SOPHIA COLLEGE

(Autonomous)

Affiliated to

University Of Mumbai

Syllabus

Program: B.Sc.

Class: S.Y.B.Sc.

Course: MICROBIOLOGY

With effect from the academic year

2022-2023

S.Y.B.Sc MICROBIOLOGY Syllabus (General Outline) Revised for Autonomy To be implemented from the Academic year 2022-2023		
COURSE NAME: MICROBIOLOGY		
	SEMESTER III	
PAPER CODE	**PAPER TITLE**	**CREDITS**
SBSMCB301	**MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION**	**2 Credits (45 lectures)**
Unit-I	Biodiversity in extreme environments	15 lectures.
Unit-II	Microbial taxonomy	15 lectures.
Unit-III	Instrumentation	15 lectures.
SBSMCB302	**ENVIRONMENTAL MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit-I	Aeromicrobiology and Freshwater Microbiology	15 lectures.
Unit-II	Soil Microbiology	15 lectures.
Unit-III	Applied Environmental Microbiology	15 lectures.
SBSMCB303	**INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS**	**2 Credits (45 lectures)**
Unit-I	Thermodynamics	15 lectures.
Unit-II	Metabolism and Biostatistics	15 lectures.
Unit-III	Enzymology	15 lectures.
SBSMCBP3	**PRACTICALS**	**3 Credits**
PRACTICAL – I	SECTION-1 MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION (Practicals Based On Unit-I, II & III Of SBSMCB301)	
PRACTICAL – II	SECTION-2 ENVIRONMENTAL MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB302)	
PRACTICAL – III	SECTION-3 INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS (Practicals Based On Unit-I, II & III Of SBSMCB303)	

Semester III

SBSMCB301- MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION

Learning Objectives:

- To make students familiar with the biodiversity of microorganisms in different habitats/ecological niches including extreme environments and applications of these microorganisms in bioremediation, pollution control, agriculture, pharmaceuticals & biotechnology.
- To understand the principles involved in microbial classification.
- To understand principles of various instrumentation techniques and their applications in biology

Learning Outcomes:

At the end of the course, learner will be able to

- recall the extreme environments and explain cultural characteristics and molecular adaptations of extremophiles
- explain principles and techniques for identifying bacteria
- explain instrumentation techniques like UV-visible spectrophotometry, chromatography and centrifugation and apply this knowledge

SBSMCB301	**MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION**	**2 Credits (45 lectures)**
Unit-I	**Biodiversity In extreme environments**	**15 lectures.**
	1.1 Microorganisms and environment Ecosystem services and the role played by microorganisms in ecosystems.	**01**
	1.2 Characteristics and examples of the following extreme environments: a. Temperature based environments- Low and high temperature environments b. pH based environments- Acidic and alkaline environments c. Environments with high salt concentration. d. Astro microbiology, or exo microbiology, study of microorganisms in outer space.	**02**
	1.3 Morphology, physiology and cultural characteristics of thermophiles, psychrophiles, acidophiles, alkaliphiles and halophiles.	**06**
	1.4 Molecular adaptations and applications of thermophiles, psychrophiles, acidophiles, alkaliphiles and halophiles.	**06**
	1.5 Unculturable microorganisms	

Unit –II	**Microbial taxonomy**	**15 lectures**
	2.1 Introduction to microbial Taxonomy	**01**
	2.2 Taxonomic ranks	**01**
	2.3 Techniques for determining Microbial Taxonomy and Phylogeny a. Classical characteristics: genetic analysis, morphological, ecological, physiological and metabolic characteristics. b. Molecular characteristics: nucleic acid base composition, nucleic acid hybridization, nucleic acid sequencing, genomic fingerprinting and amino acid sequencing.	**07**
	2.4 Phylogenetic Trees a. Types b. Construction (an overview)	**02**
	2.5 Numerical Taxonomy	**03**
	2.6 Bergey's Manual of Systematic Bacteriology. International committee on systematic procaryotes	**01**
Unit –III	**Instrumentation**	**15 Lectures**
	3.1 UV-visible spectrophotometry Principle, Instrumentation and applications	**03**
	3.2 Chromatography **a.** Principles, Working, Advantages and Disadvantages of i. Paper chromatography ii. Thin layer chromatography iii. High Performance liquid chromatography iv. Gas chromatography v. Ion-exchange chromatography vi. Affinity Chromatography	**09**
	3.3 Centrifugation a. Basic Principles of centrifugation b. Calculation of RCF c. Types of rotors – fixed angle and swinging bucket d. Low speed centrifuges e. High speed centrifuges f. Ultracentrifuges g. Differential centrifugation	**03**

SBSMCB302- ENVIRONMENTAL MICROBIOLOGY

Learning Objectives:

- To build a knowledge base concerning the microbial diversity and activity profile of air, freshwater and soil.
- To understand the principles and methods of sampling and analysis of microorganisms present in air, water and soil.
- To familiarise students with the role of microorganisms in recycling of Carbon, Nitrogen, Sulfur and Phosphorus in the environment.
- To relate human intervention in Carbon, Nitrogen, Sulfur biogeochemical cycles with its effects
- To understand the role of microorganisms in bioremediation of polluted environments

Learning outcomes:

At the end of the course, learner will be able to-

- describe the microbial diversity and their activities in air, freshwater and soil
- suggest the method to be used for study of a specific microorganisms in the environment
- describe the impacts of human interference in the geochemical cycles related to the Carbon, Nitrogen and sulfur
- explain the role of microorganisms in bioremediation of polluted environments.

