

Rayat Shikshan Sanstha's
Sadguru Gadage Maharaj College, Karad
(An Autonomous College - Affiliated to Shivaji University, Kolhapur)

Accrediated By NAAC with A⁺ Grade (CGPA 3.63)

National Education Policy (NEP-2020)

Syllabus for

B.Sc. Part -II

Microbiology

**Syllabus to be implemented from July 2023 onwards of
Academic Year 2023-24**

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Department of Microbiology

B.Sc. Part- II

Course Structure NEP-2020

Note: The following in a nutshell gives the scope and extent of each course offered. Each core theory course has two levels of teaching: Lectures and Practical's.

Evaluation Pattern: B. Sc. II Microbiology

Sem.	Paper Code	Credits	Title of Paper	Evaluation Scheme (Marks)			Grand Total Marks
				CCE	SEE	Total	
I	DSC C25:BMiT22-301	02	Microbial Physiology and Metabolism	10	40	50	100
	DSC C26:BMiT22-302	02	Applied Microbiology	10	40	50	
II	DSC D25 : BMiT22-401	02	Microbial Genetics and Molecular Biology	10	40	50	100
	DSC D26 : BMiT22-402	02	Basics in Medical Microbiology and Immunology	10	40	50	
	DSC: BMiP22-403	02	Microbiology Practicals Lab- I		100	100	100
		02	Microbiology Practicals Lab- II				
Total		12		40	260	300	300

SEE-Semester End Examination, CCE-Continuous and Comprehensive Evaluation

B.Sc. Part-II, Semester-III, Paper-V

BMiT22-301: Microbial Physiology and Metabolism (Credits: 02)

Learning Objectives:

The students should

1. understand different environmental factors influencing microbial growth.
2. Know the transport mechanism in bacterial cells
3. Learn various energy yielding pathways in micro-organisms
4. Understand anaerobic respiration

Unit I -Effect of Environment on Microbial Growth (11)

Microbial growth in response to environment –

- A. Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermoduric, psychrotrophs) Thermal destruction of bacteria - D, F, Z value TDP and TDT
- B. pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic)
- C. Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe)
- D. Osmotic pressure- isotonic, hypertonic, hypotonic, environment, xerophiles, halophiles
- E. Diauxic growth- Effect of simple and complex sugars on growth (glucose and lactose)

Unit II Nutrient uptake and Transport (11)

- A. Transport proteins - Properties of transport proteins, Structure and function of membrane transport proteins.
- B. Passive and facilitated diffusion ii) Primary and secondary active transport, concept of uniport, symport and antiport
- C. Group translocation,
- D. Iron uptake

Unit III Chemoheterotrophic Metabolism - Aerobic Respiration (12)

- A. Concept of free energy, High energy compounds
- B. Concept of aerobic respiration, anaerobic respiration and fermentation

- C. Sugar degradation pathways i.e. EMP, TCA cycle
- D. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC

Unit IV Chemoheterotrophic Metabolism - Anaerobic Respiration and fermentation (11)

- A. Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite respiration)
- B. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways)

Learning outcomes

Students should be able to

1. learn the types of microorganisms growing in different extreme environmental conditions and the effect of environmental factors on microbial growth
2. learn transport of nutrients and role of siderophores in iron uptake in microorganisms
3. Understand the concept of free energy, free energy change, endergonic and exergonic reactions, concept of coupled reactions
4. learn the pathways of sugar degradation and bioenergetics of these pathways.
5. learn the difference between aerobic, anaerobic respiration and fermentation

References-

1. Microbiology –An introduction, eighth edition. Tortora, Funke, Case, (Unit I ,Unit III)
2. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 5th ed. New York :W.H. Freeman c2008 (Unit II)
3. Microbiology – Pelczar, Reid and Chan

