SHIVAJI UNIVERSITY, KOLHAPUR.

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CHOICE BASED CREDIT SYSTEM
Syllabus For

B.Sc. Part–I

MICROBIOLOGY

(Faculty of Science and Technology)

SEMESTER I AND II

(Syllabus to be implemented from August, 2022 onwards as per NEP 2020)

Shivaji University, Kolhapur
Syllabus For Bachelor of Science Part – I : Microbiology

1. TITLE: Microbiology

2. YEAR OF IMPLEMENTATION: - Syllabus will be implemented from June, 2022 onwards.

3. PREAMBLE:

This syllabus is framed to give sound knowledge with understanding of Microbiology to undergraduate students at second year of three years of B.Sc. degree course.

Students learn Microbiology as a separate subject from B.Sc. II. The goal of the syllabus is to make the study of Microbiology popular, interesting and encouraging to the students for higher studies including research.

The new and updated syllabus is based on a basic and applied approach with vigor and depth. At the same time, precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

4. GENERAL OBJECTIVES OF THE COURSE / PAPER :

1) To make the students knowledgeable with respect to the subject and its practicable applicability.
2) To promote understanding of basic and advanced concepts in Microbiology.
3) To expose the students to various emerging areas of Microbiology.
4) To prepare students for further studies, helping in their bright career in the subject.
5) To expose the students to different processes used in industries and in research field.
6) To develop their ability to apply the knowledge of Microbiology in day to day life.
7) To prepare the students to accept the challenges in life sciences.
8) To develop skills required in various industries, research labs and in the field of human health.

5. DURATION : The course shall be a full time course.

6. PATTERN : Pattern of Examination will be Semester.

7. MEDIUM OF INSTRUCTION : The medium of instruction shall be English.

Learning Outcomes:

A candidate who wish to graduate in B.Sc. (Microbiology Course) needs to have acquired/developed following competencies:

1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.
3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/studies etc.
4. Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

Structure of Bachelor of Science Part-I with Microbiology as principle Subject

SEM	Discipline specific Core Course (DSC) (L+T+P) (Credits)	Discipline specific Elective Course (DSE)/ Open Elective (OE) (L+T+P) (Credits)	Ability Enhancement Compulsory Courses (AECC)/ Languages (L+T+P) (Credits)	Skill Enhancement Courses (SEC)		Total Credits
				Skill Based Courses (L+T+P) (Credits) (Non-CGPA)	Value Based Courses (L+T+P) (Credits) (Non-CGPA)	
I	Microbiology C1 **(4+2)** Chemistry C1 **(4+2)** Zoology C1 **(4+2)**	Botany C1 / Biotechnology C1 / Biochemistry C1 **(4+2)**	AECC-1 **(2) (Non-CGPA)** English for communication	SEC-1 **(2)** Multidisciplinary	NCC / NSS / Sports / Cultural **(1)** / SSC **(2)**	24
II	Microbiology C2 **(4+2)** Chemistry C2 **(4+2)** Zoology C2 **(4+2)**	Botany C2 / Biotechnology C2 / Biochemistry C2 **(4+2)**	AECC-2 **(2) (Non-CGPA)** English for communication	SEC-2 **(2)** Multidisciplinary	NCC / NSS / Sports / Cultural **(1)** / SSC **(2)**	24
Option 1: Exit with Certificate Course in Science (Microbiology) (with the completion of courses equal to minimum of 48 credits)						

SEMESTER- I
Paper – I (DSC 25 A)

Introduction to Microbiology

Credits - 2; Total hours – 30

Learning Objectives:

1. To develop a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
2. To develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.
3. To explain the useful and harmful activities of the microorganisms and scope of different branches of Microbiology.
4. To describe characteristics of bacterial cells, cell organelles and various appendages like capsules, flagella or pili.