SBSMCB302	**ENVIRONMENTAL MICROBIOLOGY**	**2 Credits (45 lectures)**
Unit-I	**Aeromicrobiology and Freshwater Microbiology**	**15 lectures**
	1.1 Aeromicrobiology a. Important airborne pathogens and toxins, aerosols, nature of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural and intramural aeromicrobiology b. Sampling of Air (Impingement, Impaction on surfaces, Centrifugation, Filtration, electrostatic precipitation and thermostatic precipitation) c. Air Sanitation **1.2 Freshwater Microbiology** a. Freshwater environments and microorganisms found in Lakes, Springs, rivers and streams b. Potable water: Definition, water purification, water quality standards and pathogens transmitted through water c. Microbiological analysis of water: Indicator organisms - Total Coliforms, Faecal coliforms and *E. coli*, Fecal *Streptococci* and *Clostridium perfringens*	**07** **08**

	d. Detection of coliforms in water	
Unit –II	**Soil Microbiology**	**15 lectures**
	2.1 Terrestrial Environment a. Soil- Definition, formation, composition, types and function b. Types of soil microorganisms and their activities c. Groups of microorganisms and reactions occurring in soil biogeochemical cycles- Carbon, Nitrogen, Sulfur and Phosphorus cycles. Impact of human intervention in Carbon, Nitrogen and Sulfur cycle. **2.2 Methods of studying soil microorganisms** a. Sampling plans - Random, Transect, Two-stage, Grid and 3D sampling b. Instruments for sampling soil microorganisms- soil auger and mechanical drills c. Methods of studying soil microorganism - Overview of i. Cultural methods - Viable count, most probable number and special media for specific microbial populations ii. Microscopic methods - Buried slide technique, Fluorescent microscopy and electron microscopy iii.Physiological methods - substrate disappearance, Terminal electron acceptor utilization, cell mass production and CO_2 evolution, iv. Immunological methods - ELISA, Immunofluorescence and Immunoaffinity chromatography v. Nucleic acid-based methods - PCR, Southern blot hybridization, colony hybridization and Microarray	**08** **07**
Unit-III	**Applied Environmental Microbiology**	**15 Lectures**

	3.1 Applied environmental microbiology a. Sewage treatment i. Primary, Secondary and Tertiary treatment ii. BOD, COD and TOC iii. Oxidation ponds and Septic tanks iv. Disposal of treated effluent and sludge b. Bioremediation i. Requirements for microbial growth in bioremediation process ii. Types of bioremediation processes iii. Bioremediation of hydrocarbons and Xenobiotic compounds (pesticides.) iv. Microbial leaching of ores - copper ore and Uranium c. Biofuels (Biogas, bioethanol) d. Biosensors: Basic design and applications in environmental microbiology **3.2 Microbial diversity in environment** a. Alpha, Beta and Gamma diversity of prokaryotes b. Environmental Metagenomics (Principle, metagenomic approaches (sequence driven and function driven)	**02** **13**

SBSMCB303- INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS

Learning Objectives:

- To understand principles of thermodynamics
- To learn the structure and function of ATP, NAD and FAD
- To understand the principles to solve problems on bioenergetics
- To understand various aspects of metabolism.
- To learn and understand biochemical pathways such as EMP pathway and TCA cycle and Electron transport chain
- To understand basic biostatistics, central tendency, statistical concepts and some tests used in hypothesis testing and to develop problem solving skills.
- To understand enzymes, coenzymes, co-factors, enzyme kinetics associated with reversible and irreversible inhibitors, the mechanisms of multi substrate enzyme reactions, allosteric enzymes and feedback inhibition.
- To learn the methods of enzyme purification

Learning Outcomes:

At the end of the course, learner will be able to

- describe the laws of thermodynamics and relate the same with biological systems
- recall the structure and function of ATP, NAD and FAD
- apply the principles of bioenergetics to solve problems
- compare and contrast between catabolism and anabolism
- explain oxidation-reduction reactions and distinguish between oxidation and reduction reactions
- explain and describe EMP pathway and TCA cycle
- apply the principles of biostatistics to solve problems on standard deviation, student's t test etc
- explain enzyme kinetics, allosteric enzymes, feedback inhibition mechanisms and other enzymology concepts

