

Rayat Shikshan Sanstha's
YASHAVANTRAO CHAVAN INSTITUTE OF
SCIENCE, SATARA
(AN AUTONOMOUS COLLEGE)

Reaccredited by NAAC with 'A+' Grade

Bachelor of Science

Part - II

MICROBIOLOGY

Syllabus

to be implemented w .e. f. June, 2022

Structure of the course:

2) Semester III

Sr. No.	Subject title	Theory					Practical	
		Course No. and Course code	Title of Course	No. of lectures per week	Credits		No. of lectures per week	Credits
1.	Microbiology	Course V BMiT 301	Microbiological physiology and Metabolism	6	2	Microbiology practical III BMiP 301	8	4
		Course VI BMiT 302	Bacteriology and genetics	6	2			

2) Semester IV

Sr. No.	Subject title	Theory					Practical	
		Course No. and Course Code	Title of Course	No. of lectures per week	Credits		No. of lectures per week	Credits
1.	Microbiology	Course VII BMiT 303	Basics in medical microbiology and Immunology	6	2	Practical IV BMiP 302	8	4
		Course VIII BMiT 304	Applied Microbiology	6	2			

**B.Sc. II : Evaluation structure
Semester III.**

	ESE	Internal Exam		Practical			Submission	Total
		ISE-I	ISE-II		Exam	Journal	Seminar + Student Performance	
Course V	30	5	5	Practical-III(A)	25	5	5	150
Course VI	30	5	5	Practical IV(A)	25	5	5	

Semester IV

	ESE	Internal Exam		Practical			Submission	Total
		ISE-I	ISE-II		Exam	Journal	Industrial visit/Educational Tour + Student Performance	
Course V	30	5	5	Practical-III(A)	25	5	5	150
Course VI	30	5	5	Practical IV(A)	25	5	5	

Structure and titles of the course of B.Sc. II course

Semester III

Code	Name of Course	Units
BMiT 301	MICROBIAL PHYSIOLOGY AND METABOLISM (CREDITS:02; TOTAL HOURS : 45)	Unit I: Effect of Environment on Microbial Growth Unit II: Nutrient uptake and Transport Unit III : Chemoheterotrophic Metabolism - Aerobic Respiration Unit IV : Metabolism , anerobic respiration and fermentation
BMiT 302	Applied Microbiology (CREDITS:02; TOTAL HOURS : 45)	Unit I: Water Microbiology Unit II: Milk Microbiology Unit III : Air Microbiology Unit IV : Basic concepts of fermentation

Semester IV

BMiT 303	Bacteriology and Genetics (CREDITS:02; TOTAL HOURS : 45)	Unit I: Bacterial cell structure Unit II: Bacterial systematics and taxonomy Unit III : Basic concepts of Genetics Unit IV : Mutation
BMiT 304	Basics in Medical Microbiology and Immunology (CREDITS:02; TOTAL HOURS : 45)	Unit I: Host Pathogen Interaction Unit II: Infection and Disease Unit III : Defences of the host Unit IV : Antigen and Antibodies

Semester – III

Course – BMiT 301 **MICROBIAL PHYSIOLOGY AND METABOLISM**

Course Objectives: Student will able to

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

Credits (Total Credits 2)	SEMESTER-III BMiT 301 MICROBIAL PHYSIOLOGY AND METABOLISM	No. of hours per unit/credits
UNIT - I	Effect of Environment on Microbial Growth	(11)
	Microbial growth in response to environment – A) Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, 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) Effect of UV and Heavy metals	
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)	

Course outcomes: Student should be able to

1. Understand the types of microorganisms growing in different extreme environmental conditions.
2. Understand transport of nutrients and role of siderophores in iron uptake in microorganisms
3. Understand the concept of free energy change
4. Understand the pathways of sugar degradation and bioenergetics of these pathways.

References-

1. Microbiology –An introduction, eighth edition. Tortora, Funke, Case ,
2. Lehninger Principles of Biochemistry, David L. Nelson , Michael M. Cox, 5th ed. New York :W.H. Freeman c2008
3. Microbiology – Pelczar, Reid and Chan
4. Prescott, Harley and Klein’s Microbiology 7th Edition. Joanne Willey (Author), Linda Sherwood (Author), Chris Woolverton
5. General Microbiology Vol I. Powar and Dagainawala, Himalaya publishing house
6. Brock Biology of Microorganisms, Twelfth edition. Pearson International edition Madigan, Martinko, Dunlap, Clark
7. Principles of Microbiology – Ronald M. Atlas Second edition Mc Graw Hill Education

Course – BMiT 302 **Applied Microbiology**

Course Objectives: Student will able to

1. Study the basic concepts of air, water microbiology
2. Understand concepts of routine bacteriological analysis of water, air and milk
3. Understand composition of milk
4. Study basic concept of fermentation with respect to fermentor design , fermentation media

