - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

S. Y. B. Sc. (MICROBIOLOGY)

SEMESTER III - Practicals

Course-I

COURSE -CODE: 19US3MB1

[CREDITS - 01]

Sr. No.	Experiments	Number of hours
1.	Kirby –Bauer method of AST	6
2.	MIC of antibiotics	6
3.	Study of virulence factor (enzymes): Coagulase, Haemolysin, Lecithinase. Assignments: Epidemiology- Tuberculosis, AIDS, Malaria, *Campylobacter*, *Legionella* infections, *Listeria*	18

Evaluation pattern: Practicals

External evaluation: 50 Marks practical examination at the end of each semester per course.
Major and Minor Techniques
Quiz
Journal

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Course – II

COURSE TITLE: Genetics, Virology and Taxonomy

COURSE CODE: 19US3MB2

[CREDITS - 02]

Course Specific Outcome: The student will be able to

1) Describe structure of prokaryotic chromosome and understand significance of the Central Dogma of the cell.
2) Discuss basic concepts in structure and replication of viruses.
3) Understand taxonomy with respect to bacteria.

Module	TITLE AND CONTENT	NO OF LECTURES
1	**Module: 1 : Informational Macromolecules**	12
	Learning objectives: To familiarize the learner with : 1) Central Dogma of the Cell 2) Structural aspects of ds DNA and prokaryotic chromosomes. 3) Historical aspects and significance of Genetic code. **Learning outcomes** : By the end of this course learner will be able to: 1) List the contributions of prominent scientists in elucidating structure of the double helix. 2) Explain the structural features of double stranded DNA. 3) Describe organization of DNA in prokaryotic chromosome. 4) Differentiate between positive and negative supercoiling. 4) List features of Genetic code and variations of the code. 5) Analyse reasons for degeneracy of the genetic code.	

	1.1 Central Dogma of the cell, informational macromolecules Organization of DNA in Chromosomes: Basics of exons and introns 1.2) Structure of Double helix DNA: a) Features b) Discovery c) Determination of Tm d)A, B and Z forms of DNA e) Important features of DNA structure-Palindrome structures f) Circularity, Supercoiling of prokaryotic chromosome and role of Topoisomerases 1.3 Genetic Code- a)Historical perspective b)Features of the genetic code c)Wobble hypothesis d)Variations to the genetic code	02 05 05
2	**Module II : Basics of Virology** 12 **Learning objectives**: To enable the learner to understand 1) Basic concepts under viral architecture 2) Basis of viral classification 3) Replication of different types of viruses **Learning outcomes**: By the end of this course students will be able to: 1) Describe the structure of different types of viruses with one example each. 2) List the criteria for viral classification. 3) Describe the replication of different viruses and compare major features.	
	2.1. Viral architecture- Virus structure and morphology of plant (TMV) and animal viruses (Influenza virus, HIV).	04

	2.2. Viral classification: Baltimore, ICTV 2.3. The viral replication cycle- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release. Life cycle of TMV, Influenza Virus in detail. 2.4. Viroids.	O2 O5 O1
3	**Module III: Taxonomy** 12 **Learning objectives** : To enable the learner to : 1) Understand the basic concepts under Taxonomy 2) Understand phylogenetic and classical approaches employed in bacterial taxonomy. **Learning outcomes** : The learner will be able to 1) Apply the concepts of phylogenetic and classical approaches of taxonomy for classification and identification of the isolate. 2) Apply the newer methods of bacterial taxonomy.	
	3.1) Taxonomic ranks, Binomial Nomenclature. 3.2) Phylogenetic approach and Classical approach to taxonomy 3.3) Numerical taxonomy 3.4) Newer methods to Bacterial Taxonomy: a) DNA base composition and Tm b) Nucleic acid Hybridisation. c) DNA Sequencing d) RNA Fingerprinting and Sequencing. e) Ribotyping. f) Fatty acid analysis 3.5) Bergey's Manual	O1 O1 O3 O6 O1

References:

Module I

1) Russel,I P. J. (2006), *iGenetics-A molecular approach*, 3rd edition. New York: Pearson Education International.

2) Madigan, M., Martinko, J., Parkar, J., (2009), *Brock Biology of microorganisms*, 12th edition. Pearson Education International.

Module II

1) Shors T. (2009). Understanding Viruses. Massachusets: Jones and Bartlett Publisher

Module III

1) Prescott, Harley and Klein. (2008). *Microbiology*. 7th edition. McGraw Hill international edition.
2) Stanier. R.Y., Ingraham, J.L., Wheelis, M.L., Painter, R.R, (1987). *General Microbiology*, 5th edition. The Macmillan press Ltd.
3) Frobisher, M. (1974) *Fundamentals of Microbiology*.9th Edition. W.B. Saunders Company.

