

GUJARAT UNIVERSITY
Syllabus for Second Year Microbiology
Semester III and IV
Effective from June 2018

1. A student offering Microbiology programme will be offered four theory papers of core course MI 201, 202 and MI 204, 205; each paper of 100 marks and practical papers MI 203 and MI 206 of 100 marks each as prescribed here under
2. Each theory paper at the external examination shall be of 3 hours duration and carry 70 marks. Each practical examination shall be of three consecutive days each of four hours duration. Total marks for practicals shall be 70 each
3. Internal assessment will be of 30 marks for each theory and practical papers
4. For each theory papers there will four lectures of 55 minutes per week. For practical there will be six lectures (two/practical) each of 55 minutes per week.
5. Each theory paper is divided into four units and from each unit one question shall be set. The fifth question will be of objective type covering contents of all four units
6. Practical batch shall consist of 20 to maximum 25 students
- 7. The teaching shall be based upon listed textbooks**
8. The numeric on the right depicts the number of lectures allotted

Proposed Syllabus for Microbiology Semester III and IV
Course MI- 201
Microbial Physiology

(Hours)

Unit 1 Biomolecules

Chemical structure, Properties, Classification and Biological significance of

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|------------------|------|
| A. Carbohydrates | (03) |
| B. Proteins | (03) |
| C. Lipids | (02) |
| D. Nucleic acids | (02) |

Unit 2 Enzymes

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|---|------|
| 1. General Introduction | (04) |
| A. Physical and chemical properties | |
| B. Structure of enzymes: Prosthetic group, apoenzyme, coenzyme, cofactors. | |
| C. Localization of enzymes: Extra cellular and intra cellular | |
| D. Nomenclature and classification of enzymes, IUB system of enzyme classification. | |
| 2. Enzyme action | (06) |
| A. Active site of enzymes | |
| B. Mechanism of enzyme action. | |
| C. Factors affecting enzyme activity | |
| D. Inhibition of enzyme activity: Competitive and Non competitive | |

Unit 3 Microbial Nutrition and Introduction to Metabolism

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|--|------|
| 1 Modes of Nutritional uptake: | (04) |
| Entry of nutrients in cell, Passive diffusion, facilitated diffusion and active transport. | |
| 2 Classification of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydrostatic pressure. | (04) |
| 3 Introduction to microbial metabolism | (02) |
| i) Anabolism, catabolism, primary and secondary metabolism | |

ii) Role of reducing power, precursor metabolites and energy rich compounds in cell metabolism

Unit 4 Microbial growth

1. Methods of reproduction in bacteria and new cell formation (02)
2. Growth (05)
 - A. Introduction to growth rate, generation time
 - B. Criteria for growth measurement: Cell mass and Cell number, methods of their measurement
 - C. Normal growth curve of bacteria
 - D. Continuous growth and synchronous growth.
3. Chemotherapeutic agents as growth inhibitors (03)
 - A. Principles of chemotherapy
 - B. General mode of action of various chemotherapeutic agents: Sulfonamides, Antibiotics (penicillin, streptomycin, polymyxin)

Text Books:

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986) Microbiology, 5thedn, McGraw-Hill Book company, NY
2. Ingraham J L, and Ingraham, C L, (2000) Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore
3. Black J G, (2002) Microbiology: Principles and Explorations, 5thedn, John Wiley and Sons, Inc. NY.

Semester –III
Course MI- 202
Soil and Water Microbiology

	Hours
Unit 1 Microbiology of Soil	
1 Physicochemical characteristics of soil, soil as culture media and soil microflora	(02)
2 Methods to study soil flora:	(03)
Direct microscopic methods, agar plate technique, enrichment culture technique, buried slide technique and soil respiration technique	
3 Microbial interactions in soil	(05)
A Neutral, positive and negative associations	
B Interaction between plant roots and microorganisms	
I) Rhizosphere and its significance	
II) Mycorrhiza	
Unit 2 Microorganisms as Biogeochemical Agents	
1 Introduction to biogeochemical transformations in soil: Mineralization and immobilization of elements	(01)
2 Rotation of elements in nature	(08)
A. Nitrogen Cycle	
B. Sulphur Cycle	
C. Carbon Cycle	
D. Iron Cycle	
E. Phosphorous Cycle	
3 Soil fertility: Biofertilizers	(01)
Unit 3 Microbiology of Drinking Water	
1 Natural waters: Sources of contamination	(03)
2 Microbial indicators of fecal pollution	
A. Coliforms as indicator	
B. Methods for differentiation: IMViC test and Elevated temperature test	
C. Microbial indicators other than coliforms	
3 Nuisance organisms in water: Slime forming bacteria, Iron and Sulphur bacteria and Algae	(01)
4 Water borne diseases	(01)
5 Bacteriology examination of drinking water	(03)
A. Sampling	
B. Quantitative analysis: Total viable count, Membrane filter technique	
C. Qualitative analysis: Detection of coliforms (presumptive, confirm and completed test) Defined substrate test, P-A (Presence Absence test)	
6 Purification of drinking water: sedimentation, filtration and disinfection	(01)
Unit 4 Microbiology of Waste water	
1 Types of waste water, Chemical and Microbiological characteristics of waste water	(01)
2 BOD, COD and TOD as indicators of untreated waste water, Pollution problems due to disposal of untreated waste	(03)
3 Methods of waste water treatment	(06)
A. Primary treatment and secondary treatment: Principles and role of microorganisms in: Septic tank, Imhoff tank, trickling filters, activated sludge process and oxidation ponds	
B. Advanced treatment and final treatment	
C. Solid waste processing: Anaerobic sludge digestion and composting	