Credit I	**History and mile stones in Microbiology**	**No. of hours: 15**
	A. History of Microbiology 1. Spontaneous generation *vs*. biogenesis. 2. Contributions of - a. Antony von Leeuwenhoek, b. Edward Jenner, c. Louis Pasteur, d. Robert Koch, e. Ivanowsky, f. Joseph Lister, g. Alexander Fleming, h. Martinus W. Beijerinck and i. Sergei N. Winogradsky. B. Introduction to types of Microorganisms: 1. General characteristics of different groups: a. Acellular microorganisms-Viruses, Viroids and Prions b. Cellular microorganisms- Bacteria, Algae, Fungi and Protozoa - with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. c. Ultra-structure of Prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic microorganisms. C. Bacterial Nomenclature and Classification:	

	a. Taxonomic ranks b. Common or Vernacular name c. Scientific or International name d. Whittaker's five kingdom and Carl Woese's three kingdom classification systems. D. An overview of Scope of Microbiology: 1.Beneficial and harmful activities of microorganisms. Introduction to applied branches of Microbiology: a. Air, b. Water, c. Sewage, d. Soil, e. Dairy, f. Food, g. Medical, h. Industrial, i. Biotechnology and j. Geomicrobiology.	
Credit II	**Bacterial Cell Structure and Functions**	**No. of hours: 15**
	A. Cell size, shape and arrangement B. Cytology of Bacteria: i. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative bacterial cell walls ii. Cell Membrane: Structure, function & chemical composition of bacterial cell membranes. iii. Structure and functions of Capsule and slime layer. iv. Structure and functions of Flagella v. Structure and functions of Pilli. C. Structure and functions of Cytoplasmic Components: a. Ribosomes b. Mesosomes c. Inclusion bodies d. Nucleoid e. Chromosome f. Plasmids g. Endospore: Structure, stages of sporulation h. Reserve food materials - Nitrogenous and non-nitrogenous	

Paper – II (DSC 26 A)
Basic Techniques in Microbiology
Credit- 2; Total hours - 30

Learning Objectives:

1. To study the staining techniques for the observation of bacteria and bacterial cell components
2. To study the working principle, handling and use of microscopes for the study of microorganisms
3. To understand the principles of sterilization and disinfection of culture media, glassware and plastic ware and other objects to be used for microbiological work.

Credit I	**Staining Techniques and Microscopy**	**No. of hours: 15**
	A. **Stains and staining procedures:** 1. Definition and Classification of stains - Acidic, Basic and Neutral 2. Principles, Procedure, Mechanism and applications of staining procedures i. Simple staining ii. Negative staining iii. Differential staining: Gram staining and Acid fast staining 3. Special staining methods i. Cell wall (Chance's method) ii. Capsule (Maneval's method) iii. Volutine granule (Albert's method) B. **General Principles of Microscopy:** a. Types of microscopes: light and electron microscopes b. Light microscopy: Parts, Image formation, Magnification, Numerical aperture (uses of oil immersion objective), Resolving power and Working distance. c. Ray diagram, special features, applications and comparative study of: i. Compound Microscope ii. Electron Microscope	
Credit II	**Control of Microorganisms**	**No. of hours:**

		15
	A. Definitions of - Sterilization, Disinfection, Antiseptic, Germicide, Microbiostasis, Antisepsis and Sanitization. B. Physical agents for control of microorganisms: i. Temperature – a) Dry heat b) Moist heat ii. Desiccation iii. Osmotic pressure iv. Radiations - U.V. Ray, Gamma rays, v. Filtration – Asbestos and Membrane filter C. Chemical Agents for control of microorganisms: Mode of action, application and advantages of - i. Phenol and Phenolic compounds ii. Alcohols (Ethyl alcohol) iii. Halogen compounds (chlorine and iodine) iv. Heavy metals (Cu and Hg) v. Gaseous Agents – Ethylene oxide, Beta-propiolactone and formaldehyde	

SEMESTER- II

Paper - III (DSC 25 B): Bacteriology

(Credits - 2; Total hours - 30)