SBSMCB303	**INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS,**	**2 Credits (45 lectures)**
Unit-I	**Thermodynamics**	**15 lectures**
	a. Scope of thermodynamics, Open and Closed system, universe, concepts of Gibbs free energy, standard free energy, enthalpy, entropy b. First and second law of thermodynamics c. Structure and properties of ATP, ΔG^{1o} for ATP hydrolysis, energy charge and other high energy compounds	**02** **02** **03**

	d. Biological oxidation reduction reactions e. Structure and Function of NAD and FAD f. Problems for calculation of free energy, standard free energy, equilibrium constant, oxidation reduction potential g. Energy yielding mechanisms i. fermentation ii. respiration iii. photosynthesis	**02** **02** **02** **02**
Unit –II	**Metabolism and Biostatistics**	**15 lectures**
	2.1 Introduction to Metabolism a. Metabolism- catabolism, anabolism, link between the two b. Types of biochemical pathways- linear, branched and cyclic c. Oxidation-Reduction reactions and standard reduction potential d. Glycolysis (EMP pathway) with chemical structures e. TCA cycle with chemical structures, amphibolic pathways f. Electron transport chain and oxidative phosphorylation (overview/briefly) g. Anaerobic respiration h. Constitutive and Inducible pathways **2.2 Introduction to Biostatistics** a. Introduction, Statistical terms, Sample and population b. Central Tendency-Mean, Median, Mode c. Standard Deviation d. Variance e. Student's t-test f. ANOVA (briefly)	**10** **05**
Unit –III	**Enzymology**	**15 lectures**
	3.1 Basic concepts a. apoenzyme, holoenzyme, cofactors: Vitamins as Coenzymes, Prosthetic groups, Metallic cofactors with important examples b. Multisubstrate reactions -Ordered, Random, Ping-pong (schematic with example) c. Classification of enzymes d. Michaelis-Menten equation and plot, LB equation and plot e. Effect of enzyme concentration, substrate concentration, pH and temperature on enzyme activity, constitutive and inducible enzymes, exo/endoenzymes, isozymes, ribozymes, enzyme	**01** **02** **01** **04**

	unit, specific activity, Monomeric, Oligomeric and Multimeric enzymes, Zymogens	**02**
	f. Inhibitors of enzymes: Irreversible, Reversible -competitive, Non-competitive, Uncompetitive	**01**
	g. Control of enzyme activity: Allosteric Regulation, Covalent Modification, Feedback Inhibition	**01**
	Allosteric enzymes - Properties and mechanism	**02**
	3.2 Concepts of enzyme purification	**01**

Semester III Practicals SBSMCBP3

Sr. no.	SECTION-1 MICROBIAL DIVERSITY, MICROBIAL TAXONOMY & INSTRUMENTATION
1	**Student activity** – Write a report on Origin of life, early microbial life and microbial evolution
2	Enrichment and isolation of Thermophiles
3	Enrichment and isolation of Halophiles from marine water.
4	**Student activity**- To report an interesting fact / information on any extremophile from any online book / research paper/ review article.
5	Isolating an organism from soil and identifying the same.
6	Principles underlying various biochemical tests used for classification of bacteria (Students to revise Motility- Hanging drop method and Lecithinase activity) a. Catalase b. Nitrate reduction c. Indole test d. Methyl red test e. Voges Proskauer test f. Citrate utilization test g. Starch hydrolysis h. Gelatinase i. Carbohydrate fermentation
7	Separation of amino acids using paper chromatography.
8	Separation of sugars using Thin Layer chromatography.
9	SOPs for centrifuges Use of centrifuges - Students have to learn how to use centrifuge on their own

Sr. no.	SECTION 2 ENVIRONMENTAL MICROBIOLOGY
1	Enumeration of microorganisms in air by gravity sedimentation and impingement in liquids.
2	Microbiological analysis of drinking water.
3	Rapid detection of *E. coli* by MUG technique
4	Enrichment and isolation of Cellulose degrading bacteria and fungi
5	Enrichment and isolation of Sulphate reducers
6	Isolation of phosphate solubilizing bacteria and fungi
7	Enrichment and Isolation of Nitrosifiers and Nitrifiers.
8	Setting of Winogradsky's column and microbial analysis.
9	**Student activity**- Measurement of microbial activity in soil by soil respiration method.
10	Estimation of BOD
11	Estimation of COD
12	Study of protozoa - *Entamoeba histolytica*
13	Visit to the sewage treatment / water purification plant.

Sr. no.	SECTION 3 INTRODUCTION TO MICROBIAL METABOLISM AND BIOSTATISTICS
1	Biostatistics – Introduction, statistical terms, Sample, Population, Data presentation – frequency distribution table, Histogram, bar graph, cumulative frequency graph, scatter plot, line graph, map diagrams. Central tendency – mean, median, mode, Standard deviation and problems on the same, Q test and problems on the same.
2	Estimation of reducing sugars by the DNSA method.
3	a. Enzyme production (Invertase) b. Effect of enzyme concentration on enzyme activity. c. Determination of Km of Invertase (Lineweaver-Burke plot, Michaelis- Menten graph) – Virtual problem i.e. Only calculations and graph plotting, readings will be provided.