4. Prescott, Harley and Klein's Microbiology 7th Edition. Joanne Willey (Author), Linda Sherwood (Author), Chris Woolverton. (Unit I, Unit II, Unit III, Unit IV)
5. General Microbiology Vol I. Powar & Dagainawala, Himalaya publishing house (Unit II, Unit III and IV)
6. Brock Biology of Microorganisms, Twelfth edition. Pearson International edition Madigan, Martinko, Dunlap, Clark (Unit I, Unit II, Unit III, Unit IV)
7. Principles of Microbiology – Ronald M. Atlas Second edition Mc Graw Hill Education (Unit I, Unit II, Unit III, Unit IV)

B.Sc. Part-II, Semester-III, Paper-VI

BMiT22-302 Applied Microbiology

(Credits: 02)

Learning Objectives:

The students should

1. Know the basic concepts of air, water and milk microbiology
2. understand concepts of routine bacteriological analysis of water, air and milk
3. understand composition of milk, sources of contamination and methods of Pasteurization
4. learn basic concept of fermentation with respect to fermenter design, fermentation media
5. learn about primary and secondary screening procedures

Unit I Water Microbiology

(11)

- A. Sources of microorganisms in water.
- B. Fecal pollution of water, Indicators of fecal pollution of water – *E. coli*
- C. Routine Bacteriological analysis of water.
 - a. SPC
 - b. Tests for coliforms -
 - i. Qualitative-Detection of coliforms - Presumptive test, Confirmed Test, Completed test.
 - ii. Differentiation between coliforms - IMViC test, Eijkman test.
 - iii. Quantitative – MPN, Membrane filter technique
- E. Municipal water purification process and its significance.

Unit II Milk Microbiology

(11)

- A) Sources of microorganisms in milk
- B) General composition of Milk.
- C) Microbiological examination of Milk – DMC, SPC and dye reduction test- MBRT test

- D) Pasteurization - Definition, Methods – LTH, HTST, UHT
- E) Efficiency of Pasteurization– Phosphatase test (Qualitative)

Unit III Air Microbiology (11)

- A. Sources of microorganisms in air.
- B. Definitions of - Infectious dust, Droplets & Droplet nuclei
- C. Sampling methods for microbial examination of air
 - i. Solid impaction - Sieve device
 - ii. Liquid Impingement – Bead-bubbler device

Unit : IV Basic concepts of fermentation (12)

- A. Definition, Typical Fermenter design – Parts and their functions
- B. Fermentation Media - Water, carbon source, nitrogen source, precursors, growth factors, antifoam agents & chelating agents
- C. Factors affecting fermentation process
- D. Screening - Primary and secondary screening
- E. Types of fermentations – Batch, continuous, dual and multiple
- F. Concept of primary and secondary metabolites

Learning outcomes-

Students should be able to

1. Understand the principles for routine bacteriological analysis of water. and the significance of municipal water purification process.
2. Learn about methods of pasteurization
3. Define Infectious dust, Droplets & Droplet nuclei and understand Sampling methods for microbial examination of air
4. Learn basic concept of fermentation with respect to fermenter design, fermentation media
5. Understand primary and secondary screening procedures

References

1. Industrial microbiology – A.H.Patel (Unit IV)
2. Industrial microbiology – L.E. Casida, J.R. New Age International publisher. (Unit IV)
3. Dairy Microbiology—Dr. K.C. Mahanta, Omsons publications (Unit II)
4. Industrial microbiology – Miller and Litsky Mcgraw-Hill publications (Unit IV)
5. A Text book of Microbiology – R. Dubey, D. K. Maneshwari, S. Chand Co. Ltd. Ramnagar New Delhi 110055 (Unit III)
6. Fundamentals of Microbiology – Frobisher et al W.B.Saunders company

B.Sc. Part-II, Semester-IV, Paper-VII

BMiT22-401 Microbial Genetics and Molecular Biology

(Credits: 02)

Learning Objectives:

The students should

1. learn variations in Gram positive and Gram-negative bacterial cell wall
2. Know about Archeal cell walls
3. Understand in detail different structures and functions of cell organelles and cytoplasmic inclusions
4. Know about bacterial systematic and taxonomy
5. Understand basic concepts of genetics *w.r.t.* various definitions.
6. Know mutations, types mode of action of mutagenic agents and DNA repair.