Learning Objectives:

1. To describe the nutritional requirements of bacteria and other microbes which grow under extreme environments.
2. To understand the basic laboratory experiments to isolate, cultivate and differentiate bacteria
3. To study the preservation of bacteria in the laboratory

Credit I	**Microbial Nutrition and Culture Media**	**No. of hours: 15**
	A. Nutritional requirements of microorganisms: a. Water b. Micronutrients c. Macronutrients d. Carbon e. Energy source f. Oxygen g. Hydrogen h. Nitrogen i. Sulphur j. Phosphorous k. Growth factors – auxotroph, prototroph and fastidious organisms. B. Nutritional types of microorganism based on carbon and energy sources: a. Autotrophs b. Heterotrophs c. Phototrophs d. Chemotrophs e. Photoautotrophs f. Chemoautorphos g. Photoheterotrophs h. Chemoheterotrophs C. Types of Culture Media:	

	a. Components of media b. Natural and Synthetic media c. Chemically defined media d. Complex media, Selective e. Differential f. Enriched g. Enrichment media. D. Cultivation of microorganisms: a. Use of culture media for cultivation b. Conditions required for growth of the microorganisms.	
Credit II	**Isolation, Cultivation and Preservation of Microorganisms.**	**No. of hours: 15**
	A. Isolation of Microorganisms from natural habitats: a. Pure culture techniques – Streak plate, Spread plate, Pour Plate and micromanipulator b. Isolation and cultivation of anaerobic organisms by using media components and by exclusion of air/O2 B. Preservation of microbial cultures: a. Sub culturing b. Overlaying of cultures with mineral oils c. Storage at low temperature d. Lyophilisation C. Systematic study of pure cultures: a. Morphological characteristics. b. Cultural characteristics: i. Colony characteristics on solid media ii. Growth in liquid media iii. Growth on agar slants D. Biochemical Characteristics – a. Sugar fermentation b. Production of metabolites - H_2S gas c. Production of enzymes - Amylase, Caseinase and Catalase.	

Paper - IV (DSC 26 B): Microbial Biochemistry

(Credits - 2; Total hours - 30)

Learning Objectives:

1. To develop a very good understanding of various biomolecules which are required for development and functioning of a bacterial cell.
2. To develop the knowledge of how the carbohydrates make the structural and functional components such as energy generation and as storage food molecules for the bacterial cells
3. To make well conversant about multifarious structures and functions of proteins, enzymes, lipids and nucleic acids.
4. To differentiate the concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.

Credit I	**Biomolecules**	**No. of hours: 15**
	A. Proteins: 1. General structure of amino acids, peptide bond. 2. Types of amino acids based on R group – a) Nonpolar, aliphatic amino acids. b) Aromatic amino acids. c) Polar, Uncharged amino acids. d) Positively charged (basic) amino acids e) Negatively charged (acidic) amino acids. 3. Peptides - properties 4. Structural levels of proteins: primary, secondary, tertiary and quaternary. B. Carbohydrates: Definition, classification and brief account of - a. Monosaccharides: Classification based on aldehyde and ketone groups, structure of ribose, deoxyribose, glucose, galactose and fructose. b. Disaccharides: Glycosidic bond, structure of lactose and sucrose. c. Polysaccharides: Structure and biological role of starch, glycogen and cellulose.	