Evaluation Pattern: Theory

For course I

External Evaluation – Semester End Examination (60 M)- Duration : 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III	30	20

Internal Evaluation - (40 M)

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

S. Y. B. Sc. (MICROBIOLOGY)

SEMESTER III- Practicals

Course-II

COURSE CODE: 19US3MB2

[CREDITS - 01]

Sr. No.	Experiments	Number of hours
1.	Enrichment and Enumeration of phages by phage assay method.	10
2.	Identification of a bacterial isolate using Bergey's manual	10
3.	Viable Count-Surface Spread and Pour Plate	05
4.	Extraction of DNA from onion	05

Evaluation pattern: Practicals

External evaluation: 50 Marks practical examination at the end of each semester per course.
Major and Minor Techniques
Quiz
Journal

==========

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER III

Course – III

COURSE TITLE: Bioinstrumentation

COURSE CODE: 19US3MB3

[CREDITS - 02]

Course Specific Outcomes: After the successful completion of the Course III, the learner should be able to:

1) State the principle and applications of basic Colorimetry and Spectroscopy.
2) Describe the different methods of estimation of biomolecules.
3) State and describe basic and advanced Chromatographic and Microscopic techniques.

Student is required to choose any one module from Modules III and IV.

Module	TITLE AND CONTENT	NO OF LECTURES
I	**Module I : Estimation of Biomolecules**	12
	Learning objectives: 1) To describe the composition of microbial cells. 2) To state and describe various methods to estimate biomolecules. 3) To state the basic concepts of Colorimetry and Spectroscopy. **Learning outcomes:** After successful completion of the module, the learner should be able to: 1) State the macro and micronutrients of a microbial cell. 2) State the principle of Beer- Lambert's law along with its applications. 3) Describe the basic components and working of Colorimeter. 4) Apply the principle of different biochemical assays to estimate biomolecules.	

	5) Compare and contrast between different methods of estimation of molecules.	
	1.1) Colorimeter: a) Electromagnetic radiation b) Principle of Beer-Lamberts Law c) Concepts of Absorbance, Optical Density, Molar-extinction Co-efficient d) Working of Colorimeter e) Applications of Colorimeter in Biological Sciences	O2
	1.2) Spectroscopy: a) Ultraviolet spectrophotometry b) Instrumentation: Monochromators, Cuvettes, photocells, slits. c) Applications d)Qualitative and quantitative analysis	O3
	1.3) Macromolecular Composition of a Microbial cell: Estimation of biomass by wet weight and DCW.	O1
	1.4) Principle, Method and Applications: Methods of elemental analysis: a) Carbon by Van-Slyke's method b) Nitrogen by Micro-Kjeldahl method.	O1
	1.5) Phosphorus by Fiske-Subbarow method	O1
	1.6) Estimation of Carbohydrates: a) Phenol method b) DNSA method	O1
	1.7) Estimation of Proteins: a) Biuret method b) Folin-Lowry's method.	O1
	1.8) Estimation of Amino acids: Ninhydrin method	
	1.9) Estimation of Nucleic acids: a) DPA method b) Orcinol method.	O1
	1.10) Extraction and Estimation of Lipids.	O1

2	**Module II: Separation Techniques for Biomolecules** 12 **Learning objectives**: 1) To state and define basic terminology of Chromatography and Centrifugation. 2) To state and describe the basic concepts and working of different chromatographic and Centrifugation techniques. **Learning outcomes**: After successful completion of the module, the learner should be able to: 1) Define basic terms in Chromatography and Centrifugation. 2) State and describe the principle, method and applications of Adsorption, Ion-exchange and Molecular -exclusion chromatography. 3) Explain briefly the principle of HPLC, GC, Affinity chromatography. 4) State and describe the principle, method and applications of Preparative and Analytical Centrifugation. 5) Apply column and TLC chromatographic techniques at laboratory scale for separation of biomolecules.	
	2.1) Concepts of Chromatography a) Distribution co-efficient/Partition co-efficient b) Effective distribution co-efficient c) Modes of chromatography (Tabulation-TLC, Column and Paper) d) Basic Column chromatography components. e) Analyte Development and elution-brief introduction. f) Definitions of / Introduction to: Liquid and Gas chromatography, Chromatogram, retention time, void volume, Retention factor, Theoretical plate, Plate height. g) Resolution	O2