REFERENCES: SEMESTER III

SBSMCB301

1. **Maier, R. M., Pepper, I.L., and Gerba, C.P.** (2010) Environmental Microbiology. Academic Press
2. https://www.nasa.gov/sites/default/files/files/Microbial-Observatory-Mini-Book-04-28-14-508.pdf
3. **Willey, J.M., Sherwood, L.M., and Woolverton, C.J.** (2008) Prescott, Harley and Klein's Microbiology, 7th edn. New York, McGraw Hill International Edition
4. **Stanier, Roger., Ingraham, John., Wheelis, Mark., and Painter, Page**. (1987) General Microbiology, 5th edn. Macmillan Press ltd.
5. **Wilson, Keith. and Walker, John.** (2005) Principles and Techniques of Biochemistry and Molecular Biology, 6th edn. Cambridge University Press.
6. **Wilson, Keith., and Walker, John.** (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th edn. Cambridge University Press.
7. **Plummer, David. T. (**2005) An Introduction to Practical Biochemistry, 3rd edn. Tata McGraw-Hill Publishing Company Limited.
8. **Boyer, Rodney**. (2000) Modern Experimental Biochemistry, 3rd edn. Benjamin Cummings
9. **Boyer, Rodney.** (2012) Biochemistry Laboratory Modern theory and techniques, 2nd edn, Pearson.

SBSMCB302

1. **Salle A. H.,** (2007) Fundamental Principles of Bacteriology 7th edn, McGraw-Hill Book Company
2. **Willey J.M., Sherwood L.M., and Woolverton C.J. (**2008) Prescott, Harley and Klein's Microbiology 7th edn, New York, McGraw Hill International Edition
3. **Pelczar Jr M. J., Chan E. C. S. and Krieg N. R. (**2010) Microbiology: Application Based Approach, 1st edn, New Delhi, Tata McGraw Hill

4. **Kołwzan B., Adamiak W., Grabas K. and Pawełczyk A.** (2006) Introduction to Environmental Microbiology, Oficyna Wydawnicza Politechniki Wrocławskiej
5. **Maier R. M., Pepper I. L. and Gerba C. P.,** (2010) Environmental Microbiology 2nd edn, California, Academic Press
6. **Aneja K.R, Jain P. and Aneja R**. (2009) A Textbook of Basic and Applied Microbiology, 1st edn. New Delhi, New Age International Publishers
7. **Tortora G. J., Funke B. R. and Case C. L.** (2006) Microbiology: An Introduction. 8th edn, New Delhi, Pearson Education
8. **Madigan T., Michael J. M., Martinko K. S., Bender D. H, Buckley, and Stahl D.A. (**2006) Brock Biology of Microorganisms 11th edn, Boston, Pearson Prentice Hall
9. **Singh B. D.** (2012) Biotechnology Expanding Horizons 4th edn Ludhiana, Kalyani Publishers
10. **Ogunseitan O.** (2005) Microbial Diversity, 1st edn, Australia, Blackwell Publishing

SBSMCB303

1. **Nelson, D., & Cox, M.,** (2005) Lehninger: Principles of Biochemistry, 4th edn., New York, W.H. Freeman & Co.
2. **Nelson, David L., Cox, Michael M.** (2013) Lehninger Principles of Biochemistry, 6th edn, W. H. Freeman and Company.
3. **Willey, J.M., Sherwood, L.M., Woolverton, C.J.,** (2014) Prescott's Microbiology, 9th edn, New York, McGraw-Hill Education.
4. **Madigan, Michael T., Martinko, John M., Stahl, David A., Clark, David P.** (2012) Brock Biology of Microorganisms, 13th edn, Benjamin Cummings.
5. **Tortora, G.J., Funke, B.R., and Case, C.L.** (2010) Microbiology An Introduction, 10th edn, Benjamin Cummings.
6. **Mahajan, B. K**. Methods in Biostatistics for medical students and research workers, 7th edn, New Delhi, Jaypee brothers Medical Publishers.
7. **Jeffery, GH., Bassett, J., Mendham, J., and Denney, RC.** (1989) Vogel's textbook of Quantitative Chemical Analysis, 5th edn, New edn, Longman Scientific & Technical.
8. **Kothari, RC., Gaurav Garg** (2019) Research Methodology: Methods and Techniques, Multi Colour edn, New Age International Publishers.
9. **Conn P. Stumpf, G. Bruening & R. Doi,** (1995) Outlines of Biochemistry, 5th edn, New York John Wiley & Sons.
10. **Palmer, T.,** (2004) Enzymes: Biochemistry, Biotechnology & Clinical Chemistry, New Delhi, East West Press Ltd.