	C. Lipids: a. Simple lipids – Fats and oils, waxes. b. Compound lipids – Phospholipid, Glycolipids c. Derived lipids – Cholesterol D. Enzymes: a. Definition b. Structure- Concept of apoenzyme, coenzyme, cofactor and active site. c. Types- Extracellular, Intracellular, Constitutive and Inducible. d. Features of enzyme - substrate reaction. E. Nucleic Acids: a. DNA – structure and composition (Watson and Crick Model) b. RNA – Types (mRNA, tRNA, rRNA), structure and functions.	
Credit II	**Microbial Metabolism**	**No. of hours: 15**
	A. Concept of Catabolism and anabolism with examples B. Fundamental principles of energetics- a. Exergonic and endergonic reactions, b. High energy compounds. C. Modes of ATP generation in bacteria by: a. Fermentation b. Respiration c. Photosynthesis D. Biochemical Mechanisms of ATP generation: a. Substrate level phosphorylation. b. Oxidative phosphorylation - Respiration electron transport chain, aerobic and anaerobic respiration. c. Bacterial Photophosphorylation – Cyclic and Non-cyclic. E. Catabolism of glucose – EMP, TCA cycle (schematic presentation and significance).	

PRACTICAL COURSE

Paper I &II: Introduction to Microbiology and Basic Techniques in Microbiology

Learning Objectives:

1. To understand the basic techniques in Microbiology laboratory
2. To study the working principle, handling and use of compound microscope for the study of microorganisms
3. To study the simple and special staining techniques for the observation of bacteria and bacterial cell components
4. To understand the working principles and applications various equipment's in Microbiology laboratory
5. To study the preparation, sterilization and use of various culture media.

Credit I	**Basic Techniques**	**No. of hours: 15**
	1. Preparations of- a. Stains (0.5% basic fuchsin & 0.5% crystal violet) b. Buffer (Phosphate buffer of pH 7) c. Reagents (1 N and 1M solutions of HCL and NaOH) d. Physiological saline. 2. Biosafety- a. Aseptic techniques b. Table disinfection c. Hand wash d. Use of aprons e. Proper disposal of used material f. Cleaning and sterilization of glassware 3. Study of parts of light compound microscope, its use and care. 4. Staining Techniques - a. Monochrome staining b. Negative staining c. Gram's staining d. Cell wall staining (Chance's method), e. Capsule staining (Maneval's method), f. Volutine granule staining (Albert' s method)	

	5. Motility by Hanging drop method. 6. Study of the principle and applications of instruments – a. Biological safety cabinets – Laminar Air Flow Device b. Autoclave c. Incubator d. Hot air oven e. Colorimeter, f. Colony counter	
	Preparation of Culture Media	**No. of hours: 15**
	1. Preparation of culture media and their sterilization - agar plates, buts and slants 2. Simple media: a. Peptone water – 1% & 2 % b. Nutrient broth c. Nutrient agar 3. Biochemical test media: a. Glucose phosphate broth b. Koser's citrate broth c. Milk agar d. Starch agar 4. Selective media - Sabouraud's agar 5. Selective & Differential Media -MacConkey's agar. 6. Sterilization of culture medium using autoclave and assessment for sterility. 7. Sterilization of glassware using hot air oven and assessment for sterility	

Paper III & IV: Bacteriology and Microbial Biochemistry

Learning Objectives:

1. To understand the basic laboratory experiments to isolate and cultivate
2. To study various biochemical tests used to differentiate bacteria

Credit II	**Study of Bacteria**		**No. of hours: 15**
	1. Demonstration of presence of micro flora in / on – a. Air by solid impaction technique on nutrient agar plates b. Water by direct cultivation method c. Hand, nails, teeth and skin (swabbing) by direct cultivation methods. 2. Isolation of pure cultures of bacteria by four quadrant streaking method and study of Colony characteristics, Gram staining and motility of – a. *Escherichia coli* b. *Bacillus species* c. *Staphylococcus aureus* 3. Enumeration of bacteria from water and milk by SPC method.		
	Biochemical Tests		No. of hours: 15
	a. Indole test b. Methyl red test c. Voges Proskauer's test d. Citrate Utilization test e. H_2S production test f. Sugar fermentation - glucose and lactose g. Enzyme production - i. Amylase ii. Catalase iii. Caseinase		