Text Books:

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986) Microbiology, 5thedn, McGraw-Hill Book Company, NY.
2. Alexander M, (1977), **Soil Microbiology**, 2nd Edition Krieger Publ. Co. Melbourne, FL
3. Atlas R M, (1977), **Principles of Microbiology** 2nd Edition, Wm. C. Brown Publ. Iowa USA

Semester III

MI 203

Microbiology Practicals

1 Study of different types of media

- A. Selective media: Rose Bengal agar medium
- B. Differential medium: MacConkey's agar medium, EMB agar medium, Triple sugar iron agar medium
- C. Enrichment media: Selenite broth
- D. Enriched media: Blood agar medium, Glucose yeast extract agar medium
- E. Natural media: Soil extract agar medium,

2 Qualitative analysis of biomolecules

- A. Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed's test, Bial's test and Seliwanoff's test
- B. Protein: Biuret test, Ehrlich's test, Glyoxilic acid test and Xanthoproteic test

3 Study of effect of antimicrobial compounds on growth of bacteria

- A. Study of effect of heavy metal on growth of bacteria
- B. Study of effect of chemicals (5% phenol, 1% crystal violet and 0.001% HgCl₂) on growth of bacteria (Agar cup method)
- C. Study of effect of antibiotics on growth of bacteria using paper disc method
- D. Study of effect of antibiotic on growth of bacteria using agar ditch method

4 Study of Biochemical reactions

A Based on Carbon source

- i. Oxidative and fermentative breakdown of glucose
- ii. Fermentation of Sugars: Glucose, Xylose, Mannitol, Lactose, Maltose and Sucrose
- iii. Glucose break down products: Methyl red test and Voges Proskauer's test
- iv. Citrate utilization test
- v. Starch utilization test
- vi. Lipid utilization test

B Based on Nitrogen source

- i. Indole production test
- ii. H₂S production test
- iii. Urea utilization test
- iv. Casein hydrolysis test
- v. Gelatin Hydrolysis test
- vi. Deamination test
- vii. Ammonia production test
- viii. Nitrate reduction test

C Other tests

- i. Catalase test
- ii. Dehydrogenase test
- iii. Oxidase test

5 Microbiological analysis of soil

- A. Enumeration of organisms from soil (Standard plate count)
- B. Isolation and cultivation of symbiotic and non-symbiotic nitrogen fixing bacteria, Actinomycetes and Fungi (*Mucor*, *Rhizopus*, *Aspergillus* and *Penicillium*) from soil

6 Microbiological analysis of drinking water

- A. Standard plate count
 - B. Detection of fecal pollution of water by performing presumptive, confirmed and completed test
 - C. Determination of MPN of coliforms in water
- 7 Study of skin flora
- 8 Study of Air flora by settling plate technique

Scheme for Practical Examination

Exercise	Marks
1 Microbiological Analysis of soil/water	(15)
A. Standard plate count	
B. MPN	
C. Presumptive and confirmed test	
D. Confirmed and completed test	
2 Biochemical reactions (any five)	(15)
3 General Exercise (any one)	(10)
A. Study of effect of antimicrobial agents on growth of bacteria (antibiotics, heavy metals and Chemicals)	
B. Qualitative analysis of protein/carbohydrates	
C. Study of cultural and morphological characters of Actinomycetes/Fungi	
D. Cultivation and study of nitrogen fixing bacteria from soil	
E. Study of Air flora	
F. Study of skin flora	
4 Spotting	(10)
5 Vive voce	(10)
6 Journal and slides	(05)