Credits (Total Credits 2)	SEMESTER-III BMiT 302 Applied Microbiology	No. of hours per unit/credits
UNIT - I	Water Microbiology	(11)
	A) Sources of microorganisms in water. B) Fecal pollution of water, Indicators of fecal pollution of water – <i>E. coli</i> C) Routine Bacteriological analysis of water. a. SPC and 2) Tests for coliforms - i. Qualitative-Detection of coliforms - Presumptive test, ii. Confirmed Test, Completed test. Differentiation between iii. coliforms - IMViC test, Eijkman test. iv. Quantitative – MPN, Membrane filter technique D) Municipal water purification process and its significance. E) Water borne diseases: 1. Cholera 2. Giardiasis	
UNIT - II	Milk Microbiology	(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	Air Microbiology	(11)

	A) Sources of microorganisms in air. B) Definitions of - Infectious dust, Droplets and 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 Fermentor design – Parts and their functions B) Fermentation Media - Water, carbon source, nitrogen source, precursors, growth factors, antifoam agents and 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	

Course outcomes- Students should be able to

1. Understand the principles and the significance of municipal water purification process.
2. Perform routine bacteriological analysis of water.
3. Understand importance of Infectious dust, Droplets and Droplet nuclei
4. Understand primary and secondary screening procedures

References

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

BMiP 302 Microbiology Practical III

Course Objectives: Student will able to

1. Understand the effect of various environmental factors on growth of micro organisms.
2. Study diauxic growth pattern of *E.coli*.
3. Study about oxidative and fermentative metabolism of sugars
4. Understand the technique for routine Bacteriological analysis of water

Credits (Total Credit 04)	SEMESTER-III BMiP 302 Microbiology Practical III	No. of hours per unit/credits
	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 <i>E. coli</i> . 6. Study of diauxic growth of <i>E.coli</i> 7. Preparation of HI medium	
	B. Biochemical tests	
	8. H L 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	

Course outcomes- Students should be able to

1. Understand various effect of environmental factors
2. Understand the significance of TDT, and decimal reduction time.
3. Understand to prepare different culture media
4. Understand the technique for routine Bacteriological analysis of water.

Practical references-

1. Microbiology in action by J. Heritage, E. G. V. Evans and R. A. Killington
2. cambridge university press
3. Practical Microbiology laboratory manual by B .Senthil Kumar, Zothansanga, N. Senthil Kumar
4. Experimental microbiology by Rakesh Patel, Vol I
5. Experimental microbiology by Rakesh Patel, Vol II
6. Basic and Practical Microbiology – Atlas.
7. Handbook of Bacteriological techniques F.J.Baker second ed.,Butterworth publications.
8. Laboratory Fundamentals of Microbiology – Alcamo, I. E
9. Media preparation- High media manual

SEMESTER- IV

Course BMiT401 **Bacteriology and Genetics**

Course Objectives: Student will able to

1. Study variations in Gram positive and Gram negative bacterial cell wall
2. Understand in detail different structures and functions of cell organelles
3. Study about bacterial systematic and taxonomy
4. Understand basic concepts of genetics w.r.t. various definitions.

Credits (Total Credits 2)	SEMESTER-IV BMiT401 Bacteriology and Genetics	No. of hours per unit/credits
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) nonnitrogenous Carbon (Glycogen PHB), Sulphur, Phosphorus	
UNIT - II	Modes of Gene transfer in bacteria and plasmids.	(11)
	a. Fate of exogenote in recipient cell. b. Transformation, Conjugation, Transduction c. Plasmids – i) Natural – Properties, types F plasmid, R plasmid, Col plasmid, Ti plasmid, Metabolic plasmid, structure and applications ii) Artificial – pBR 322- structure and applications	
UNIT - III	Basic concepts of Genetics	(11)

	<p>A) Gene, genome, genotype, phenotype, mutagen, recombinant, cistron, Split genes.</p> <p>B) Forms of DNA</p> <p>C) DNA sequence with unusual structure, Palindromic, hairpin or cruciform mirror repeat, triplex DNA, Tetraplex and H-DNA</p> <p>D) Genetic code – definition and properties of genetic code. Operon – Concept (Lac Operon)</p>	
UNIT - IV	Mutations	(12)
	<p>A) Basic Concepts, definitions- Missense , nonsense, neutral, silent , pleiotropic and suppressor mutations.</p> <p>B) Types of Mutation:</p> <p>a) Spontaneous mutation - Definition and basic concept</p> <p>b) Induced mutations -</p> <p>1) Physical and chemical mutagens</p> <p>2) Mechanism of mutagenesis by physical and chemical mutagens:</p> <p>i. Base analogues : 5-Bromouracil and 2- aminopurines</p> <p>ii. Mutagens modifying nitrogen bases- Nitrous acid, Hydroxylamine, Alkylating agents</p> <p>iii. Mutagens that distort DNA - a. Acridine dyes b. UV light</p> <p>G) C) DNA repair mechanisms- Photoreactivation</p>	