	2.2) Adsorption Chromatography: a) Principle b) Hydroxylapatite Chromatography	01
	2.3) Introduction to Partition Chromatography: a) Concepts of Liquid-liquid and Bonded-phase Chromatography b) Concepts of Normal phase and Reverse phase Liquid Chromatography	01
	2.4) Ion-exchange Chromatography: a) Principle b) Materials and c) Types of Exchanger	01
	2.5) Molecular Size-Exclusion Chromatography: a) Principle b) Applications	01
	2.6) Principle and Applications of: a) High Performance Liquid Chromatography (HPLC) b) Gas Chromatography (GC) c) Affinity Chromatography.	01
	2.7) Centrifugation: a) Basic Principle of Sedimentation, Concepts of Applied Centrifugal field, angular velocity, sedimentation co-efficient. b) Types of Centrifuges and types of rotors (only names) c) Preparative Centrifugation: Differential and Density-gradient Centrifugation d) Applications: Scheme of fractionation of skeletal muscle homogenate into various sub-cellular fractions e) Affinity purification of membrane vesicles f) Analytical Centrifugation: Applications and Schematic diagram of Optical system of Analytical	01 01 01 01 01

	Ultracentrifuge.	
3	**Module III: Advanced Chromatography**	12
	Learning objectives: 1)To state and describe the advanced concepts of Chromatographic techniques. 2)To emphasize the significance of advanced techniques of chromatography. **Learning outcomes**: After the successful completion of the module, the learner should be able: 1) Schematically represent the flowsheet of the steps and describe the steps in HPLC, HPTLC, GC. 2) Compare and contrast between the different chromatographic techniques. 2) State the principle and applications of GC-MS.	
	3.1) High Performance Liquid Chromatography (HPLC): a) Columns b) Application of sample c) Mobile phases d) Pumps e) Detectors	04
	3.2) High Performance Thin Layer Chromatography (HPTLC) a) Principle b) Sample preparation c) Selection of stationary phase d) Sample Application e) Chromatogram development f) Derivatization g) Visualization and documentation of	03

	chromatogram h) Densitometry 3.3 Gas Chromatography (GC): a) Columns b) Sample Application c) Mobile phase d) Detectors 3.4 High Resolution GC-Concept and Applications a) Brief introduction to GC-MS	 03 02
3	**Module III: Advanced Microscopy** 12 **Learning objectives:** 1) To state and describe the different advanced versions of Microscopy. **Learning outcomes:** 1) State and describe the different advanced versions of Microscopy. 2) Cite the criteria for selection of microscopic technique for appropriate imaging of a cell. 3) Apply the microscopic technique and study morphology as well as internal structure of cells with a better resolution	
	4.1) Atomic Force Microscopy: a) Principle b) Applications 4.2) Principle and Applications of: a) High Resolution Fluorescence Microscopy: b) Different configurations of Fluorescence Microscopy: Epifluorescence Scanned Confocal and Stimulated Emission-Depletion Super- Resolution microscopy Total Internal Reflection and photo-switching based Super- Resolution microscopy c)Forster Resonance Energy Transfer (FRET) d)Super Resolution Fluorescence Microscopy:	03 09

References:

1. Norris and Robbins VA. (1971). *Methods in Microbiology*. New York: Academic Press London.

2. Wilson and Walker. (2009). *Principles and Techniques of Biochemistry and Molecular Biology*. 7th edition.

3. William and Wilson. . *Instrumentation in Biochemistry*.

4.H. R. Bolliger, M. Brenner. (). *Thin Layer Chromatography, A Laboratory Handbook*. Springer Verlag.

5.Eike Reich, Anne Schibli. (2006). *High Performance Thin Layer Chromatography for the Analysis of Medicinal Plants*. Thieme Medical Publishers Inc.

6. Advanced-Microscopy Techniques for the Characterization of Cellulose Structure and Cellulose-Cellulase Interactions, Jose M. Moran-Mirabal, http://dx.doi.org/10.5772/56584.

Evaluation Pattern: Theory

For course I

External Evaluation – Semester End Examination (60 M)- Duration : 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III or IV	30	20

Internal Evaluation - (40 M)

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

S. Y. B. Sc. (MICROBIOLOGY)

SEMESTER III - Practical

Course-III

COURSE CODE: 19US3MB3

[CREDITS - 01]

Sr. No.	Experiments	Number of hours
1.	Determination of λmax of a coloured solution.	02
2.	Verification of Beer and Lambert's Law Linear Range.	02
3.	Determination of Molar extinction coefficient	02
4.	Determination of dry weight and wet weight	02
5.	Estimation of amino acids by Ninhydrin method	03
6.	Estimation of Proteins by Biuret method.	02
7.	Estimation of reducing sugars by DNSA method	02
8.	Estimation of DNA by DPA method.	02
9.	Estimation of RNA by Orcinol method	02
10	Study of Centrifuge, Density gradient centrifugation (Yeast and bacteria)	02
11	Paper chromatography of amino acids.	03
12.	TLC of Amino acids	03
13.	Column chromatography	03

Evaluation pattern: Practical:

External evaluation: 50 Marks practical examination at the end of each semester per course.
Major and Minor Techniques
Quiz
Journal

==========

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Course outcome:

After the successful completion of the three courses, the learner should be able to:

1. Identify and describe the immune system and its components.
2. Describe basic metabolism and importance of energy transductions and enzymes in the functioning of a living cell.
3. State and describe the basic concepts and processes of Industrial and Food Microbiology

Semester IV	Course Number	Course Title	Course code	Credits	Hours	Periods (50 min)	Unit/ Module	Lectures (50 MINUTES)	Examination		
									Internal Marks	External Marks	Total Marks
THEORY											
Core courses											
	I	Immunology	19US4MB1	2	30	36	1	12	40	60	100
							2	12			
							3	12			
	II	Concepts in Biochemistry	19US4MB2	2	30	36	1	12	40	60	100

							2	12			
							3	12			
	III	Industrial and Food Microbiology	19US4MB3	2	30	36	1	12	40	60	100
							2	12			
							3	12			
PRACTICALS											
CORE COURSES											
		Immunology	19US4MBP	1	10	12				50	50
		Concepts in Biochemistry		1	10	12				50	50
		Industrial and Food Microbiology		1	10	12				50	50

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Course – I

COURSE TITLE: Immunology

COURSE CODE: 19US4MB1

[CREDITS - 02]

Course Specific Outcome:

To enable the learner

1. To build on the basic information regarding Innate Immunity and Virulence factors.
2. To comprehend the ability of our immune system to defend against invading pathogens.
3. To recognize the molecular nature of antigens and antibodies along with the role of different cells and their surface molecules in acquired immunity.

Module	TITLE AND CONTENT	NO OF LECTURES
I	**Module I : Immune system**	12
	Learning objectives: To enable the learner to comprehend: 1) Various types of human blood cells and its function. 2) The function response of leukocytes to eliminate the pathogens. 3) The concept of Antigen presentation 4) Distinguish between primary and secondary lymphoid organs and tissues **Learning outcomes** : By the end of this course learner will be able to: 1) Classify various blood cells and relate its functions. 2) Differentiate between granulocytes and agranulocytes. 3) Infer the anatomy and significance of primary and secondary	

	lymphoid organs and tissues.	
	1.1) Overview of host resistance: a) Introduction of host resistance b) Immunity : types of immunity c) Major components of the mammalian immune system 1.2) Cells of immune system: a) Pluripotent stem cells in the bone marrow b) Normal adult blood count c) Monocyte and macrophages system d) Polymorphonuclear leukocytes: basophils, eosinophils, neutrophils e) Mast cells f) Dendritic cells g) Lymphocytes : T and B lymphocytes, Natural killer cells 1.3) Organs and tissues of the immune system. a) Primary lymphoid organ and tissue b) Secondary lymphoid organ and tissue.	02 01 01 01 01 01 01 01 03
2	**Module II : Concept of antigen and antibody** 12 **Learning objectives**: To enable the learner to : 1) Explain various terms related to antigen 2) Concept of immunogen 3) Different types of antigens 4) Immunoglobulin structure, function and different types **Learning outcomes**: By the end of this course students will be able to: 1) Two entities responsible for outcome of immune response i.e. immunogen and host 2) Structure-function relationship of antibodies 3) Structure of immunoglobulin in relation to antigen binding	

	4) Differences amongst different types of immunoglobulins.	
	2.1) Introduction- a) Terms of antigen, immunogen, hapten, epitope, difference between these terms b) Properties of immunogen that contribute to immunogenicity	01
	2.2) Immunogenicity of some natural substances	01
	2.3) Types of antigen : a) Heterophiles antigen b) Isophile antigen c) Sequestered antigens d) Bacterial antigens	01
	2.4) Factor influencing the immune response of host	01
	2.5) Adjuvants : a) Types : Freund's complete and incomplete adjuvant and other examples b) Mechanism	01
	2.6) Basic structure of antibodies : a) Main features of immunoglobulin b) Immunoglobulin structure c) Chemical and enzymatic methods revealing basic antibody structure	02
	2.7) Structure function relationship of antibodies and structure of immunoglobulin in relation to basic antigen binding. Concepts of affinity and avidity	01
	2.8) Types of antibodies : a) Isotype b) Allotype c) Idiotypes	02
	2.9) Isotypes of immunoglobulin properties, structure, and function: IgG, IgM, IgD, IgE, and IgA.	01
	2.10) Immunoglobulin receptors	01
3	**Module III: Concept of antigen and antibody reaction** 12 **Learning objectives** : To enable the learner: 1) To categorise various reactions between antigen-antibody	