Semester IV
MI-204
Diversity of Bacteria

	Hours
Unit 1 Archea bacteria	
A. Introduction and phylogeny	(01)
B. General properties	(04)
1) Cell wall and cell membrane	
2) Chromosome	
3) Ribosome	
C. Salient features of:	(05)
1) Methanogens	
2) Halophiles	
3) Thermophilic S ⁰ metabolizers	
Unit 2 Eubacteria I (Selected genera)	
A. Photosynthetic bacteria: General properties	(05)
1) Oxygenic photosynthetic bacteria: <i>Cyanobacteria</i>	
2) Anoxygenic photosynthetic bacteria: Purple bacteria, Purple non sulphur bacteria, Green bacteria	
B. Chemolithotrophic bacteria	(05)
1) Nitrifying bacteria: <i>Nitrobacter</i> , <i>Nitrosomonas</i>	
2) Colorless Sulphur bacteria: <i>Thiobacillus</i> , <i>Acidiphilium</i>	
3) Iron, Hydrogen and Magnetotactic bacteria: <i>Siderococcus</i> , <i>Hydrogenobacter</i> , <i>Aquaspirillum</i>	
Unit 3 Eubacteria II (Selected genera)	
A. Gram negative spiral and curved rods	(03)
1) Spirocheatales	
2) Spiral bacteria: <i>Spirillum</i> and <i>Azospirillum</i>	
3) Curved rods: <i>Bdellovibrio</i> , <i>Desulfovibrio</i>	
B. Gram negative aerobic rods and cocci	(02)
1) Pseudomonadaceae: <i>Pseudomonas</i> , <i>Xanthomonas</i>	
2) Neisseriaceae: <i>Neisseria</i>	
C. Gram-negative anaerobic and facultative rods and cocci	(03)
1) Enterobacteriaceae: <i>E coli</i> , <i>Serratia</i> , <i>Enterobacter</i> , <i>Proteus</i> , <i>Shigella</i> , <i>Salmonella</i>	
2) Vibrionaceae: <i>Vibrio</i> , <i>Photobacterium</i>	
3) Veillonellaceae: <i>Veillonella</i>	
D. Obligatory Parasites	(02)
1) Rickettsiaceae: <i>Rickettsia</i> , <i>Coxiella</i>	
2) Chlamydiaceae: <i>Chlamydia</i>	
3) Mollicutes: <i>Mycoplasma</i>	
Unit 4 Eubacteria III (Selected genera)	
A. Gram positive rods and cocci	(02)
1) Micrococcaceae: <i>Staphylococcus</i>	
2) Deinococcaceae: <i>Deinococcus</i>	
3) Other genera: <i>Streptococcus</i> , <i>Leuconostoc</i> , <i>Peptococcus</i>	

- 4) Endospore formers: *Bacillus, Clostridium*
- 5) Non spore forming Rods: *Lactobacillus*
- B. Gram positive irregular rods (03)
 - 1) Nonfilamentous rods: *Corynebacterium, Arthrobacter*
 - 2) Aerobic curved rods: *Mycobacterium*
 - 3) Nocardioforms: *Nocardia*
- C. Filamentous bacteria with complex morphology: *Frankia, Streptomyces* (02)
- D. Bacteria with unusual morphology (03)
 - 1) Prosthecate budding/nonbudding bacteria: *Hyphomicrobium, Caulobacter*
 - 2) Nonprosthecate budding/nonbudding bacteria: *Planctomyces, Gallionella*
 - 3) Sheathed bacteria: *Spherotilus, Crenothrix, Leptothrix*
 - 4) Gliding fruiting/nonfruiting bacteria: *Myxobacteria, Beggiatoa*

Note: (Content of syllabus should not be beyond the prescribed text book)

Textbook: Atlas R M, (2015), **Principles of Microbiology** 2nd Edition, McGraw Hill education, Mumbai

Suggested Reading:

Garrity George M, Noel R Krieg et al (2011) Bergey's Manual of Systematic Bacteriology (Vol. I to IV) 2nd edition, Editors James T Staley and Aidan C Parte Springer

Semester IV

MI-205 Food and Dairy Microbiology

Hours

Unit I Microbes in Food Infection and Poisoning

1. Food as a substrate for microorganisms (01)
2. Microbial flora of food: fruits, vegetables, meat, eggs, biochemical, temperature and pathogenic types of milk (02)
3. Factors affecting kinds and numbers of microorganisms: intrinsic and extrinsic (02)
4. Food and milk borne infections: Microorganism involved, source of infection, Incubation period and characteristics in brief: (02)
 - A. Bacterial infections: *Salmonella* sp., *Shigella* sp., *E. coli*, *Vibrio* sp., *Campylobacter jejuni*, *Listeria monocytogenes*
 - B. Viral infections: Rotavirus, Hepatitis A, Poliovirus
 - C. Protozoal infections: *Entamoeba*
5. Food poisoning: (03)
 - A. Role of *Staphylococcus aureus*, *Clostridium botulinum* and *Salmonella* spp
 - B. Molds as poisoning agents: Role of Mushroom, *Aspergillus*, *Claviceps purpurea*, *Fusarium moniliformis*.

