

**NORTH MAHARASHTRA UNIVERSITY, JALGAON**



**SYLLABUS FOR T.Y.B.Sc. MICROBIOLOGY**

**(WITH EFFECT FROM JUNE-2014)**

**North Maharashtra University, Jalgaon.**  
**Class:-T.Y.B.Sc. (Semester Pattern)**  
**(w.e.f. June 2014)**

MB YSC [Y for year, S for semester and C for course number].

The course structure and title of the courses for T.Y.B.Sc. (Microbiology) are as given below:

**Theory Courses (Semester I)**

Course	Title	Semester	Periods
MB 311	Microbial Genetics	I	60
MB 312	Fermentation Technology	I	60
MB 313	Microbial Metabolism	I	60
MB 314	Medical Microbiology	I	60
MB 315	Immunology	I	60
MB 316	Applied Microbiology	I	60

**Theory Courses (Semester II)**

Course	Title	Semester	Periods
MB 321	Molecular Biology	II	60
MB 322	Pharmaceutical Microbiology	II	60
MB 323	Enzymology	II	60
MB 324	Clinical Microbiology	II	60
MB 325	Diagnostic Immunology	II	60
MB 326	Environmental Microbiology	II	60

**Practical Courses (Annual)**

Course	Title
MB 307	Techniques in Diagnostic Microbiology
MB 308	Techniques in Industrial Microbiology
MB 309	Techniques in Applied Microbiology

**Note:-**

- ❖ A Study tour is compulsory for the T.Y.B.Sc students. The students should submit their tour reports at the time of practical examination.
- ❖ Each period is of 45 minutes duration.
- ❖ Each theory course is having weightage of 4 periods per week.
- ❖ Examination of practical course shall be held annually.
- ❖ This syllabus booklet contains 15 pages

**MB 311 Microbial Genetics**

<b>Unit I Central Dogma</b>	<b>20</b>
➤ Introduction to concept of central dogma	
➤ Meselson and Stahl experiment	
➤ Hershey and Chase experiment	
➤ Mechanism of DNA replication (Initiation, Elongation and Termination)	
➤ Mechanism of Transcription (Initiation, Elongation and Termination)	
➤ Mechanism of Translation (Initiation, Elongation and Termination)	
<b>Unit II Bacteriophage Genetics</b>	<b>20</b>
➤ Types of viral genome	
➤ Unusual features of viral genome	
➤ Structure of T4 and $\lambda$ phage	
➤ One step growth experiment	
➤ Lysogenic cycle	
➤ Lytic cycle	
➤ Phage mutants (Conditionally lethal, Host range and Rapid lysis mutants)	
<b>Unit III Gene Transfer Mechanism</b>	<b>20</b>
➤ Transformation –Mechanism in Gram positive and Gram negative bacteria	
➤ Conjugation –Mechanism, F plasmid, (Hfr, F <sup>+</sup> and F' cells)	
➤ Transduction –Mechanism of Generalized, Specialized & Abortive transduction, Phage conversion	
➤ Transposable elements –( IS elements, Tn3, Composite, Transposable phages)	

**MB 321 Molecular Biology**

<b>Unit I Gene Regulation</b>	<b>20</b>
➤ Modes and Mechanism of regulation (Induction and Repression)	
➤ Diauxic growth phenomenon.	
➤ Lac operon (Positive and Negative regulation)	
➤ Lac mutants	
➤ Tryptophan operon	
<b>Unit II Molecular Techniques</b>	<b>22</b>
➤ Methodology of rDNA technology	
➤ Applications of genetic engineering	
➤ Blotting techniques –Southern, Northern and Western blotting	
➤ Gene library & cDNA Library	
➤ Autoradiography	
➤ Gene mapping (Co-transformation and interrupted mating experiment)	
➤ Gene sequencing (Sanger and Maxam–Gilbert sequencing methods)	
<b>Unit III DNA Repair Mechanisms</b>	<b>18</b>
➤ Necessity of DNA repair	
➤ Photo reactivation	
➤ Excision repair	
➤ Base excision	
➤ Nucleotide excision	
➤ Mismatch repair	
➤ SOS repair	

**References**

1. David Clark and Nanette J. Pazdernik(2012) Molecular Biology, Academic Press,USA
2. Malacinski G. M. (2006) Essentials of Molecular biology, Narosa Publishing House, Delhi
3. Trun N. and Trempy J. (2004) Fundamentals of molecular biology, Blackwell Science Ltd, UK
4. Benjamin, L., (2000), Genes VIII, Oxford University Press Inc., New York.
5. Dale, J. W., (1994), Molecular Genetics of Bacteria, John Wiley and Sons Inc., New York.
6. Freifelder, D., (1993), Microbial Genetics, Jones and Bartlett Publishers, Inc.
7. Gardner (1994), Principles of Genetics, 8th Ed., John Wiley and Sons Inc., New York.
8. Glazer, A. N., (1995), Microbial Biotechnology, Academic Press, London.
9. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1995). General Microbiology, 5th Edition, MacMillan Press Ltd. London.