Course outcomes: Student should be able to

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

References

1. General Microbiology – R. Y. Stainer 5th ed Macmillan and Co (1961).
2. Chemical Microbiology – A. H. Rose Butterworths publications
3. Microbiology – Pelczar, Reid and Chan publications
4. Brock Biology of Microorganisms, Twelfth edition. Pearson International edition Madigan, Martinko, Dunlap, Clark Michael Madigan, John Martinko
5. Genetics. Monroe W. Stickberger 3rd edn MacMillan 1985 publication
6. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 5th ed. New York: W. H. Freeman c2008
7. Principles of microbiology – Ronald M. Atlas, Mosby publications 1995

Course – BMiT402 **Basics in Medical Microbiology and Immunology**

Course Objectives: student will able to

1. Study the basic concepts and definitions regarding host pathogen interactions.
2. Understand types of infections, modes of transmission and process of disease production
3. Understand defence mechanisms of host
4. Study about antigen, antibody definition, types and reactions

Credits (Total Credits 2)	SEMESTER-IV BMiT402 Basics in Medical Microbiology and Immunology	No. of hours per unit/credits
UNIT - I	Host Pathogen Interaction	(12)
	<p>A) Definitions : Host, Parasite, Commensal, etiological agent, Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Signs of disease, symptoms, syndrome, sequelae infections</p> <p>B) Classification of disease : Occurance (Epidemic, Endemic, Pandemic, Sporadic), severity or duration (Acute, Chronic), Extent of host involvement, Infectious(Communicable), noninfectious(Non communicable).</p> <p>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</p> <p>D) Sources and modes of transmission of infection : Exogenous and Endogenous (Patient, Carrier : types of carrier, Animals, insects, soil, water, food, Reserviors of infection), Fomites</p> <p>F) Modes of Transmission of disease :</p> <ol style="list-style-type: none"> 1. Transmission by air, water and food 2. Contact transmission 3. Vector borne transmission <p>F) Disease Process : How bacteria Cause Disease: Entry and Exit of Organisms : Portal of entry, preferred entry</p> <p>Virulence : Adherence, Attachment, colonization, Invasiveness, Enzymes and Toxin produced, Cell structures Viz. Cell wall, Capsule.</p>	

UNIT - II	Infection and Disease	(11)
	<p>A) Stages of infectious disease : Incubation period , Prodromal phase, invassive 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.</p>	
UNIT - III	Host defence mechanism	(11)
	<p>A) Organs and tissue of the immune system : Types of primary and secondary lymphoid organs 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 B) Types of Immunity : Active and Passive C)First line of defence : Physical, Chemical and Cellular mechanism D) Second line of defence : Inflammation and fever: Antimicrobial substances present in blood and tissue fluids , Phagocytic cells and phagocytosis. E) Third line of defence (Specific defence 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</p>	
UNIT - IV	Antigen and Antibodies	(11)
	<p>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 E) Test with example and application, Agglutination-slide and tube, haemagglutination, precipitation-slide, tube, immunodiffusion. Complement Fixation</p>	

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

BMiP- Microbiology practicals –IV

Course objectives: Student will able to

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. Isolate *Salmonella* and *Proteus Spp* from clinical sample.
4. Detect presence of antibody against *Salmonella spp* in serum sample by qualitative widal test

Credits (Total Credit 04)	SEMESTER-IV BMiP- Microbiology practicals –IV	No. of hours per unit/credits
	<ol style="list-style-type: none"> 1. Isolation of lac negative mutants of <i>E.coli</i> 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 <ol style="list-style-type: none"> a. peptone water b. Sugar fermentation medium- Glucose , Mannitol c. Simmon’s citrate agar slant d. Glucose phosphate broth e. Wilson and Blairs medium f. Christensen’s urea agar. g. phenylalanine deamination medium h. Gelatin agar <ol style="list-style-type: none"> i. Selenite F broth, j.tetrathionate broth 	

	<p>9. Isolation of causative agent of enteric fever : <i>Salmonella</i></p> <p>10. Isolation of causative agent of urinary tract infection : <i>Proteus</i></p> <p>11. Serological diagnosis of Enteric fever : Widal test (Qualitative)</p> <p>12. Agglutination test : Blood group detection</p> <p>13. RPR test</p> <p>14. Phenyl alanine deamination test</p> <p>15. Urea hydrolysis test</p> <p>16. Gelatin hydrolysis test</p> <p>17. Indole test</p> <p>18. Methyl red test</p> <p>19. Voges proskur's test</p> <p>20. Citrate utilization test</p>	
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Coures outcomes-Students should be able to

1. Understand the technique of isolation of lac negative mutants of E.coli
2. Able to perform Spore staining, Flagella staining, Nucleus staining, PHB granules staining
3. Isolate *Salmonella* and *Proteus Spp* from clinical sample
4. Determine the blood group.

Practical references:

1. Basic and Practical Microbiology – Atlas.
2. Bacteriological techniques F. J. Baker.
3. Laboratory Fundamentals of Microbiology – Alcamo, I. E.
4. Experimental microbiology by Rakesh patel, Vol I
5. Experimental microbiology by Rakesh patel, Vol II
6. Media preparation- High media manual