Unit I Bacterial cell structure

(11)

- A. Structures of components of Gram positive and Gram-negative bacterial cell wall with their variations.
- B. Bacterial cell membrane-Structure, chemical composition and functions
- C. Bacterial Endospore - Ultrastructure, Sporulation and Germination
- D. Flagella – Structure, Mechanism of movement, tactic behavior
- E. Cytoplasmic inclusions- Chlorobium vesicles, Gas vesicles, Magnetosomes, Carboxysomes.
- F. Reserve food materials –
 - i) Nitrogen
 - ii) non nitrogenous Carbon (Glycogen PHB), Sulphur, Phosphorus

Unit II Bacterial systematics (11)

- A. Aim and principles of classification
- B. Systematics and taxonomy, Concept of species, taxa, strain
- C. Conventional, molecular recent approaches to polyphasic bacterial taxonomy
- D. rRNA oligonucleotide sequencing

Unit III Basic concepts of Genetics (11)

- A. Gene, genome, genotype, phenotype, mutagen, recon, muton, cistron, Split genes.
- B. Forms of DNA
- C. Genetic code – definition and properties of genetic code.
- D. Operon – Concept (Lac Operon)

Unit IV Mutations (12)

- A. Basic Concepts, definitions- Missense, nonsense, neutral, silent, pleiotropic and suppressor mutations.
- B. Types of Mutation:
 - a. Spontaneous mutation - Definition and basic concept
 - b. Induced mutations -
 - 1. Physical and chemical mutagens
 - 2. Mechanism of mutagenesis by physical and chemical mutagens:
 - i. Base analogues: 5-Bromouracil and 2-aminopurines
 - ii. Mutagens modifying nitrogen bases - Nitrous acid, Hydroxylamine, Alkylating agents
 - iii. Mutagens that distort DNA -
 - a. Acridine dyes
 - b. UV light
- C) DNA repair mechanisms- Photoreactivation

Learning outcomes

Student should be

1. Able to understand structure and functions of different organelles and cytoplasmic inclusions of bacteria.
2. Able to understand ecological significance and economic importance of different groups of bacteria and learn about nomenclature of bacteria.
3. Able to understand the concept of gene, genetic code and operon
4. Able to learn about mutation and different types of mutations and DNA repair mechanisms

References

1. General Microbiology – R. Y. Stainer 5th ed Macmillan and Co (1111). (Unit I, Unit II)
2. Chemical Microbiology – A.H. Rose Butterworths publications (Unit I, Unit II)
3. Microbiology – Pelczar, Reid and Chan publications (Unit III, Unit IV)
4. Brock Biology of Microorganisms, Twelfth edition. Pearson International edition Madigan, Martinko, Dunlap, Clark Michael Madigan, John Martinko (Unit II)
5. Genetics. Monroe W. Stickberger 3rd edn MacMillan 1985 publication (Unit III, Unit IV)
6. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 5th ed. New York: W.H. Freeman c2008 (Unit IV)
7. Principles of microbiology – Ronald M. Atlas, Mosby publications 1995 (Unit II)

B.Sc. Part-II, Semester-IV, Paper-VIII

BMiT22-402 Basics in Medical Microbiology and Immunology

(Credits: 02)

Learning Objectives:

The students should

1. Know the basic concepts and definitions regarding host pathogen interactions.
2. Understand types of infections, modes of transmission and process of disease production
3. Know about general principle of cultivation of disease producing organisms and concepts of prevention and control of diseases
4. Learn defense mechanisms of host
5. Learn about antigen, antibody definition, types and reactions