**MB 312 Fermentation Technology****Unit I Bioreactor Engineering** **20**

- Types of bioreactor (Air-lift fermenter and Bubble column bioreactor )
- Types of - Impeller, Sparger and Baffle arrangements
- Probes (O<sub>2</sub>&pH), Control of Temperature &Foam
- On-line, In-situ, Measurements within fermentors

**Unit II Industrial Sterilization and Strain Improvement** **20**

- Need of aseptic conditions in fermentation process
- Fermentation media sterilization –Batch and Continuous
- Sterilization of air by Filtration
- Methods of strain improvement based on
  1. Modification of permeability
  2. Mutation
  3. rDNA technology

**Unit III Scale Up and Large Scale Production** **20**

- Criteria for scale up
- Scale up of industrial process
- Large scale production :
  1. Beer
  2. Wine
  3. Vinegar

**MB 322 Pharmaceutical Microbiology****Unit I Quality Control and Quality Assurance** **20**

- Concept of quality control and quality assurance
- Raw material
- Finished product
- Packaging
- Documentation
- Regulations
- Pharmaceutical audit
- Pharmaceutical testing
  1. Ames test
  2. Sterility test
  3. Toxicity test
  4. Microbial assay (Antibiotic)

**Unit II Microbiological Aspects of Pharmaceuticals** **20**

- General organization of pharmaceutical industry
- Microbiological environmental monitoring
  1. Sterile manufacturing unit
  2. Bio-safety level
  3. Validation of LAF, Autoclave, Balance, pH meter and Centrifuge
  4. Large scale production of vaccine /immune sera –seed lot system

**Unit III Large-Scale Production of the following with respect to organisms involved, inoculum preparation, fermentation media, fermentation process, flow chart, recovery.** **20**

- Antibiotics: Streptomycin and Penicillin
- Enzyme : Amylase
- Vitamin: Cyanocobalamine
- Organic acids: Citric acid and Lactic acid
- Organic solvent: Ethanol
- Amino acids: L- Lysine and L- Glutamic acid

**References**

1. Stanbury, P. F., Whitaker, A., Hall, S. J, (1997), Principles of fermentation Technology, Aditya Book Pvt. Ltd., New Delhi.
2. Demain Arnold L. and Davies Julian E., (1999) Manual of Industrial Microbiology and Biotechnology, 2nd ed. Panima, ASM Press.
3. Bu'lock, J. and Kristiansen, B, (1987), Basic Biotechnology, Academic Press, London
4. Rehm, li J. and Reed, G, (1983), Biotechnology vol.111, VerlagChenue, Florida
5. Vyas, S. P. and Dixit, V. K., (1998), Phamaceutical Biotechnology, CBS Publisher, New Delhi.
6. Casida, L. E., (1991), Industrial Microbiology, Wiley Eastern, New Delhi
7. Pepler, H. J., Perlman, D., (1979), Microbial Technology, vol. I & II, Academic Press.
8. Prescott, S. C. And Dunn, C. G, (1987), Industrial Microbiology, 3rd Ed., McGraw Hill, New York.
9. Ratledge, C. and Kristiansen, B., (2001), Basic Biotechnology, Cambridge University Press.
10. Patel, A. H., (1984), Industrial Microbiology, MacMillan India Ltd., New Delhi.
11. Doelle, H. W., Mitchell, D. V. and Rolz, C E., (1992), Solid Substrate Cultivation, Elsevier Science Publishers Ltd.. England.
12. Crueger W and Crueger A., (2000) Biotechnology: A text book of Industrial microbiology, 2nd ed. Panima Publishing corporation, New Delhi
13. Jogdand S. N. (2006) Industrial Biotechnology, Himalaya Publishing House, Mumbai.