	2) To demonstrate the applications of antigen-antibody reactions **Learning outcomes** : By the end of this course students will be able to evaluate: 1) Different types of in vitro reactions between antigen and its homologous antibody 2) Applications of antigen antibody reaction in diagnosis of disease by immunological assays which can be used to detect the presence of either antibody or antigen	
	3.1 Introduction of terms used in serological reactions : a) Agglutination b) Precipitation c) flocculation d) Agglutinin e) Agglutinogen f) Precipitin g) Precipitinogen 3.2 a) Comparative efficiency of various immunoglobulins in different serological reactions b)Important parameters in serological test 3.3 Zone phenomenon 3.4 Agglutination test : a) Mechanism b) Applications – Slide agglutination Tube test (Widal test) 3.5 Precipitation reaction : a) Mechanism of precipitation :lattice hypothesis b) Types of precipitation c) Flocculation 3.6 Immuno-diffusion 3.7 Complement fixation 3.8 Immunofluorescence test	O2 O1 O1 O2 O2 O1 O1 O1

	3.9 ELISA	01

REFERENCES:

Module I:

1) Prescott, Harley and Klein. (2008). *Microbiology*. 7th edition McGraw Hill international edition.

Module II

1) Pathak, S., Palan U. () *Immunology Essential and Fundamental*. Bombay: Pareen publications.
2) Khan F.H. The elements of immunology.1st edition. Pearson Education.
3) Thomas J. Kindt, Richard A. G, Barbara A. Osburne (2007) *Kuby Immunology*: New York: W. H. Freeman and Company.

Module III

1) Ananthanarayan and Paniker. (2009). *Textbook of Microbiology.* 8th Edition. Universal Press
2) Khan F.H. The elements of immunology.1st edition. Pearson Education.

Evaluation Pattern: Theory

For course I

External Evaluation – Semester End Examination (60 M)- Duration : 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III	30	20

Internal Evaluation - (40 M)

Probable options:

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

S. Y. B. Sc. (MICROBIOLOGY)

SEMESTER IV- Practicals

Course-I

COURSE CODE: 19US4MB1

[CREDITS - 01]

Sr. No.	Experiments	Number of hours
1.	Blood staining	05
2.	Blood grouping	02
3.	Single radial immunodiffusion and Double immunodiffusion	05
4.	Widal qualitative and quantitative –Demonstration.	06
5.	Preparation of O and H antigens	08
6.	ELISA test(demonstration)	04
7.	Internship at pathology lab	--

Evaluation pattern: Practicals

External evaluation: 50 Marks practical examination at the end of each semester per course.
Major and Minor Techniques
Quiz
Journal

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Course – II

COURSE TITLE: Concepts in Biochemistry

COURSE CODE: 19US4MB2

[CREDITS - 02]

Course Specific Outcome: After the successful completion of the course, the learner should be able to:

1) Explain the principles thermodynamics with respect to a living cell.
2) List and describe the basic concepts in cellular metabolism.
3) Describe the basic structural and functional aspects of enzymes in the functioning of a living cell.

Module	TITLE AND CONTENT	NO OF LECTURES
I	**Module I : Thermodynamics**	12
	Learning objectives: 1) To familiarize the student with basic concepts of thermodynamics from a biological perspective. 2) To introduce various common ATP yielding mechanisms in a cell **Learning outcomes :** The learner will be able to 1) Define terms related to Thermodynamics. 2) Differentiate between ΔG and $\Delta G'^{0}$ 3) Explain relation of K'eq and ΔG. 4) Describe structure and significance of ATP. 5) Explain role of high energy compounds 6) Identify and compare energy yielding mechanisms.	

	1.1 a) Scope of thermodynamics, First and second laws of thermodynamics system, universe, enthalpy, entropy. b) Concepts of Gibbs free energy, free energy change, exergonic and endergonic reactions, relation between Keq and ΔG, ΔG and $\Delta G'^0$ Keq and K'eq.	04
	1.2 a) Structure and properties of ATP b) $\Delta G'^0$ for ATP hydrolysis and other high energy compounds viz. 1,3-diphosphoglyceric acid and phosphoenolpyruvate.	04
	1.3. Energy yielding mechanisms 1. Fermentation: alcoholic and lactic acid 2. Respiration; aerobic and anaerobic 3. Photosynthesis: cyclic and non-cyclic	04
2	**Module II : : Introduction to Metabolism** 12 **Learning Objectives:** 1) To familiarize the learner with basic terminologies of metabolism. 2) To introduce the learner to role of redox reactions. 3) To enable the learner to understand types of metabolic pathways with details of two central metabolic pathways. **Learning Outcomes:** The learner will be able to 1) Compare features and significance of anabolism and catabolism. 2) Explain link between anabolism and catabolism. 3) Discuss role of pyridine nucleotides. 4) Explain different types of biochemical pathways with examples. 5) Schematically represent EMP and TCA pathway.	
	2.1. Metabolism- catabolism, anabolism, link between catabolism and anabolism viz. ATP, reducing power, precursors (list of 12 precursors), amphibolic pathways.	02

