SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

(Autonomous) Sion (West), Mumbai – 400022

Faculty: Science

Program: B.Sc.

Subject: MICROBIOLOGY

Academic Year: 2023– 2024
AS PER NATIONAL EDUCATION POLICY 2020
Choice Based Credit System (CBCS)

F.Y.B.Sc.

Revised Credit Based Semester and Grading Syllabus approved by Board of Studies in Microbiology brought into effect from June 2023

	MANDATORY PAPER	
	SEMESTER I	
Course code	**Title**	**Credits**
Course code	**FUNDAMENTALS OF MICROBIOLOGY I**	**3 Credits (45 lectures)**
Unit-I	Microscopy and Staining	15 lectures
Unit-II	Prokaryotic Cell Structure and function	15 lectures
Unit-III	Biomolecules	15 lectures
Course Code	**PRACTICALS**	**1 Credit**

SKILL ENHANCEMENT COURSE		
Course code	**BASICS OF MICROBIOLOGY**	**2 Credits (30 lectures)**
Unit-I	Nutrition and Cultivation & Control of Microorganisms	15 lectures
Unit-II	Study of Different Groups of Microbes & Microbes and human health	15 lectures

VOCATIONAL SKILL COURSE		
Course code	**APPLIED MICROBIOLOGY**	**2 Credits**
	PRACTICALS BASED ON Nutrition and Cultivation Control of Microorganisms Study of Different Groups of Microbes Microbes and Human Health	

	SEMESTER II	
	MANDATORY PAPER	
Course code	**Title**	**Credits**
Course code	**FUNDAMENTALS OF MICROBIOLOGY II**	**3 Credits (45 lectures)**
Unit-I	Microbial Interactions	15 lectures
Unit-II	Genetics and Biotechnology	15 lectures
Unit-III	Microbial Growth	15 lectures
Course code	**PRACTICALS**	**1 Credit**

Course code	Title	Credits
Semester I		
	FUNDAMENTALS OF MICROBIOLOGY I (MANDATORY)	3
	FUNDAMENTALS OF MICROBIOLOGY I (MANDATORY) PRACTICAL	1
	BASICS OF MICROBIOLOGY (SEC)	2
	APPLIED MICROBIOLOGY (VSC)	2
		Total = 08
Semester II		
	FUNDAMENTALS OF MICROBIOLOGY II (MANDATORY)	3
	FUNDAMENTALS OF MICROBIOLOGY II (MANDATORY) PRACTICAL	1
	BASICS OF MICROBIOLOGY (SEC)	2
	APPLIED MICROBIOLOGY (VSC)	2
		Total = 08

PROGRAM OUTCOME (PO)

At the end of an Undergraduate Program, a student would have obtained the following:

- **PO1. Solving Complex Problem:**
  Applying the knowledge of various course learned under a program with an ability to break down complex problems into simple components, by designing processes required for problem solving.
- **PO2. Critical Thinking:**
  Organizing thoughts to identify assumptions, verifying the accuracy and validity of assumptions, making informed decisions that guide actions (at Institutional, Personal and Intellectual level), developing the ability to think with different perspectives and ideas.
- **PO3. Reasoning ability and rational thinking:**
  Developing rational thinking on the basis of acquired contextual knowledge, assessing societal, public health and safety, cultural, legal, gender, ethnic and environmental issues, and performing with decisive responsibility.
- **PO4. Research skill:**
  Utilizing the contextual knowledge in an inter-disciplinary framework. Integrating research-based knowledge and research methods involving problem definition, analysis and interpretation of data, synthesis of the information to provide valid conclusions. Exercising analytical skill, research ability, creativity, for employability and collaborating with industries.
- **PO5. Effective Communication skill:**
  Facilitating to speak, read, write and listen effectively through both formal language and in one's own mother tongue, in order to make meaning of the world around. Enabling to comprehend and write effective reports and documentation, make successful presentations, give and receive clear instructions.
- **PO6. Proficiency with ICT**:
  Equipping to create, select, apply appropriate tools and techniques, resources through electronic media for the purpose of gathering, analyzing data and drawing inference with an understanding of its merits and demerits.
- **PO7. Social Interactive Skills and team work:**
  Eliciting networking with people, mediate disagreement and help reach conclusions in group settings. Functioning effectively as an individual, and as a member in diverse groups, and in multidisciplinary settings exhibiting adaptability, leadership quality and team-building.