<b>MB 313 Microbial Metabolism</b>	
<b>Unit I Bioenergetics</b>	<b>20</b>
➤ Laws of thermodynamics	
➤ Concept of free energy, entropy and enthalpy	
➤ High energy compounds	
➤ Redox potential	
➤ Electron transport chain (ETC)	
➤ Reverse electron transport chain (RETC)	
<b>Unit II Catabolism</b>	<b>20</b>
➤ Catabolism of Polysaccharides: Starch and glycogen	
➤ Beta oxidation of fatty acids	
➤ Overview of catabolism of proteins	
➤ Transamination	
➤ Oxidative deamination	
➤ Non oxidative deamination	
➤ Stickland reaction	
<b>Unit III Anabolism</b>	<b>20</b>
➤ Polysaccharides: Glycogen and Peptidoglycan biosynthesis	
➤ Fatty acid biosynthesis	
➤ Purine and Pyrimidine nucleotide biosynthesis (de Novo and Salvage pathway)	
➤ Bacterial Photosynthesis (Light reaction and Dark reaction- Calvin cycle)	
<b>MB 323 Enzymology</b>	
<b>Unit I Vitamins and Coenzymes</b>	<b>18</b>
➤ Role of cofactor in metabolism	
➤ Structure and biochemical functions of the following:	
1.Nicotinic acid	
2.Riboflavin	
3.Thiamine	
4.Biotin	
5.Coenzyme A	
6.Folic acid	
<b>Unit 2. Enzyme Regulation</b>	<b>20</b>
➤ Allosteric enzyme: ATCase	
➤ Isoenzyme: LDH	
➤ Definition and significance of $K_M$ and $V_{Max}$	
➤ Reversible inhibition (Competitive, Uncompetitive and Noncompetitive)	
➤ Irreversible inhibition	
➤ Covalent modification	
➤ Proteolytic modification	
<b>Unit III Enzyme Technology</b>	<b>22</b>
➤ Methods of enzyme purification	
1.Molecular size: Gel exclusion chromatography	
2. Solubility difference :Isoelectric precipitation, salt precipitation	
3. Electric charge: Electrophoresis (SDS-PAGE)	
4. Adsorption – Affinity chromatography,	
➤ Enzyme assay technique (Spectrophotometric assay)	
➤ Immobilization: Concept, Methods and Applications	
➤ Enzyme engineering : Objectives, Principle and Methodology	

**References**

1. Lehninger, A I., (1982), Principles of Biochemistry, Butterworth Publishers, New York.
2. Moat, A., Foster, J., (1988), Microbial Physiology, 2nd Ed., Wiley Interscience Publications, New York.
3. Palmer T., (1985). Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester
4. Price, N. C, Stevens, L, (1989), Fundamentals of Enzymology, 2<sup>nd</sup> Ed., Oxford Sci. Publ., Oxford
5. Rose, A. H., (1983), Chemical Microbiology, 3rd Ed., Butterworth Publishers.
6. Stamen R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R., (1990), General Microbiology, 5th Ed., MacMillan Edu. Ltd., London
7. Stryer, L., (1988), Biochemistry, W H Freeman and Co., New York.
8. Satyanarayan U., (1999), Biochemistry, Books and Allied (P) Ltd. Calcutta

**MB 314 Medical Microbiology****Unit I Concepts in Medical Microbiology****20**

- Normal flora of human body
- Portal of entry of pathogen
- Stages of infectious diseases
- Virulence factors: Invasiveness and Toxigenicity
- Pattern of disease: Chronic and Acute
- Signs, symptoms and syndrome
- Laboratory diagnosis
- Prophylaxis
- Treatment
- Epidemiology
- introduction to CDC and WHO ;their efforts in various epidemics and diagnosis and control of community infection

**Unit II Anatomy of Human System****18**

- Brief with illustrations of following
  1. Skin
  2. Digestivesystem
  3. Respiratory system
  4. Nervous system (peripheral and central)
  5. Reproductive system
  6. Excretory system

**Unit III Chemotherapeutic agents****22**

- Criteria for evaluation of chemotherapeutic agents
- Antimicrobial spectrum of activity
- Mechanism of drug resistance
- Mode of action of antimicrobial agents
  - Penicillin, Cephalosporin, Tetracycline and Chloramphenicol
  - Polyenes and Griseofulvin
  - Amantadine and Zidovudine
  - Sulphonamides and Quinones
- Vaccines- Classification, General instruction for vaccination, Vaccination for high-risk individuals
- Antitoxin and Interferon as therapeutic drugs