	SEMESTER IV	
SBSMCB401	**MEDICAL MICROBIOLOGY & IMMUNOLOGY**	**2 Credits (45 Lectures)**
Unit-I	Innate immunity and the immune system	15 lectures.
Unit-II	The epidemiology of infectious disease:	15 lectures.
Unit-III	Diagnostic and clinical microbiology	15 lectures.
SBSMCB402	**APPLIED MICROBIOLOGY**	**2 Credits (45 Lectures)**
Unit-I	Industrial Microbiology	15 lectures.
Unit-II	Food Microbiology	15 lectures.
Unit-III	Dairy Microbiology	15 lectures.
SBSMCB403	**BASICS IN GENETICS AND MOLECULAR BIOLOGY**	**2 Credits (45 Lectures)**
Unit-I	DNA and chromosomes	15 lectures.
Unit-II	Gene expression: Transcription and Translation	15 lectures.
Unit-III	Estimation of Biomolecules and instrumentation techniques	15 lectures.
SBSMCBP4	**PRACTICALS**	**3 Credits**
PRACTICAL – I	SECTION 1 MEDICAL MICROBIOLOGY & IMMUNOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB401)	
PRACTICAL –II	SECTION-2 APPLIED MICROBIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB402)	
PRACTICAL –III	SECTION 3 BASICS IN GENETICS AND MOLECULAR BIOLOGY (Practicals Based On Unit-I, II & III Of SBSMCB403)	

Semester IV

SBSMCB401- MEDICAL MICROBIOLOGY & IMMUNOLOGY

Learning Objectives:

- To understand the anatomical and physiological barriers of the body, the process of phagocytosis and inflammation and the cells and organs of the immune system
- To understand the terms and tools involved in epidemiology of infectious diseases and to make learners aware about the spread of infection by different routes and sources of infection.
- To understand the functioning of a clinical microbiology laboratory and the techniques used in diagnosis of a disease.

Learning Outcomes:

At the end of the course, learner will be able to

- explain defence mechanism of the body and the role / function of different cells of the immune system
- explain the principles of epidemiology and apply this knowledge
- describe the methods for isolation and detection of pathogens from clinical samples and relate this with the medical microbiology practicals in semester 4 and 5 of SYBSc and TYBSc

SBSMCB401	**MEDICAL MICROBIOLOGY & IMMUNOLOGY**	**2 Credits (45 lectures)**
Unit-I	**Innate immunity and the immune system**	**15 Lectures**
	INNATE HOST RESISTANCE **1.1 Overview of the Immune system** a. Passive and active immunity b. Innate and adaptive immunity **1.2. Host defense mechanism** a. First line of defense- i. Anatomic - Skin, Mucous membranes ii. Physiologic- pH, chemical factors- lactic acid, lysozyme, basic proteins b. Second line of defense i. Fever ii. Phagocytosis- Cells involved, Opsonin dependent and opsonin independent mechanisms, Self and non self recognition by phagocytes iii. Inflammation- Mechanism involved, Chemical mediators of inflammation, Signs and functions of inflammatory response	**02** **02** **05**

	iv. Chemical mediators- Complement and Cytokines v. Acute phase proteins vi. Toll- like receptors **1.3. Cells and Organs of the immune system** a. Cells of the immune system i. Lymphocytes- T cells, B cells, NK cells ii. Mononuclear phagocytes iii. Granulocytic cells -neutrophils, eosinophils, basophils iv. Mast cells, dendritic cells b. Organs of the immune system i. primary lymphoid organs-thymus and bone marrow ii. Secondary lymphoid organs- lymph nodes, spleen, Mucus associated lymphoid tissue	**06**
Unit II	**The epidemiology of infectious disease**	**15 Lectures**
	2.1 Epidemiological Terminology: Epidemiology, sporadic disease, endemic disease, hyper endemic disease, epidemic disease, index case, pandemic disease, outbreak **2.2** Epidemiologists tools of measuring disease frequency a. Morbidity rate b. Mortality rate c. Prevalence rate **2.3** Course of an infectious disease **2.4** Surveillance of an infectious disease; list methods. **2.5** Mapping infectious diseases: Remote sensing and Geographic information system **2.6** Types of epidemics in a population: Common source and propagated epidemics. **2.7** The spread of infection: a. Reservoirs of infection i. Human reservoirs ii. Animal reservoirs iii. Non-living reservoirs b. Transmission of disease: i. Contact transmission,	**01** **01** **01** **02** **02**

	ii. Vehicle transmission, iii. Vectors	**02**
	2.8 Nosocomial Infections	**01**
	2.9 Control of epidemics: a. Immunization, b. Role of public health system	
	2.10 Emerging and Re-emerging Infectious Diseases: a. Factors favoring its development b. Examples: Dengue and Chikungunya, Covid 19	**02**
	2.11 Biosafety - Biosafety levels of pathogens with examples and care needed to handle them, Biosafety cabinets	**03**
Unit-III	**Diagnostic and clinical microbiology**	**15 lectures**
	3.1 Overview of the Clinical Microbiology Laboratory.	**01**
	3.2 Isolation of Pathogens from clinical specimens. a. Growth media and Culture b. Collection of specimens, handling and transport c. Types of specimens and their culture: Blood, urine, feces, sputum, cerebrospinal fluid, pus, genital and culture of anaerobes.	**04**
	3.3 Identification of microorganisms from specimens: a. Microscopy b. Growth-Dependent Identification Methods	**02**
	3.4 Rapid Methods of Identification: a. Mechanized/ automated systems b. Manual biochemical systems c. Immunological systems	**02**
	3.5 Bacteriophage Typing	**01**
	3.6 Molecular Methods and Analysis of Metabolic Products: a. Nucleic Acid –Based Detection Methods b. Gas liquid Chromatography c. Plasmid Fingerprinting	**05**

SBSMCB402- APPLIED MICROBIOLOGY

Learning Objectives:

- To introduce fundamental concepts in industrial microbiology.
- To understand the biotechnological importance of microorganisms for production of food and dairy products.
- To know about the microbial spoilage of food and dairy products.
- To know the methods used for microbial analysis of food and dairy products.
- To learn about methods of prevention of microbial spoilage of food and milk.