	2.2. Biological oxidation reduction reactions, role of pyridine nucleotides in metabolism. 2.3. a) Types of biochemical pathways- linear, branched and cyclic with one example each. b) Constitutive and Inducible pathways with one example each 2.4 EMP and TCA with structures	O2 O4 O4
3	**Module III: Enzymology** 12 **Learning objectives**: 1) To define and explain the basic concepts in Enzymology. 2) To state and describe the basic structural features of enzymes. 3) To describe the effect of different parameters on enzyme activity. 4) To introduce concepts in enzyme kinetics. 3) To describe allosteric enzymes and their role in metabolism **Learning outcomes**: After the successful completion of the module, the learner should be able to: 1) Define and explain the basic concepts of Enzymology 2) Describe the methods for purification of enzymes 3) State and describe enzyme classification. 4) Derive Michaelis- Menten equation. 5) Plot Michaelis- Menten and Lineweaver-Burk plot for an enzyme. 6) Differentiate between Michaelis-Menten and Lineweaver-Burk plot. 7) Apply the enzymatic assay to study effect of pH. temperature, substrate and enzyme concentration on enzyme activity. 8) Determine Km and Vmax for a given enzyme. 9) Describe basic enzyme kinetics. 10) Describe the structure and the role of allosteric enzymes in metabolism. 11) Compare and contrast reversible and irreversible enzyme inhibition.	

	3.1. a) Basic concepts, Apoenzyme, Holoenzyme, Co-factors, Prosthetic groups, Metal activators. b) Vitamins as coenzymes (only list all vitamins and their coenzymes) c) Classification of enzymes	O3
	3.2 Enzyme purification: Methods: Use of Ammonium sulphate precipitation, organic solvents, and Dialysis Definitions of Enzyme Unit, Specific activity, International Unit (IU)	O2
	3.3. Enzyme kinetics a) Michaelis- Menten equation and plot, Line-weaver Burk equation and plot Km and Vmax. b) Effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity	O3
	3.4. Allosteric enzymes a) Structure, kinetics (sigmoidal curve) b) Activation: Concerted and sequential models c) Inhibition: Reversible and irreversible (Competitive, Uncompetitive and Non-competitive)	O4

References:

1) Tortora Funke and Case. (1998). *Microbiology An Introduction*. 6th edition Addison Weseley Longman Inc.

2) Nelson, D. and Cox, M. (2005*). Lehninger Principles of Biochemistry.* 4th edition. New York: W H Freeman and Company.

3) Conn P., Stumpf, G., Bruening and Doi R. (1995). *Outlines in Biochemistry*. 5th edition. New York: John Wiley and Sons .

2) Palmer, T.. (2004).*Enzymes, Biochemistry, Biotechnology and Clinical Chemistry.* New Delhi: .East West Press Ltd.

Evaluation Pattern: Theory

For course I

External Evaluation – Semester End Examination (60 M)- Duration : 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III	30	20

Internal Evaluation - (40 M)

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

S. Y. B. Sc. (MICROBIOLOGY)

SEMESTER IV - Practicals

Course-II

COURSE CODE: 19US4MB2

[CREDITS - 01]

Sr. No.	Experiments	Number of hours
1.	Production of Invertase from yeast Crude enzyme preparation by ammonium sulphate precipitation Purification by dialysis	05
2.	Effect of parameters like enzyme concentration, substrate concentration, pH and temperature on activity of yeast Invertase. Michaelis-Menten and Line-weaver Burk plot Determination of Km and Vmax	20
3	Problems on Bioenergetics	05

Evaluation pattern: Practicals

External evaluation: 50 Marks practical examination at the end of each semester per course.
Major and Minor Techniques
Quiz
Journal
==========

S.Y. B. Sc. (MICROBIOLOGY) SEMESTER IV

Course – III

COURSE TITLE Industrial and Food Microbiology

COURSE CODE: 19US4MB3

[CREDITS - 02]

Course Specific Outcome:

1) To understand basic concepts of fermentation technology.
2) To appreciate application of Microbiology in Food and Dairy industries.
2) To introduce the concepts and applications of Biofertilizers and Biopesticides.

Student is required to choose any one module from Modules III and IV.

Module	TITLE AND CONTENT	NO OF LECTURES
1	**Module I : Fermentation Technology**	12
	Learning Objectives: 1) To familiarize the learner with the different types of fermentation media components. 2) To enable the learner to learn the principles underlying Inoculum Development. 3) To ensure that the learner is able to analyze the choice of appropriate fermentation type. **Learning Outcomes:** 1) The learner will be able to plan an inoculum development plan for a given production. 2) The learner will be able to distinguish the different types of fermentation. 3) The learner will be able to understand the formulation of media for an industrial production.	