- **PO8. Ethical values:**
  Recognizing and respecting different value systems including one's own, to understand the moral dimensions of one's decisions, intention to help the society and feeling good about it, commitment to professional duties and responsibilities.
- **PO9. Self-directed Learning:**
  Acquiring the ability to explore and gain knowledge in independent ways, keep evolving lifelong in the broad context of socio-technological changes.
- **PO10. Sensitization towards Environment and Sustainability:**
  Understanding the need for sustainable development and concern for environmental issues, realizing the importance of co-habitation, co-evolution in our achievements of sustainable development goal
- **PO11. Gender Sensitization:**
  Demonstrating knowledge and understanding of gender equity-issues and gender justice.
- **PO12. Civic Values and Global Citizenship:**
  Expressing empathetic social concern while helping others when their rights are violated, no matter where in the world they live, to act with an informed awareness on issues, to participate in civic life by volunteering for social justice.

PROGRAMME SPECIFIC OUTCOMES (PSO) (FOR MICROBIOLOGY)

- **PSO1**- Students will be introduced to the subject of Microbiology which is not taught at the junior college
- **PSO2:** Eloquence in specific phraseology pertaining to the subject of microbiology.
- **PSO3:** Familiarize with the theories and techniques of the various areas in microbiology.
- **PSO4:** Obtain expertise in essential practical techniques required in microbiological analysis and prepare for advance studies.
- **PSO5:** Discuss the applications of microorganisms in the various fields of microbiology.

COURSE OUTCOMES
SEMESTER I: MANDATORY PAPER

COURSE: FUNDAMENTALS OF MICROBIOLOGY I

Course code:

COURSE OUTCOMES:

1. Describe the prokaryotic cell structure.
2. Describe the types of microscopes and principles of staining techniques.
3. Describe and differentiate biomolecules that make up the microbial cell.

COURSE: BASICS OF MICROBIOLOGY (SEC)

Course code:

COURSE OUTCOMES:

1. Learn different methods of sterilization for the control of microorganisms.
2. Differentiate between various nutritional types of bacteria and deduce methods for their cultivation.
3. Characteristics of diverse groups such as Viruses, Archaebacteria and Actinomycetes with respect to medical & ecological importance.
4. The role of the host defense mechanism in response to the microbial virulence factors.

COURSE: PRACTICALS BASED ON APPLIED MICROBIOLOGY (VSC)

Course code:

COURSE OUTCOMES:

1. Prepare culture media for the cultivation of microorganisms.
2. Perform aseptic techniques.
3. Isolate and differentiate microorganisms based on colony characteristics.
4. Differentiate between Yeast & Molds.
5. Identify Actinomycetes based on morphological characteristics.
6. Identify and differentiate pathogenic bacteria based on their virulence factors.

F.Y.B.Sc. MICROBIOLOGY SYLLABUS

SEMESTER I

Course code	MANDATORY PAPER	3 CREDITS
	FUNDAMENTALS OF MICROBIOLOGY I	**45 LECTURES 3 CREDITS**
UNIT	**TOPIC**	**LECTURES**
Unit I	**Microscopy & Staining Techniques** • **Microscopy (9L)** ▪ Optical spectrum, Lenses and mirrors ▪ Simple and compound light microscope ▪ Electron microscopy-TEM, SEM ▪ Fluorescence Microscopy ▪ Atomic force Microscopy (brief) • **Staining and Contrast enhancement techniques (6L)** ▪ Dyes and stains: Types, Physicochemical basis, Fixatives ▪ Mordants, Decolorizers ▪ Simple and differential staining ▪ Special staining (Cell wall, Capsule, Lipid granules, Spores, Metachromatic granules and Flagella)	**15L**
Unit II	**Prokaryotic Cell structure and Function** ▪ Cell wall: Gram positive & Gram negative & differences ▪ Cell membrane, significance of porins in Gram positive &Gram negative bacteria. ▪ Components external to cell wall- Capsule, Slime layer ▪ Flagella, Pili, Fimbriae ▪ Cytoplasmic matrix- Cytoskeleton, Inclusion bodies, magnetosomes, ribosomes, gas vesicles Bacterial endospores and their formation	**15L**