Unit I Host Pathogen Interaction

12

- A. Definitions: Host, Parasite, Commensal, etiological agent, Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Signs of disease, symptoms, syndrome, sequelae infections
- B. Classification of disease: Occurrence (Epidemic, Endemic, Pandemic, Sporadic), severity or duration (Acute, Chronic), Extent of host involvement, Infectious (Communicable), noninfectious (Non communicable).
- C. Types of Infections: Opportunistic infections, Nosocomial infections, Primary, Reinfection, secondary, focal, Cross, Iatrogenic, Inapparent, Latent, Inherited, congenital, Nutritional, Endocrine, Mental Immunological, Neoplastic, Idiopathic, Local, Generalised, Covert, overt, Simple, Mixed, Pyogenic
- D. Sources and modes of transmission of infection: Exogenous and Endogenous (Patient, Carrier: types of carrier, Animals, insects, soil, water, food, Reservoirs of infection)

E. Modes of Transmission of disease:

1. Transmission by air, water and food
2. Contact transmission
3. Vector borne transmission

F. Disease Process: How bacteria Cause Disease:

Entry and Exit of Organisms: Portal of entry, preferred entry

Virulence: Adherence, Attachment, colonization, Invasiveness, Enzymes and Toxin produced, Cell structures Viz. Cell wall, Capsule.

Unit II Infection and Disease

11

- A. Stages of infectious disease: Incubation period, Prodromal phase, invasive phase, decline phase,
- B. Laboratory Diagnosis: Sample collection, transport, culturing of clinical samples
- C. Causative agent, spread, pathogenesis, symptoms, microbiological diagnosis, prevention and control of Enteric fever, UTI caused by Proteus
- D. General principles of prevention and control: Isolation, Quarantine, Immunization, Vector control.

Unit III Host defense mechanism

11

- A. Organs and tissue of the immune system: Types of primary and secondary lymphoid organs
- B. Cells of the immune system: Monocytes and macrophages, granulocytes, mast cells, dendritic cells, NK cells: Killer cells and Mechanism of Killing of lymphocytes - B and T cells
- C. Types of Immunity: Active and Passive
- D. First line of defence: Physical, Chemical and Cellular mechanism

- E. Second line of defence: Inflammation and fever: Antimicrobial substances present in blood and tissue fluids, Phagocytic cells and phagocytosis.
- F. Third line of defense (Specific defense mechanism) –Antibody mediated and cell mediated immunity (activation of resting B lymphocytes to effector cells, Activation of Tc cells and mechanism of Killing by CD8 cells

Unit IV Antigen and Antibodies

11

- A. Antigens: Nature, types, factors affecting antigenicity
- B. Antibodies: Structure, Properties and Types
- C. Primary and Secondary immune response
- D. Antigen – Antibody reactions - Basic concepts of precipitation and agglutination

Learning outcomes

Student should be able to

1. Classify the disease and understand modes of disease transmissions, process of disease development in host from entry of pathogen to recovery of disease.
2. Understand the principles of diagnosis, prevention and control of disease.
3. Know defence mechanisms of human host.
4. Understand concept of antigen-antibody types and reactions.

References

1. Ananthnarayan and Paniker's Textbook of Microbiology by R. Ananthnarayan Orient Blackswan publications 2006 (Unit I, Unit II Unit III, Unit IV)
2. Microbiology: An Introduction: Tortora, Funke, Case: 8th Edi. Pearson Education publication (Unit I, Unit II, Unit III, Unit IV)

3. Microbiology : Jacquelyn G. Black 8th Edi. International student version, Wiley Publication (Unit I, Unit II, Unit III)
4. Zinsser's Microbiology – by Wolfgang K. Joklik, (1995) Mc Graw-Hill Co. (Unit I, Unit III)
5. Medical Microbiology by N.C. Dey and T. K. Dey (Unit II)
6. Textbook of Preventive and social medicine by K. Park, Bhanot publications (Unit II)
7. Basic experimental microbiology by Ronald Atlas, Robert Brown, Bonus
8. Miller (1986) – Pren- Tice Hall (Unit II)
9. Immunology by Fatima, Saras publication (Unit I, Unit III)

Microbiology Practical

BMiP22 - 403

Lab- I

Credit :2

Learning Objectives:

Student should

1. understand the effect of various environmental factors on growth of microorganisms.
2. study diauxic growth pattern of *E. coli*.
3. learn about oxidative and fermentative metabolism of sugars
4. Understand the technique for routine Bacteriological analysis of water
5. Learn methods of screening