Learning Outcomes:

At the end of the course, learners will be able to

- recall the role of microorganisms in the fields of industrial, food and dairy microbiology
- understand the process of isolation and selection of a few industrially important producer microorganisms
- explain the importance of microorganisms in the production of dairy products
- describe the methods to prevent spoilage of food
- select appropriate method for microbiological analysis of milk, milk products and foods

SBSMCB402	APPLIED MICROBIOLOGY	2 Credits (45 lectures)
Unit I	**Industrial Microbiology**	**15 lectures**
	1.1 Strains of industrially important microorganisms a. Desirable characteristics of industrial strain b. Principles and methods of primary and secondary screening c. Industrially important microbial products along with the associated microorganisms d. Overview of an industrial process (upstream and downstream processing)	**05**
	1.2 Types of fermentations and fermenters used, advantages and disadvantages a. Aerobic - bacteria - stirred tank fermenter, - yeast (SCP) and fungi (airlift fermenter) b. Anaerobic (devices used for methanol and biogas fermentation) c. Solid state fermentations (tray, packed bed and rotary drum fermenter) d. Surface fermentations (flat bottles, tray fermenters)	**02**
	1.3 Types of fermentation processes a. Batch	**04**

	b. Continuous c. Fed-batch fermentation process **1.4 Media for industrial fermentations** a. Production and Inoculum media b. Media components: - Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers	**04**
Unit-II	**Food Microbiology**	**15 lectures**
	2.1 Microbial growth in foods a. Intrinsic and extrinsic factors influencing growth of microorganisms in food **2.2 General Principles of spoilage** Spoilage of foods a. Fruits and vegetables b. Eggs c. Meat and poultry d. Canned food **2.3 General principles of food preservation** (principle of each method and process used with example of foods) a. High temperature b. Low temperature c. Drying d. Radiations e. Food additives and preservatives (salt, sugar and organic acids only) **2.4 Food Safety** a. Introduction to principles of HACCP b. Food borne diseases and intoxications (differences) **2.5 Methods of detection of microorganisms in food**: a. Sampling of food and homogenisation methods b. Overview of - i. Cultural methods -SPC, Spiral Plate Counter and MPN ii. Microscopic methods- DMC, Direct Epifluorescent Filter Technique and microscopic colony counts iii. Physical methods (Principle and examples) Impedance, Microcalorimetry and Flow cytometry iv. Chemical methods (Principle and examples)-Limulus amoebocyte lysate (LAL) test, ATP measurement, Detection of	**02** **04** **04** **02** **03**

	Thermostable nuclease, Use of Fluoro and Chromogenic substrates and Radiometry v. Bioassay methods- Use of whole animals, animal models requiring surgical procedures and cell culture systems	
Unit-III	**Dairy Microbiology**	**15 lectures**
	3.1 Milk- Definition, Composition of milk and Sources of contamination of milk, human pathogens associated with milk, effects of microbial contamination on milk quality and Control of microorganisms in milk.	**02**
	3.2 Pasteurization of milk-LTLT, HTST and UHT	**02**
	3.3 Milk products - production and spoilage of a. Butter b. Cheese- types of cheese, Cheddar and Cottage cheese	**06**
	3.4 Quality control of milk a. Rapid platform test and organoleptic tests b. Microbiological analysis of milk.:- SPC, Coliform count, LPC, Psychrophiles, Thermophilic count and DRT	**05**

SBSMCB403- BASICS IN GENETICS AND MOLECULAR BIOLOGY

Learning Objectives:

- To learn the basic structure and features of DNA
- To understand prokaryotic and eukaryotic chromosomes and to learn DNA supercoiling and role of topoisomerases in the same
- To learn the features of genetic code
- To learn and understand the molecular details of transcription and translation in prokaryotes and eukaryotes
- To learn and understand the principle of working of various methods of estimation of macromolecules present in a cell.
- To understand the principles of frequently used techniques in Genetics and Molecular Biology such as Gel electrophoresis and Density Gradient centrifugation.