Unit II Microbial Food Spoilage and Preservation

1. Microbial Spoilage of food (04)
 - A. Spoilage of milk and milk products, fruits, vegetables, eggs, meat
 - B. Spoilage of canned foods
2. Preservation of food and Milk (06)
 - A. General principles
 - B. Methods of preservation
 - i. Use of aseptic handling
 - ii. High temperature: Pasteurization, sterilization, canning
 - iii. Low temperature: Refrigeration and freezing
 - iv. Dehydration
 - v. Osmotic pressure
 - vi. Preservatives
 - vii. Radiations: Ionizing and non-ionizing radiation

Unit III Microbes as Food and Food Products

1. Fermented dairy products (05)
 - A. Starter culture
 - B. Cheese: Types, curdling, processing, ripening
 - C. Other fermented dairy products: Yogurt, cultured buttermilk, acidophilus milk, Kefir and cultured sour milk
 - D. Introduction to probiotics, prebiotics and synbiotics
2. Fermented food products: Pickles, sauerkraut and bread (02)
3. Microbes as food: Mushrooms, spirulina and yeasts (03)

Unit IV Methods in Food Microbiology

1. Biological methods: Generalized scheme for microbiological examination (05)
 - A. Direct microscopic examination, colony forming units (CFU)

- B. Most probable number (MPN)
- C. Identification of specific group or species of microorganisms
- 2. Bacteriological analysis of milk (03)
 - A. Grading of milk: Methylene Blue Reduction and Resazurin test
 - B. Determination of efficiency of pasteurization: Phosphatase test
 - C. Determination of MPN
 - D. Acid-fast staining
- 3. Microbiological criteria of food safety: (02)
 - A. Microbial standards for food
 - B. FDA, BIS, Food Safety and Standard Act of India
 - C. Food certification marks in India: ISI, Agmark, FPO, BIS, FSSAI

Text Books:

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986), *Microbiology: An Application Based Approach*, 5th edn. McGraw-Hill Book Company, NY
2. Frazier W C and Westhoff D C (1988), *Food Microbiology*, 4th edn. McGraw-Hill Book Company, NY
3. Prescott L, Harley J P, and Klein D A, (2008), *Microbiology*, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA.
4. Indian Standards: Food Hygiene-Microbiological Criteria-Principles for Establishment and Application
5. Fssai: Manual of methods of analysis of foods- food safety and standards authority of India, Ministry of health and family welfare, Government of India, New Delhi, 2015

Semester IV

MI-206

Microbiology Practicals

1. Study of bacterial diversity in soil by using Winogradsky column (Demonstration only)
2. Study of bacterial motility
3. Measurement of bacterial yeast and fungal cell size using micrometer
4. Pure culture study: Morphological, Cultural and Biochemical Characters
 - A. Gram positive bacteria: *Staphylococcus aureus*, *Bacillus subtilis*, *B megaterium* and *B cereus*
 - B. Gram negative bacteria: *E coli*, *Enterobacter aerogenes*, *Proteus vulgaris* and *Pseudomonas aeuginosa*
5. Isolation and cultivation of yeast
6. Study of permanent slides: Amoeba, *Euglena*, *Paramecium*, Diatoms and *Spirogyra*
7. Microbiological analysis of food
 - A. Standard plate count
 - B. Determination of MPN of coliforms
8. Microbiological analysis of milk
 - A. Standard plate count
 - B. Determination of microbial load by use of MBRT and RRT of raw, boiled and pasteurized milk
 - C. Detection of fecal coliforms
 - D. Detection of Acid fast bacteria in milk

Scheme for Practical Examination

Exercise	Marks
1 Microbiological Analysis of food/milk	(15)
A. Standard plate count	
B. MPN	
C. Presumptive and confirmed test	
D. Confirmed and completed test	
E. MBRT/RRT and Acid fast staining	
2 Pure culture study (any one)	(20)
3 General Exercise (any one)	(10)
A. Isolation and cultivation of yeast	
B. Study of Bacterial motility	
C. Micrometry	
4 Spotting	(10)
5 Vive voce	(10)
6 Journal and slides	(05)