Unit III	**Biomolecules** • **Water- Structure, properties in brief (2L)** • **Chemical foundation**: **(3L)** ▪ Biomolecules as compounds of carbon with a variety of functional groups ▪ Macromolecules as the major constituents of cells ▪ Configuration and Conformation with definitions and suitable examples only ▪ Types of Stereoisomers and importance of stereoisomerism in biology ▪ Types of bonds and their importance: Electrovalence, covalent, ester, phosphodiester, thioester, peptide, glycosidic • **Carbohydrates: (3L)** ▪ Definition, Classification, Biological role ▪ Monosaccharides, oligosaccharides (maltose,cellobiose, sucrose, lactose) and polysaccharide (starch, glycogen, peptidoglycan, cellulose) • **Lipids: (3L)** ▪ Fatty acids as basic component of lipids and their classification, nomenclature, storage lipids and structural lipids ▪ Types of lipids with general structure of each and mention examples • **Amino acids, proteins and enzymes: (4L)** ▪ General structure and features of amino acids(emphasis on amphoteric nature) Classification by R- group *(no structures)* ▪ Uncommon amino acids and their functions ▪ Peptides and proteins- Definition and general features and examples with biological role ▪ Primary, secondary, tertiary, quaternary structures of proteins- Brief outline	**15L**

SEMESTER I

	PRACTICALS	1 Credits
	MANDATORY PAPER	**1 Credit**
	FUNDAMENTALS OF MICROBIOLOGY I	
Unit I	**Practicals Based On** • **Microscopy & Staining Techniques** ▪ Parts of a microscope ▪ Micrometry ▪ Florescence microscopy demonstration (Video tutorial/Lab visit) ▪ Monochrome staining ▪ Gram Staining ▪ Negative Staining	
Unit II	• **Special staining** ▪ Cell wall ▪ Capsule ▪ Endospore ▪ Flagella ▪ Lipid ▪ Metachromatic Granules	
Unit III	• **Qualitative Tests for Biomolecules** ▪ Qualitative Tests for carbohydrates: Molisch & Benedicts test ▪ Qualitative Tests for protein: Biuret test ▪ Qualitative Tests for amino acid: Ninhydrin test	

COURSE CODE	SKILL ENHANCEMENT COURSE	2 CREDITS
COURSE CODE	BASICS OF MICROBIOLOGY	30 LECTURES
UNIT	TOPIC	LECTURES
UNIT I	**Nutrition, Cultivation and Preservation** • **Nutrition and Cultivation (3L)** ▪ Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors ▪ Nutritional types of microorganisms ▪ Ingredients and Types of Culture media (selective and differential) with examples • **Isolation and Preservation of Cultures (3L)** ▪ Isolation of microorganisms and pure culture techniques ▪ Study of cultural characteristics ▪ Preservation of microorganisms ▪ Culture Collection Centers • **Control of Microorganisms (1L)** ▪ Definitions of frequently used terms ▪ Rate of microbial death ▪ Factors affecting the effectiveness of antimicrobial agents ▪ Properties of an ideal disinfectant • **Physical methods of microbial control (2L)** ▪ Dry and moist heat – mechanisms, instruments used and their operations ▪ Electromagnetic radiations – Ionizing & Nonionizing radiations, mechanisms – advantages and disadvantages ▪ Bacteria proof filters ▪ Osmotic pressure • **Chemical methods of microbial control (5L)** ▪ Mechanism advantages and disadvantages (if any) applications ▪ Phenolics ▪ Alcohols ▪ Heavy metals and their compounds ▪ Halogens ▪ Dyes ▪ Surfactants	15L