Books recommended for Theory

1) Microbiology by Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
2) Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.
3) Fundamentals of Microbiology by Frobisher, Hindsdill, Crabtree, Good Heart, W.B. Saunders Company, 7th edition.
4) Medical Microbiology Vol. I and II by Cruick Shank R., Duguid J.P., Marmion B.P., Swain R.H.A., XIIth edition, Churchill Livingston, New York.
5) A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
6) General Microbiology by Stanier R. Y. Vth edition, McMilan, London.
7) General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
8) Medical Bacteriology by Dey and Dey – Allied Agency, Calcutta.
9) Food Microbiology by W. C. Frazier.
10) Basic Experimental Microbiology by Ronal M. Atlas, Alfred E. Brown, Kenneth W. Dobra, Wonas Miller (1986) Pren-tice Hall.
11) General Microbiology by Robert F. Boyd (1984), Times, Mirror/Mosby College.
12) A Biologics guide to principles, techniques of Practical Biochemistry by K. Wilson and K. H. Goulding, Edward Arnold Publication.
13) Introduction to Practical Biochemistry by D. Plummer, J. Willey and Sons.
14) Microbiology by Prescott, Herley and Klein, IInd edition.
15) Bacteriological Techniques by F. K. Baker
16) Introduction to Microbial Techniques by Gunasekaran.
17) Biochemical methods by Sadasivam& Manickam
18) Elementary Microbiology Vol. I by Dr. H.A. Modi, Akta Prakashan, Nadiad, Gujrat.
19) Principles of Biochemistry by Nelson and Cox (Lehninger) – Fifth edition.

Books recommended for Practical

1) Medical Microbiology by Cruickshank Vol. II.
2) Stains and Staining procedures by Desai and Desai.
3) Introduction to Practical Biochemistry by D. Plummer, J Wiley and Sons.
4) Bacteriological techniques by F. J. Baker.
5) Introduction to Microbial techniques by Gunasekaran.
6) Biochemical methods by Sadasivam and D. Manickam.
7) Laboratory methods in Biochemistry by J. Jayaraman.
8) Experimental Microbiology by Patel & Patel

List of Minimum Equipment's

1) Hot air oven – 1
2) Incubator - 1
3) Autoclave - 1
4) Refrigerator – 1
5) Medical microscopes - 10 nos. for one batch
6) Chemical balance - 2
7) pH meter - 1
8) Seitz filter – 1
9) Centrifuge - 1
10) Colorimeter - 1
11) Distilled Water Plant – 1
12) Laminar air flow cabinet - 1
13) Arrangements for gas supply and fitting of two burners per table.
14) One working table of 6' x 2½' for two students.
15) One separate sterilization room attach to the laboratory (10' x 15')
16) At least one wash basin for a group of five students
17) Colony counter
18) Water bath
19) One separate instrument room attached to lab (10' x 15')
20) One laboratory for one batch including working tables (6' x 2½') per two students for one batch
21) Store room (10' x 15')

Theory Examination

Nature of Question paper

Q.1 Multiple choice questions (10- Questions) ----	10 marks
Q.2 Attempt **any two** of the following.	
(Essay type/Broad answer questions) ----	20 marks
Q.3 Write short notes (**any four**) ----	20 marks

Practical Examination

(A) The practical examination will be conducted on two consecutive days for three hours per day per batch of the practical examination.

(B) Each candidate must produce a certificate from the Head of the Department in her/his college, stating that he/she has completed in a satisfactory manner the practical course on lines laid down from time to time by Academic Council on the recommendations of Board of Studies and that the journal has been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and have written a report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of the year. Candidates must produce their journals at the time of practical examinations.

(C) Nature of question paper and distribution of marks for Practical Examination

Q.1	Special Staining	10
Q.2	Isolation and study of colony characters, gram nature and motility of bacteria / Enumeration of bacteria from water / milk by SPC	15
Q.3	Biochemical tests	05
Q.4	Detection of enzyme activity	05
Q.5	Spotting	10
Q.6	Journal	05
	Total Marks	**50**

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