Learning Outcomes:

At the end of the course, learners will be able to

- describe the structure and features of DNA and differentiate between different models of DNA
- analyze the differences between prokaryotic and eukaryotic chromosomes
- describe the molecular details of transcription in prokaryotes and eukaryotes and also distinguish between prokaryotic and eukaryotic transcription.
- recollect translation and genetic code
- explain the principles of various chemical estimation techniques and relate them with the practical application
- explain and describe various techniques such as gel electrophoresis and centrifugation

SBSMCB403	**BASICS IN GENETICS AND MOLECULAR BIOLOGY**	**2 Credits (45 lectures)**
Unit I	**DNA and chromosomes**	**15 lectures**
	1.1- The Search for the genetic material a. Griffith's transformation experiment b. Avery's transformation Experiment c. Hershey and Chase's Bacteriophage experiment d. RNA as viral genetic material (briefly)	**02**
	1.2 The composition and structure of DNA a. Nucleotide and nucleoside, purines and pyrimidines, phosphodiester bonds b. Base composition studies done by Erwin Chargaff c. X ray diffraction studies done by Rosalind Franklin d. Watson and Crick's model e. Different DNA structures- A, B and Z DNA	**04**

	1.3- Absorption of UV light, Sedimentation behavior and Denaturation-Renaturation	**01**
	1.4 Gene and its function	
	1.5 Chromosomes a. Prokaryotic chromosomes b. Supercoiling- negative and positive supercoiling and role of topoisomerases I and II in detail, linking number (briefly) c. Eukaryotic chromosomes- structure of chromatin, histones and non-histones, nucleosome and nucleosome packaging, Euchromatin and heterochromatin, centromere, telomere and its sequences	**05**
	1.6 Genetic code a. Characteristics of the genetic code b. Exceptions to the Genetic code	**02**
	1.7 Non chromosomal elements a. Plasmids b. Transposable elements (only definition, not in detail)	**01**
Unit II	**Gene expression: Transcription and Translation**	**15 lectures**
	2.1 Central dogma - Overview	**01**
	2.2 Transcription- a. Introduction b. Transcription in bacteria - Initiation - promoter, consensus sequence (-10 and -35), structure and function of RNA polymerase enzyme (holoenzyme and core enzyme, sigma factors), Elongation, Termination - Rho-dependent and Rho-independent termination mechanisms c. Transcription in Eukaryotes - Eukaryotic RNA polymerases, Promoters, Transcription factors, structure and production of eukaryotic mRNA, comparison with prokaryotic mRNAs, production of mature mRNA in eukaryotes, processing, 5' modification, 3' modification, introns, exons, splicing (briefly)	**10**
	2.3 Translation a. Introduction b. tRNA- structure	**04**

	c. Ribosomes - structure, composition d. Initiation, Elongation and termination of translation	
Unit III	**Estimation of biomolecules and instrumentation techniques**	**15 lectures**
	3.1 Estimation of biomolecules (Students to revise macromolecular composition of a microbial cell) a. Estimation of Carbohydrates (Principle, advantages, disadvantages) i. Phenol method ii. DNSA method b. Estimation of Proteins (Principle, advantages, disadvantages) i. Biuret method a. Direct b. Robinson Hodgen ii. Folin-Lowry's method c. Estimation of Amino acids by Ninhydrin method d. Estimation of Nucleic acids i. DNA by DPA method ii. RNA by Orcinol method e. Extraction of lipids by Soxhlet method **3.2 Techniques used in Genetics and Molecular Biology** **a. Electrophoresis** i. General Principles- Vertical and horizontal apparatus ii. Factors affecting electrophoresis iii. Electrophoresis of proteins- SDS-PAGE iv Isoelectric focussing gel electrophoresis of proteins iv Electrophoresis of nucleic acids- Agarose gel electrophoresis (AGE) **b. Density Gradient centrifugation-** Zonal and Isopycnic centrifugation	**08** **07**

Semester IV Practicals SBSMCBP4

Sr. no.	Section-1 MEDICAL MICROBIOLOGY & IMMUNOLOGY
1	Write a report on Biosafety and Biosafety cabinets
2	Use of Selective and Differential Solid Media: a. MacConkey's agar b. Salmonella Shigella agar c. XLD agar d. TCBS agar e. Salt Mannitol agar f. CLED agar
3	Use of Biochemical Media/Tests for Identification of Pathogens: a. Indole test - Student activity / Inquiry-based learning b. Methyl Red test - Student activity / Inquiry-based learning c. Voges Proskauer test - Student activity / Inquiry-based learning d. Citrate utilization test - Student activity / Inquiry-based learning e. Lysine Decarboxylase f. Phenylalanine deaminase test g. Urease test h. TSI agar i. Oxidase test j. H_2S production

Sr. no.	SECTION-2 APPLIED MICROBIOLOGY
1	Isolation of antibiotic producers from soil - Crowded plate technique and Wilkin's overlay method
2	Isolation of microorganisms causing food spoilage a. amylolytic b. lipolytic c. proteolytic and d. pectinolytic
3	Determination of MIC of salt (for bacteria)
4	Determination of MIC of sugar (for bacteria / yeast)
5	**Student activity**- Food cupboard – Make a tabulation of food items at home with the method of preservation and principle of the method of preservation.
6	Rapid platform tests of raw and pasteurized milk a. MBRT b. RRT c. DMC
7	Microbiological analysis of raw and pasteurized milk.
8	Microbiological analysis of Butter or Cheese.
9	Visit to the Food/Dairy industry.