	1.1 Fermentation Media: a) Concept of defined and undefined media b) Medium formulations -Water -Energy and carbon sources, nitrogen sources, minerals, chelators, growth factors, buffers, precursors, inhibitors, inducers, steering agents, antifoam agents c)Animal Cell Culture Media (Serum, serum-free media supplements, protein free media, trace elements, osmolality, pH, nonnutritional media supplements	04
	1.2 Inoculum development: a) Definition b) Principles and various aspects of inoculum development: - Inoculum size -Inoculum media and incubation conditions -Transfer of microbial growth -Contamination -Back mutation c)Example: Inoculum development in the production of Sagamicin by *Micromonospora spp*	04
	1.3 Types of Fermentation: a) Principle, Concept, advantages and limitations of - -Batch, Continuous, fed-batch -Aerobic, Anaerobic, Surface, Submerged, Solid Substrate	04
2	**Module II : Food Microbiology** 12 **Learning Objectives:** 1) To enable the understanding of the intrinsic and extrinsic parameters	

	involved in food spoilage. 2) To familiarize the learner with the hazards and basic safety measures 3) To equip the students to decide the critical control points in any production **Learning Outcomes:** 1) The learner will be able to suggest methods of preservation depending on the food type. 2) The learner will be able to isolate food spoilage causing organisms and suggest their control methods. 3) The learner will be able to identify critical control points.	
	2.1) General principles of food spoilage: a) Intrinsic parameters: pH ,Moisture content, Oxidation-reduction, Nutrient content, Antimicrobial constituents, Biological structures b) Extrinsic parameters: Temperature of storage, Relative humidity of environment, Presence and concentration of gases 2.2) Contamination, spoilage and preservation of Meat 2.3) Methods of food preservation: a) High temperature: Definitions of: Thermoduric and thermophilic microorganisms, sterilization, ultra-high temperature. Factors affecting heat resistance Thermal destruction of Microorganisms (Concepts of: TDT, D value, z value, F value). b) Low temperature-Freezing: Definitions: Psychrophiles, Psychrotrophs, Mesophiles.	O2 O1 O2

	Preparation of food for freezing (Blanching) Freezing of food and freezing effects (Quick freezing and slow freezing) Effects of freezing on microorganisms (Thawing) c)Irradiation: Units of radioactivity Characteristics of radiations of interest in food preservation Principle underlying the destruction of microorganisms by radiation Processing of food for irradiation Application of radiation Three types of Radiation treatment: Radappertization Radicidation Radurization Effect of Irradiation on Food quality. e)Chemical preservatives: Benzoic acid and the Parabens Sorbic acid Propionates Nitrates and nitrites(Curing of Meat) NaCl and Sugars f)Indirect antimicrobials: Antioxidants Flavoring agents Spices and Essential oils Medium chain fatty acids and esters Acetic and Lactic acid 2.4) Concepts underlying use of the following for preservation: a) Antibiotics b) Lactoperoxidase system c) Antifungal agents for fruit	O2 O2 O1 O1

	d) Ethylene and propylene oxides e) Miscellaneous chemical Preservatives 2.5) Role of microbiologist in food industry 2.6) HACCP: a) Concept and HACCP b) Seven principles c) Decision tree to identify critical control points	O1
3	**Module III: Dairy Microbiology** 12 **Learning Objectives**: 1) To enable the learner to understand the normal and abnormal microflora of milk. 2) To familiarize the learner with different rapid platform tests and culture-based methods to determine milk quality. **Learning Outcomes**: 1) The learner will be able to know different types of organisms as microflora of milk. 2) The learner will be able to detect the quality of milk.	
	3.1. Microbial flora of milk, normal and abnormal flora, their sources and changes induced by them: a) Sources of microorganisms in milk. b) Biochemical types of bacteria in milk c) Temperature characteristics of bacteria in milk d) Pathogenic types of bacteria in milk (milk-borne disease) 3.2. Processing: Pasteurization (HTLT, LTST, UHT) and Phosphatase test 3.3. Analysis of milk: a) Platform tests: Determination of acidity Determination of pH Dye reduction tests (MBRT, Resazurin)	O3 O2 O4

	Sedimentation test, Alcohol test, Alizarin- Alcohol test, Clot on boiling b) Direct test for enumerating microbes in milk: DMC, SPC, LPC, Thermoduric count, psychrophilic count. 3.4, Grading of milk: Raw and Pasteurized milk 3.5. Shelf life, Packaging, Storage and distribution	 O2 O1
3	**Module IV: Biofertilizer and Biopesticide** 12 **Learning Objectives:** 1) To familiarize learners with the microbes used as bio fertilizers and biopesticides and their advantages over chemical fertilizers. 2) To provide the learner with an overview of relevance of use of biofertilizers and biopesticides. 3) To allow the learner to understand the use of bacteria and fungi for supply of nutrients required for crop production. **Learning Outcomes:** 1) Learner will be able to give an overview of relevance of use of biofertilizers and biopesticides. 2) Learner will be able to describe the use of bacteria and fungi for supply of nutrients required for crop production. 3) Learner will be able to know the microbes that can be used as bio fertilizers for various crop plants and their advantages over chemical fertilizers.	
	4.1 Bio fertilizers: a) Different microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. b) Symbiotic and non-symbiotic nitrogen fixers. 4.2 Azolla & BGA Bio fertilizers: a) Characteristics	O1 O2