**MB 324 Clinical Microbiology****Unit I Viral Infections and Diseases****20**

- Study of disease –causative agent, infectious dose, portal of entry, virulence, epidemiology, laboratory diagnosis, prophylaxis and treatment of following
  1. AIDS
  2. Polio
  3. Rabies
  4. Hepatitis
  5. Newly emerging diseases – Swine flu and Dengue

**Unit II Bacterial Infections and Diseases****22**

- Study of disease –causative agent, infectious dose, portal of entry, virulence, epidemiology, laboratory diagnosis, prophylaxis and treatment of following
  1. Tuberculosis
  2. Diphtheria
  3. Typhoid
  4. Cholera
  5. Tetanus
  6. Syphilis

**Unit III Fungal and Protozoal Diseases****18**

- Study of disease–Causative agent, portal of entry, pathogenicity, laboratory diagnosis and treatment of following
  1. Dermatophytosis
  2. Malaria
  3. Amoebic dysentery

**References**

1. Anantnarayan, P., Paniker, C. K. J., (2009), Ed 8<sup>th</sup>Textbook of Microbiology, Universities press, Hyderabad
2. Atlas, R. M.. (1995), Microorganisms in our world, Mosby Year Book Inc.
3. Chakraborty P (2013) A text book of Microbiology, New Central Book Agency, Delhi
4. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore.
5. Dey, N. C. and Dey, T. K., (1999) Medical Bacteriology and Microbiology, 16th Ed, Allied Agency, Calcutta.
6. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publ, England
7. Tortora, G. J., Funke, B. R. and Case, C. L., (2004), Microbiology, 8<sup>th</sup>Ed., Person Education (low price edition), Delhi
8. Zinsser, H. (1938), Microbiology, 19th Ed., Joklik, W. K., Willett, H. P., Amos, D. B., Wilfert, C. M., Prentice Hall International, Inc.

**MB 315 Immunology****Unit I Cells and Organs of Immune System****18**

- Blood cells: Morphology, formation and function
- Primary lymphoid organs (Structure and function of Thymus and Bone marrow)
- Secondary lymphoid organs (Structure and function of Spleen and Lymph node)



**Unit II Immune Mechanism** **22**

- Primary and secondary immune response
- Antigen processing and presentation
- Inflammatory response
- Cell Mediated Immunity (T cell -Types, T cell activation, mechanism)
- Humoral immunity ( B- cell Proliferation, Differentiation)
- Role of lymphokines in immune mechanism (IL 1 and IL2)
- Complement: Classical and Alternative pathway
- Interferon: Introduction, Mechanism and Significance.
- Tumor Necrosis Factor (TNF)

**Unit III Immunological Disorders** **20**

- Hypersensitivity: Types and mechanism in detail (Type I to IV)
- Autoimmune diseases :
  1. Anemia
  2. Rheumatoid arthritis
  3. Diabetes
  4. Myasthenia gravis

**MB 325 Diagnostic Immunology****Unit I Antigen and Antibody Reaction** **18**

- Concept of antibody avidity and affinity
- Antibody specificity – cross reactivity and types of specificity
- Precipitation
- Agglutination

**Unit II Immunological Technique** **22**

- Radio-Immuno Assay (RIA)
- Enzyme Linked Immuno Sorbent Assay (ELISA)
- Immunofluorescence
- Immunoelectrophoresis
- Complement fixation
- Widal test
- Western blot
- Immunodiffusion

**Unit III Tissue and Organ Transplantation** **20**

- Blood grouping – ABO and Rh system
- Structure and role of HLA
- HLA typing
- Transplantation: Types of graft, Graft rejection mechanism - suppression and tolerance

**References**

1. Ananthnarayan, P., Paniker, C. K. J., (1990), Textbook of Microbiology, Orient Longman, Madras.
2. Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
3. Coleman, R. M, Lombard M F, Sicard, R. E., (1989), Fundamental Immunology, 2nd Ed., W. C. Brown Publishers, USA.

4. Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
5. Kimball, J. W., (1990), Introduction to Immunology, MacMillan Publishing Company, New York.
6. Kuby, J. W. H., (1994), Immunology, Freeman and Company, New York.
7. Roitt, E. M., (1988), Essential Immunology, ELBS, Blackwell Sci. Publ., Oxford
8. Vyas, S. P. and Dixit, V. K.. (1998), Phamaceutical Biotechnology, CBS Publisher, New Delhi.
9. Weir, D. M., (1991), Immunology, Livingstone, ELBS and Churchill

<b>MB 316 Applied Microbiology</b>
------------------------------------

**Unit I Milk Microbiology****18**

- Milk - Definition, Composition and Types
- Pasteurization of Milk : Principle and Types
- Microbiological examination of milk-
  1. Standard plate count
  2. Breed count
  3. Test for mastitis
  4. MBRT test
  5. Resazurin test
  6. Brucella ring test
- Spoilage of milk
  1. Succession of microorganisms in milk
  2. Colour and flavour defects
  3. Sweet curdling
  4. Stormy fermentation ropiness
- Milk products : Fermented milk : Dahi / Yoghurt
- Milk products : Cheese (Types , General production process, Ripening and defects).

**Unit II Food Microbiology****22**

- Food fermentations
  1. Bread
  2. Idli
  3. Sauerkraut
- Food preservation : Principles and methods
- Microbial Food poisoning with respect to toxins, their effects, properties of toxins and treatment.
  1. *Staphylococcus aureus*
  2. *Bacillus cereus*
  3. *Clostridium botulinum*
- Food infection: Sources and prevention
  1. *Salmonella*
  2. *Vibrioparahaemolyticus*
- Aflatoxins: Structure, detection, mode of action and detoxification

**Unit III Geomicrobiology and Nanotechnology****20**

- Microbial leaching (Concept, laboratory and field methods)
- Copper and manganese leaching
- Nanotechnology- Scope, Microbial synthesis of silver nanoparticles

**MB 326 Environmental Microbiology****Unit I Plant pathology****20**

- Classification of plant diseases based on symptoms
- General methods of plant disease control
- Study of plant diseases with respect to causative agent, host, symptom and control:
  1. Wilt of cotton
  2. Citrus canker
  3. Downy mildew of grapes
  4. Whip smut of sugarcane
  5. Tikka disease of groundnut
  6. BBTV-Banana Bunchy Top Viral disease

**Unit II Soil Microbiology****20**

- Soil (Types, Composition and Soil microbes)
- Rhizosphere
- Biogeochemical cycles: C, N, S and P
- Concepts - Bioremediation, Bioaugmentation and Biostimulation
- Xenobiotics biodegradation e.g. Pesticide
- Degradation of Cellulose and Lignin

**Unit III Microbial Waste Treatment Methods****20**

- Waste (Types and management )
- Liquid waste (Aerobic and anaerobic methods)
- Solid waste (Composting)
- Role of microbes in greenhouse effect
- Acid rain

**References**

1. Adams, M. R., Moss, M. O, (1995), Food Microbiology, New Age International, New Delhi.
2. Banwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi.
3. Bilgrami, K. S, Dube, H. G., (1994), Text book of Modern Plant pathology, Vikas Publ., New Delhi.
4. Frazier, W. C, Westhoff, D C., (1988), Food Microbiology, Tata McGraw Hill, New Delhi.
5. Kuderia, V. P., (1998), Water Pollution, PragatiPralkashan, Meerut.
6. Martin Alexander, Introduction to Soil Microbiology, 2nd Ed., Wiley Eastern Ltd.
7. Mitchell, R. (!974), Introduction to Environmental Microbiology, Prentice Hall, New Jersey.
8. Pathak, V. N, Khatri, N.K., Pathak, M., (1996), Fundamentals of Plant Pathology, Agro- botanical Publ., Bikaner.
9. Powar, C. B., Dagainwalla, H. F., (1990), General Microbiology, vol. I & II, Himalaya Publishing House, Mumbai.
10. Rao, M. N. and Rao, H. V N , (1989), Air Pollution, Tata McGraw Hill Publ, Company, Ltd., New Delhi.
11. Salle, A. J., (!990), Fundamentals of Microbiology, Tata McGraw Hill, New Delhi.
12. Winton, A. L , Winton, K. B , (1998), Milk and Milk Products, Agro-botanical Publ, Bikaner.
13. Sayyed R Z and Patil, A S, (2009) Biotechnology: Emerging Trends, Scientific Publishers Jodhpur.