	▪ Aldehydes ▪ Peroxygens ▪ Sterilizing gases ▪ Chemotherapeutic agents - types of agents [only give tabular form Prescott & target site diagram from Talaro] • **Evaluation of disinfectant (1L)**–Tube dilution and Agar plate techniques and Phenol coefficient	
UNIT II	**Study of Different Groups of Microbes:** • **Viruses**: **(3L)** ▪ Historical highlights, General properties of viruses ▪ Classification for viruses using different criteria ▪ Structure of viruses- capsids, envelopes, genomes, examples (T4, Coronavirus, Herpesvirus) ▪ Cultivation of viruses- overview ▪ Bacteriophages: Lytic cycle, Lysogeny ▪ Prions, Viroids • **Rickettsia, Chlamydia, Mycoplasma (2L)** General features and medical significance • **Archaebacteria (2L)** Characteristics of major Archaeal groups • **Actinomycetes (1L)** General features of *Nocardia sp.* and *Streptomyces sp.* Importance: ecological, commercial and medical • **Yeasts and Molds (2L)** Characteristics: structure, Reproduction. Cultivation of Yeasts and Molds. Major fungal divisions- overview. Life cycle of yeast, Biological and economic importance • **Slime molds and Myxomycetes (1L)** • **Microbes and human health** **Important terminology (2L):** Primary infection, secondary infection, Nosocomial, Acute, Chronic infections, Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonosis, genetic disorder, vector borne infection • **Factors affecting infection: (2L)** ▪ Microbial-Virulence factors: Exo & Endotoxins (characteristics, examples & differences), Coagulase,	**15L**

	Hemolysin, Lecithinase & Hyaluronidase ▪ Host factors: natural resistance, species resistance, &racial resistance ▪ Individual factors: Age, nutrition, personal hygiene, stress, hormones & addiction to drugs/ alcohol	

COURSE CODE	VOCATIONAL SKILL COURSE	2 CREDITS
COURSE CODE	APPLIED MICROBIOLOGY	30 LECTURES
UNIT	TOPIC	LECTURES
UNIT I	**Practical Based On Nutrition & Cultivation, Isolation and Preservation of microbial cultures** • Preparation of Culture Media: • Liquid medium (Nutrient Broth) • Solid Media (Nutrient agar, Sabouraud's agar) • Preparation of slant, butts and plates • Inoculation techniques and Study of Growth a. Inoculation of Liquid Medium b. Inoculation of Solid Media (Slants, Butts and Plates) • Study of Colony Characteristics of pigmented and non-pigmented bacteria • Study of Motility (Hanging Drop Preparation) • Use of Differential and Selective Media: (MacConkey, Salt Mannitol Agar & Blood agar **Practical Based On Control of Microorganisms** Introduction to Laboratory equipments, disinfection, decontamination and discarding techniques in laboratory • Methods of preparation of glassware for sterilization • Control of microorganisms using moist heat and to determine the efficiency of autoclaving (Using sporestrips) • Control of microorganisms using dry heat (e.g. Sterilization of Paraffin oil) ▪ Effect of UV Light, Desiccation, surfactants, Osmotic pressure, heavy metals (Oligodynamic action) ▪ Effect of dyes, phenolic compounds and chemotherapeutic agents (disc diffusion method)	
UNIT II	**Practical Based On Study of Different Groups of Microbes** • Slide Culture technique (Actinomycete culture) • Isolation of yeast, cultivation of other fungi • Static and Shaker Conditions • Fungal wet mount and Study of Morphological	15L

	Characteristics: *Mucor sp., Rhizopus sp., Aspergillus sp., Penicillium sp.*	
	Practical Based On Microbes and human health • Cough plate technique on SIBA (Demo) • Study of virulence factors – Coagulase, Hemolysin & Lecithinase	

SEMESTER II
SEMESTER II: MANDATORY PAPER
COURSE: FUNDAMENTALS OF MICROBIOLOGY II

Course code:

COURSE OUTCOMES:

1. Classify the different types of microbial interactions.
2. Memorize and differentiate between the structures of nucleic acid.
3. Define the applications of Biotechnology.
4. Describe microbial growth and perform various enumeration techniques.