	b) Production c) Methods of application 4.3) PSB Bio fertilizer (Phosphate solubilising Bacteria) a) Mechanism of phosphate solubilisation b) Production c)Methods of application on field	O2
	4.4) VAM Biofertilizer a) Characteristics & types of association b) Production	O1
	4.5) Methods of applications of biopesticide a) Seed inoculation b) Vegetative part inoculation c) Soil inoculation d) Use of Mycorrhizzal fungi	O2
	4.6) Bt crops: a) Bacillus thuringiensis as a source of insecticidal protein b) Examples of Bt crops	O1
	4.7) Biocontrol of Insect pest a) Bacterial pesticide b) Viral pesticide c) Mycopesticide	O1
	4.8) Biological control of weeds a) Mycoherbicides b) Insect as biocontrol agents	O1
	4.9) Mass production of biopesticide a) Solid substrate fermentation: Fungal Biopesticide	O1

References: Module I:

I) Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition,Elsevier Science Ltd.

2) Fermentation Technology by Modi.

3) Patel A.H. (1996). *Industrial Microbiology*. Ist edition, Macmillan India Limited

4) Casida LE. (1991). *Industrial Microbiology*. Ist edition. Wiley Eastern Limited.

Module II:

I) James J. *Food Microbiology*.

2) Prescott, Harley and Klein. (2008). *Microbiology*. 7th edition McGraw Hill international edition.

3) Frobisher, M. (1974) *Fundamentals of Microbiology*.9th Edition. W.B. Saunders Company.

4) Adams, M .and Moss, M. (2004). Food Microbiology 2nd edition. New Delhi: Anima Publishing House

5) Purohit, S.(2001). *Biotechnology Fundamentals and Applications*. 3rd edition. India: Agrobios.

Module-III:

I) Eckles, C., Combs W. and Macy, H. *Milk and milk products* .4th edition. New Delhi: TMH.

2) Casida LE. (1991). *Industrial Microbiology*. Ist edition. Wiley Eastern Limited.

Module: IV:

I) Singh, B.D. (2010). Biotechnology- Expanding Horizon, 3rd Revised Edition, Kalyani Publishers..

2) Bagyaraj, D. J. and Rangaswami, G. (1993). *Agricultural Microbiology*. India: Prentice-Hall. ,ISBN, 0876926685, 9780876926680.

3) Sharma, A. K.. (2002). *Biofertilizers for Sustainable Agriculture*. India Agro-Bios. ISBN-10: 9788177541182 .

4) Dubey, R.C. A Text Book of Biotechnology. New Delhi: S.Chand & Co Ltd.

5) *Integration of Insect-Resistant Genetically Modified Crops within IPM Programs*: edited by Jörg Romeis, Anthony M. Shelton, George Kennedy.

6) Fulekar, M.H. Environmental Biotechnology.

Evaluation Pattern: Theory

For course I

External Evaluation – Semester End Examination (60 M)- Duration : 2 hours

Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	30	20
2	II	30	20
3	III or IV	30	20

Internal Evaluation - (40 M)

Plickers

Testmoz

Google form

Moodle

Objective-MCQ

Short answer test

S. Y. B. Sc. (MICROBIOLOGY)

SEMESTER IV - Practicals

Course-III

COURSE CODE: 19US4MB3

[CREDITS - 01]

Sr. No.	Experiments	Number of hours
1.	Determination of antibacterial spectrum (Agar streak and Agar strip)	04
2.	Auxanography.	02
3.	TDP and TDT.	05
4.	Food preservative –Sugar and Salt (MIC)	04
5.	Selective isolation of food spoilage organism	03
6.	Comparative state of solid state and submerged fermentation	02
Module III 1.	Microbial analysis of milk: MBRT: Methylene Blue Reduction Test RRT: Resazurin Reduction Test DMC: Direct Microscopic Count SPC: Standard Plate Count LPC: Laboratory Pasteurization Count Coliform count Presumptive test	10
Module IV 1.	Isolation of Azotobacter and Rhizobium	02
2.	Preparation of Biofertilizer.	02
3.	To study about mass production technology of	01

	important biopesticides.	
4.	Isolation of Azospirillum from soil.	O2
5.	Isolation of Phosphate solubilising bacteria from soil.	O2
6.	Demonstration of vermicomposting.	O1

Evaluation pattern: Practicals

External evaluation: 50 Marks practical examination at the end of each semester per course.
Major and Minor Techniques
Quiz
Journal