**PRACTICALS (Annual)****MB 307 Techniques in Diagnostic Microbiology**

1. Isolation and identification of *Proteus* from urine sample
2. Isolation and identification of *E. coli*. from stool sample
3. Isolation and identification of *Salmonella* from blood sample
4. Isolation and identification of *Staphylococcus* from pus sample
5. Isolation and identification of *Pseudomonas* from blue pus sample
6. Isolation and identification of *Candida albicans* from skin
7. Determination of Minimum Inhibitory Concentration (MIC) of an antibiotic
8. Antibiotic resistance/sensitivity testing
9. Demonstration of Koch's postulates
10. Widal test using slide test (Qualitative & Quantitative)
11. HIV DOT ELISA test
12. VDRL test for syphilis by antigen- antibody reaction
13. Demonstration of precipitation reaction based on Immuno diffusion test
14. Demonstration of DNA / Protein separation by gel electrophoresis
15. Cultivation of anaerobic bacteria using anaerobic jar / any suitable method.
16. Isolation of microflora from human skin
17. Demonstration of permanent slides : *Plasmodium*, *Entamoeba histolytica*
18. Demonstration of universal precautions for handling of blood and other body fluids
19. Bactericidal activity of human blood
20. **Activity:** Visit to blood bank/Diagnostic Pathology Lab

**MB 308 Techniques in Industrial Microbiology**

1. Preparation of alcoholic beverage from fruit juice
2. Production of citric acid by fermentation
3. Separation and identification of sugar/ amino acid by Thin Layer Chromatography (TLC)
4. Determine protein content of commercial enzyme preparation (e.g. amylase)
5. Determine activity of enzyme (e.g. amylase) and calculation of specific activity
6. Measurement of fungal growth by biomass (mycelia dry weight) method
7. Total fungal spore count using Neubauer's chamber
8. UV survival curve
9. Immobilization of yeast cells
10. Validation of Laminar air flow system / Autoclave validation
11. Microbiological assay of Streptomycin or Penicillin by cup plate/ paper disc method
12. Sterility testing by membrane filter technique
13. Study of microbial quality of pharmaceutical substance using microbial limit test
14. Isolation of antibiotic resistant bacterial population by gradient plate method
15. Determine Thermal Death Point (TDP) of given microorganism
16. Determine Thermal Death Time (TDT) of given microorganism
17. Standardization of given disinfectant by using Phenol coefficient test (Rideal Walker test)
18. Wine Preparation (from fruits e.g. grapes)
19. Presentation of data in an appropriate form (graphs/ tables using MS Excel)
20. **Activity:** Visit to Food-Milk Processing/ Pharmaceutical/Fermentation Industry OR Research organization

**MB 309 Techniques in Applied Microbiology**

1. Measurement of microbial cell size by micrometry
2. Estimation of cellulose
3. Estimation of nitrogen/ protein by micro-Kjeldahl method
4. Isolation of phosphate solubilizing microorganism from soil
5. Isolation of bacteriophage from sewage
6. Demonstration of cultivation of virus in chick embryo
7. Determination of Biological Oxygen Demand (BOD) of sewage water
8. Determination of Chemical Oxygen Demand (COD) of sewage water
9. Detection of antifungal/antibacterial activity of plant extract (e.g. Garlic)
10. Isolation and identification of *Rhizobium* from root nodules
11. Isolation and identification of *Xanthomonas* from infected citrus fruit or leaf
12. Isolation and identification of *Azotobacter* from rhizospheric soil
13. Enumeration of rhizospheric microorganisms
14. MBRT test for milk sample
15. Phosphatase test for milk sample
16. Preparation and application of biofertilizer *Azotobacter/ Rhizobium/ Tricoderma*
17. Isolation and characterization of food fermenting microorganism from idli batter
18. Mushroom cultivation
19. Demonstration safety handling of hazards chemicals and awareness of Material Safety Data Sheet (MSDS)
20. **Activity: Exposition activity**

**Guideline for exposition activity**

**Exposition activity should be based on current/relevant topic** related to microbiology or allied life science discipline and should have local/global importance. The activity should be submitted as **Survey report/PowerPoint Presentation /MiniReview/Design and execution of experiment/Demonstration of sophisticated instruments/Demonstration of microbiological techniques/Practices**

**Objective :**

- To learn team work and co-operative learning
- To enhance the interaction between students and teachers
- To aware students about local problems
- Intellectual thinking and research awareness
- To improve writing/presentation/interview skills
- Effective use of library and online resources