COURSE CODE	**MANDATORY PAPER**	**3 CREDITS**
COURSE CODE	**FUNDAMENTALS OF MICROBIOLOGY II**	**45 LECTURES 3 CREDITS**
UNIT	**TOPIC**	**LECTURES**
Unit I	**Microbial interactions (15L)** • **Types of Microbial Interactions (5L)** Mutualism, Cooperation, Commensalism, Predation Parasitism, Amensalism, Competition also include N_2 fixation and Mycorrhizae, Phyllosphere & Rhizosphere • **Human Microbe Interactions (7L)** ▪ Normal flora of the human body: Skin, Nose and Nasopharynx, Oropharynx, Respiratory tract, Eye, External ear, Mouth, Stomach, Small intestine, Large intestine, Genitourinary tract ▪ Gnotobiotic animals • **Introduction to Biofilms (3L)**	**15L**
Unit II	**Genetics and Biotechnology** • **Genetics (9L)** ▪ DNA as genetic material; Forms of DNA ▪ RNA as genetic material, Types of RNA ▪ Griffith, Avery and McCleod, Hershey and Chase experiment ▪ Watson and Crick Model • **Nucleic acids**: **(3L)** ▪ Nitrogenous bases – Purines & Pyrimidines, Pentoses –Ribose & Deoxyribose	**15L**

	▪ Nomenclature of Nucleosides and nucleotides, polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds) ▪ Basic structure of RNA and DNA • **Biotechnology (3L)** ▪ Introduction Biotechnology as an interdisciplinary science ▪ Energy and Biotechnology –Biofuels, Microbial fuel cells (MFC) ▪ Biotechnology and Health care –Diagnosis and treatment ▪ Biosafety – introduction	
Unit III	**Microbial growth** • **Definition of growth, Mathematical Expression, Comparison of Generation time (Table), Growth curve, Phases of growth curve, VBNC** (**3L**) • **Measurement of growth** (**6L**) ▪ Direct microscopic count – Breed's count, Petroff – Hausser counting chamber- Haemocytometer, Coulter counter ▪ Viable count – Spread plate and Pour plate technique ▪ Measurements of cell constituents ▪ Turbidity measurements – Nephelometer and spectrophotometer techniques • **Types of growth** (**4L**) ▪ Synchronous growth, Continuous growth (Chemostat and Turbidostat) ▪ **Diauxic growth**- concept and example (**1L**) • **Physical conditions required for growth** (**1L**)- ▪ Oxygen, Anaerobic cultivation, pH, temperature and Osmotic Pressure	**15L**

SEMESTER II

	PRACTICALS	1 Credits
COURSE CODE	**MANDATORY PAPER**	**1 Credit**
COURSE CODE	**FUNDAMENTALS OF MICROBIOLOGY II**	
Unit I	• Normal flora of skin and saliva • Wet Mount of Lichen • Isolation of Rhizobium • Isolation of Azotobacter	
Unit II	• Nucleic acid detection by DPA and Orcinol	
Unit III	• Growth curve (group experiment) (Use logarithmic values for plotting the graph) • Direct enumeration methods ▪ Breed's Count ▪ Haemocytometer • Indirect enumeration methods ▪ Viable count: Spread plate and pour plate ▪ Brown's opacity tubes • Effect of pH and temperature on microbial growth	

Evaluation Pattern: 33% - 50% continuous internal evaluation and remaining at the end of each semester.

REFERENCES

1. Advances in Biotechnology S. N. Jogdand, 6th edition revised, Himalaya Publishing House, 2007.
2. Brock Biology of Microorganisms, Michael T. Madigan and J. M. Martin,11th edition, International edition, Pearson Prentice Hall, 2006.
3. Foundations in Microbiology, International edition, Kathleen Park Talaro and Arthur Talaro, McGraw Hill, 2002.
4. Fundamental Principles of Bacteriology, A.J. Salle, 7th edition McGraw Hill Book Company Inc.1984.
5. Microbiology, Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg, 5th edition, Tata-McGraw HillBook, 1998.
6. Outlines of Biochemistry, Conn P. Stumpf, G. Bruening and R. Doi. 5th edition, JohnWiley and Sons, New York, 1995.
7. Prescott, Harley, Klein-Microbiology, Willey, J., Sherwood, L. and Woolverton, 5th and6th edition, McGraw Hill. 2002 and 2006.
8. Principles of Biochemistry. Lehninger D. Nelson and M. Cox, 4th Edition, W.H.Freeman and Company. New York 2005.
9. Textbook of Microbiology, R. Ananthanarayan 7th Edition, Universities Press, 2009.