A. Effect of environmental factors on microorganisms:

1. Temperature
2. pH
3. Salt (NaCl)
4. Determination of thermal death time of given bacterial culture
5. Determination of decimal reduction time of *E. coli*.
6. Study of diauxic growth of *E. coli*

B. Biochemical tests-

8. HL test
9. Nitrate reduction test
10. Oxidase test

C. Preparation of microbiological media

11. HL medium
12. Peptone nitrate broth
13. Bacteriological analysis of water

D. Qualitative tests –

14. Presumptive
15. Confirm

16. Completed test

E. Quantitative tests-

17. MPN

F. Primary Screening of -

18. Antibiotic producers – crowded plate technique

19. Amylase producers

20. Alcohol fermentation- Demonstration

Learning outcomes-

Students should be able to

1. Learn the effect of environmental factors-temperature, pH, salt on microbial growth.
2. Understand the significance of TDT, and decimal reduction time.
3. Learn the growth pattern of bacteria when two sugars are present in the growth medium.
4. Learn about oxidative and fermentative metabolism of sugars
5. Prepare different culture media
6. Know the significance of media components.
7. Understand the technique for routine Bacteriological analysis of water.
8. Learn about methods of screening

Learning objectives:

Student should

1. carry out isolation of lac negative mutants of *E. coli*
2. perform staining of different bacterial organelles like flagella, endospore, nucleus and PHB granules.
3. Prepare different microbiological media
4. Isolate *Salmonella* & *Proteus sp* from clinical sample.
5. Detect presence of antibody against *Salmonella sp* in serum sample by qualitative Widal test

Practicals:

1. Isolation of lac negative mutants of *E. coli* by visual detection method
2. Effect of U.V. light on growth of bacteria

Stains and staining procedures:

3. Spore staining (Dorner's method)
4. Flagella staining (Bailey's method)
5. Nucleus staining (Giemsa's method) using yeast cells.
6. PHB granules staining
7. Micrometry
8. Preparation of Microbiological media
 - a. Peptone water
 - b. Sugar fermentation medium- glucose, mannitol
 - c. Simmon's citrate agar slant
 - d. Glucose phosphate broth
 - e. Wilson and Blair's medium
 - f. Christensen's urea agar.
 - g. Phenylalanine deamination medium
 - h. Gelatin agar
 - i. Selenite F broth,

j. Tetrathionate broth

9. Isolation of causative agent of enteric fever : *Salmonella*
10. Isolation of causative agent of urinary tract infection : *Proteus*
11. Serological diagnosis of Enteric fever : Widal test (Qualitative)
12. Agglutination test : Blood group detection
13. RPR test
14. Phenyl alanine deamination test
15. Urea hydrolysis test
16. Gelatin hydrolysis test
17. Indole test
18. Methyl Red test
19. Voges Proskur's test
20. Citrate utilization test

Learning outcomes-

Students should be able to

1. Able to learn technique of isolation of lac negative mutants of E.coli
2. Able to perform Spore staining, Flagella staining, Nucleus staining, PHB granules staining
3. Able to understand Effect of U.V. light on growth of bacteria
4. Isolate *Salmonella* & *Proteus Spp* from clinical sample
5. Detect presence of antibody against *Salmonella* spp in serum sample by qualitative widal test
6. Determine the blood group.

Practical references:

1. Microbiology in action by J. Heritage, E. G. V. Evans and R. A. Killington
cambridge university press
2. Practical Microbiology laboratory manual by B .Senthil Kumar,
Zothansanga, N. Senthil Kumar

3. Handbook of Bacteriological techniques F. J. Baker second ed., Butterworth publications.
4. Laboratory Fundamentals of Microbiology – Alcamo, I. E
5. Basic and Practical Microbiology – Atlas.
6. Laboratory Fundamentals of Microbiology – Alcamo, I. E.
7. Experimental microbiology by Rakesh patel, Vol I
8. Experimental microbiology by Rakesh patel, Vol II
9. Media preparation- High media manual