**Procedure :**

- ❖ Group of **(2-4) students** should be assigned the work guided by all interested staff members in the department. The students will be expected to work as a team involving reporting of their activities individually in the form of dissertation Report/ Presentation/Demonstration
- ❖ Report of this activity should not exceed 4 Pages (Page size A4, Font used - Times New Roman Font size 12 Double space) OR 10 PowerPoint slides. OR 5-8 minutes demonstration
- ❖ In charge Teacher and head should certify the work completed by the student with note that the opinion/data/result generated in the **project has only academic importance and has no legal/ commercial significance.**

**Example 1**

**“Emergence of Swine Flu in 2009 in Dhule District”** allotted to 4 students. All students should work together to collect data by visiting hospitals, health centres online and use library resources. Conclusively each student should submit a separate report.

Student 1 : Survey report of Emergence of Swine Flu in 2009 in Dhule city,

Student 2 : Minireview on Swine flu,

Student 3: Give demonstration about prophylactic measurements

Student 4: Give Power Point Presentation on Emergence of Swine Flu in 2009 in Dhule District.

**Example 2**

**“Microbiological quality assessment of drinking water supplied to Shirpur city”** allotted to 3 students

Students should work together for collection of data, design and execution of experimental work. Finally each student should submit separate report.

Student 1 : Report on sample collection, methodology and results

Student 2: Minireview on “Quality of drinking Water –microbiologist’s view”

Student : Presentation on quality improvement methodology used for Shirpur Municipal corporation

**References for practical courses**

1. Aneja, K. R. (1996) Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., WishwaPrakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Harley, J.P. and Prescott, L. M (1996) Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
3. Jayararnan, I (1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
4. Mackie and McCartney (1989) Practical Medical Microbiology, 13rd \ Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
5. Plummer, D. T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
6. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. 2007, Ane’s Book India, New Delhi
7. Gunashekharan P, Introduction to microbial techniques,
8. Parija S. C., (2007) Textbook of Practical Microbiology, Ahuja Publishing House New Delhi
9. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi.
10. Deshmukh A.M. (1997) 1st Edition, Handbook of Media, Stains and reagents in Microbiology Pama Publications.
11. Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai

## Skills acquired by the students for job prospectus

An relevant emphasis is given on educating the students about the basic and applied knowledge along with fine skills as a good microbiologist. Emphasis has also been given on various opportunities available as microbiologist and how to avail these. Following is the list every student will acquire during his/her graduation programme.

### Laboratory Skills.

**A student successfully completing B.Sc. microbiology will demonstrate ability in Using a bright field light microscope to view and interpret slides, including**

- Correctly setting up and focusing the microscope
- Proper handling, cleaning, and storage of the microscope
- Correctly using all lenses
- Recording microscopic observations

**Properly preparing slides for microbiological examination, including**

- Cleaning and disposing of slides
- Preparing smears from solid and liquid cultures
- Performing wet mount and/or hanging drop preparations
- Performing Gram stains

**Using properly aseptic techniques for the transfer and handling of microorganisms and instruments, including**

- Sterilizing and maintaining sterility of transfer instruments
- Performing aseptic transfer
- Obtaining microbial samples

**Using appropriate microbiological media and test systems, including**

- Isolating colonies and/or plaques
  - Maintaining pure cultures
  - Using biochemical test media
  - Recording accurately macroscopic observations
- Estimating the number of microbes in a sample using serial dilution techniques, including
- Choosing and using correctly pipettes and pipetting devices
  - Spreading correctly diluted samples for counting
  - Estimating appropriate dilutions
  - Extrapolating plate counts to obtain the correct CFU or PFU in the starting sample

**Using standard microbiology laboratory equipment correctly, including**

- Using the standard metric system for weights, lengths, diameters, and volumes
- Lighting and adjusting a laboratory burner
- Using an incubator

### Laboratory Thinking Skills.

**A student successfully completing B.Sc. microbiology will demonstrate an increased skill level in Cognitive processes, including**

- Formulating a clear, answerable question
- Developing a testable hypothesis
- Predicting expected results
- Following an experimental protocol

**Analytical skills, including**

- a. Collecting and organizing data in a systematic fashion
- b. Presenting data in an appropriate form (graphs, tables, figures, or descriptive paragraphs)
- c. Assessing the validity of the data (including integrity and significance)
- d. Drawing appropriate conclusions based on the results