Sr. no.	SECTION-3 BASICS IN GENETICS AND MOLECULAR BIOLOGY
1	Use of micropipettes and eppendorf microcentrifuge tubes
2	Use of UV-visible spectrophotometer
3	Isolation of DNA from onion, its confirmation by UV-visible spectrophotometry
4	**Student activity -** Write a report on methods of elemental analysis - Estimation of carbon, nitrogen and phosphorus. Also watch YouTube videos on the same
5	Estimation of soluble proteins by direct Biuret method.
6	Estimation of DNA by DPA method.
7	Estimation of RNA by Orcinol method.
8	Extraction of lipids by Soxhlet method
9	Agarose gel electrophoresis
10	Density gradient centrifugation

REFERENCES: SEMESTER IV

SBSMCB401

1. **Willey, J.M., Sherwood, L.M., and Woolverton, C.J.** (2008). Prescott, Harley and Klein's Microbiology, 7th edn. New York, McGraw Hill International Edition.
2. **Mouffak, S., Shubbar, Q., Saleh, E., & El-Awady, R.** (2021). Recent advances in management of COVID-19: A review. *Biomedicine & Pharmacotherapy*, *143*, 112107. https://doi.org/10.1016/j.biopha.2021.112107.
3. **Parasher, A.** (2020). COVID-19: Current understanding of its Pathophysiology, Clinical presentation and Treatment. *Postgraduate Medical Journal*, *97*(1147), 312-320. https://doi.org/10.1136/postgradmedj-2020-138577.
4. www.d.umn.edu - Microbiology Lab practices and Safety Rules Randall E. Hicks.
5. https://www.cdc.gov/training/quicklearns/biosafety/ -
6. Laboratory biosafety manual, 3rd edn., World Health Organization, 2004.
7. Laboratory biosafety manual, 4th edn., World Health Organization, 2020
8. **Kuby.** Immunology, 6th edn. W. H Freeman and Company
9. **Talaro, Kathleen. P.** Foundations in Microbiology, 7th edn, McGraw Hill
10. **Tortora, G.J., Funke, B.R., and Case, C.L.** (2010) Microbiology An Introduction, 10th edn, Benjamin Cummings.
11. **Madigan, M., Martinko, J. Bender, K., Buckley, D., and Stahl, D. (**2015) Brock Biology of Microorganisms 14th edn. Pearson.

SBSMCB402

1. **Casida L. E. (**2016) Industrial Microbiology, Reprint, New Delhi, New Age International (P) Ltd. Publishers
2. **Stanbury P. F., Whitaker A. and Hall S. J. (**1997) Principles of Fermentation Technology 2nd edn, New Delhi, Aditya Books Pvt. Ltd.
3. **Prescott and Dunn. (**1982) Industrial Microbiology, 4th edn, London, Macmillan Publishers

4. **Modi H. A. (**2009) Fermentation Technology Vol 2, Jaipur, Pointer Publications
5. **Patel A. H.** (2007) Industrial Microbiology 1st edn, New Delhi, Macmillan Publishers
6. **Jay James M.** (1996) Modern Food Microbiology 5th edn, New York, Springer Publishing
7. **Frazier W.C. and Westhoff D.C.,** (2013) Food Microbiology, 5th edn, McGraw Higher Ed
8. **Willey J.M., Sherwood L.M., and Woolverton C.J.** (2008) Prescott, Harley and Klein's Microbiology 7th edn, New York, McGraw Hill International Edition
9. **De S. (**2001) Outlines Of Dairy Technology,1st edn, New Delhi, Oxford University Press
10. **Madigan T., Michael J. M., Martinko K. S., Bender D. H, Buckley and Stahl D.A.** (2006) Brock Biology of Microorganisms 11th edn. Boston, Pearson Prentice Hall
11. **Singh B. D.** (2012) Biotechnology Expanding Horizons 4th edn, Ludhiana, Kalyani Publishers

SBSMCB403

1. **Russell, Peter J.** (2010) iGenetics: A Molecular Approach, 3rd edn, Benjamin Cummings.
2. **Willey, J.M., Sherwood, L.M., Woolverton, C.J.,** (2014) Prescott's Microbiology, 9th edn., New York, McGraw-Hill Education.
3. **Madigan, Michael T., Martinko, John M., Stahl, David A., Clark, David P.** (2012) Brock Biology of Microorganisms, 13th edn, Benjamin Cummings
4. **Snustad, Peter D., Simmons, Michael J.** (2012) Principles of Genetics, 6th edn, John Wiley & Sons, Inc.
5. **Brooker, Robert J.** (2012) Genetics: Analysis & Principles, 4th edn, McGraw-Hill
6. **Wilson, Keith., and Walker, John.** (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th edn. Cambridge University Press.
7. **Boyer, Rodney**. (2000) Modern Experimental Biochemistry, 3rd edn. Benjamin Cummings
8. **Boyer, Rodney.** (2012) Biochemistry Laboratory Modern theory and techniques, 2nd edn, Pearson