**Communication skills, including**

- a. Discussing and presenting lab results or findings in the laboratory
- Interpersonal and citizenry skills, including
- a. Working effectively in teams or groups so that the task, results, and analysis are shared
  - b. Effectively managing time and tasks allowing concurrent and/or overlapping tasks to be done simultaneously, by individuals and within a group
  - c. Integrating knowledge and making informed judgments about microbiology in everyday life

**Laboratory Safety skills.****A student successfully completing B.Sc. microbiology will demonstrate ability to explain and practice safe Microbiological procedures, including**

- a. Reporting all spills and broken glassware to the instructor and receiving instructions for cleanup
- b. Identifying methods of aseptic transfer
- c. Minimizing or containing the production of aerosols and describing the hazards associated with aerosols
- d. Washing hands prior to and following laboratories and at any time contamination is suspected
- e. Using universal precautions with blood and other body fluids
- f. Disinfecting lab benches and equipment prior to and at the conclusion of each lab session, using an appropriate disinfectant and allowing a suitable contact time
- g. Identifying proper disposal of different types of waste
- h. Reading and signing a laboratory safety agreement indicating that the student has read and understands the safety rules of the laboratory
- i. Practicing good lab practices, including returning materials to proper locations, proper care and handling of equipment, and keeping the bench top clear of extraneous materials

**Protective procedures, including**

- a. Tying long hair back, wearing personal protective equipment (eye protection, coats, gloves, closed shoes; glasses may be preferred to contact lenses), and using such equipment in appropriate situations
- b. Using always appropriate pipetting devices and understanding that mouth pipetting is forbidden
- c. Never eating or drinking in the laboratory
- d. Never applying cosmetics, handling contact lenses, or placing objects (fingers, pencils, etc.) in the mouth or touching the face

**Emergency procedures, including**

- a. Locating and properly using emergency equipment (eye wash stations, first aid kits, fire extinguishers, chemical safety showers, telephones, and emergency numbers)
- b. Reporting all injuries immediately to the instructor

**Following proper steps in the event of an emergency**

- Train faculty, staff, and students in proper waste stream management
- Provide and maintain all necessary safety equipment and information resources
- Train faculty, staff and students in the use of safety equipment and procedures
- Train faculty and staff in use of MSDS

(Reference : ASM's Curriculum Recommendations: Microbiology Majors Program, [www.asm.org](http://www.asm.org))



### Careers in the Field of Microbiology

Microbiological sciences, the study of microorganisms and their relationship to the environment, provide a foundation for a variety of careers. Some scientists conduct basic research to increase the knowledge of these microscopic organisms, while those in applied field use this knowledge to develop new medicines, increase crop yields and improve the environment. Science graduates also work in management or administration, planning programs for food and drug testing, some work as consultants to business firms, sell chemicals or laboratory instruments, or write for technical publications. Even a bachelor's degree is sufficient for advanced technician jobs in the various fields, lab/research assistant positions, or testing and inspection jobs. An advanced degree is required for most other positions in the scientific field. The students can pursue carrier in diverse fields such as Pharmaceutical Microbiology, Industrial Microbiology, Microbial biotechnology, Environmental Biology, Food and Dairy Microbiology, Biofuels and Bioenergy. The research carrier includes the areas in Biomedical Research, Immunology, Proteomics and Genomics, Genetic Engineering and molecular biology. The opportunities are also in some allied fields like Intellectual Property Rights, Forensic Science, Clinical research, Bioinformatics, Nanotechnology etc.

As microbiologist could work for a number of different profit and nonprofit organizations and business or the government. Here is a list of just a few of them:

- Pharmaceutical, Biotech, cosmetic and Chemical Companies
- Public Health Agencies - blood bank, pathology etc.
- State / Government Laboratories and Agencies
- Medical Research Laboratories, Clinics and Hospitals - Cancer, AIDS, TB, Malaria etc.
- Private / Govt. Research Foundations - NCL, NARI, NEERI, CCMB, CDFD, NIV, Reliance, ARI, ICMR, CDRI, TFIR, CSIR, CSRI, etc.
- Agricultural /Dairy / Pesticide Industries
- Food / Beverages Manufacturers and Food & Drug Administration
- Patent / Forensic officials, Forensic Department
- Bio Instrument companies

Currently abundant opportunities are knocking in different areas such as academic institutions, medical schools, the government, and pharmaceutical industry for individuals with training in modern microbiology. Student can work in these settings with a Bachelor's or Master's degree as a technician, lab in charge, manager, junior scientist in R&D lab or as a scientist with a Ph.D.