M.Sc. APPLIED MICROBIOLOGY

SYLLABUS BASED ON THE SEMESTER SYSTEM

ELIGIBILITY REQUIREMENTS:

Candidates who have passed B.Sc (Hons.)/B.Sc. with 10+2+3 pattern with any two of the following subjects: Botany, Zoology, Biotechnology, Microbiology, Chemistry, Industrial Microbiology, Life Science, Environmental Sciences and secured at least 50% marks in aggregate, shall be considered eligible for admission to M.Sc. in Applied Microbiology Course.

GENERAL GUIDELINES:

1. There shall be four semesters in 2 years M.Sc. Course of Applied Microbiology with a total of 80 credits.
2. Candidates will select two minor elective courses (2 credits each) offered from other Department/Schools, Faculty of Science, BHU.
3. The dissertation work will be carried out by the students in the 4^{th} Semester at BHU or any other university/institute, and this would include submission of Dissertation and Viva-voce examinations.
4. The dissertation work and seminar presentation shall be evaluated separately by the internal as well as external examiners.

M.Sc. APPLIED MICROBIOLOGY
Department of Botany, Banaras Hindu University, Varanasi - 221005

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

SEMESTER-I		
Course Code	**Course Title**	**Credits**
AMM-101	General Microbiology	3
AMM-102	Biochemical and Molecular Techniques	3
AMM-103	Microbial Metabolism	3
AMM-104	Microbial Genetics	3
AMM-105	Lab work based on Course AMM-101 and Course AMM-102	2+2
AMM-106	Lab work based on Course AMM-103 and Course AMM-104	2+2
	Total	**20**
SEMESTER-II		
AMM-201	Environmental Microbiology and Wastewater Management	3
AMM-202	Immunology	3
AMM-203	Microbial Genomics	3
AMM-204	Microbial Enzyme Technology	3
AMM-205	Lab work based on Course AMM-201 and Course AMM-202	2+2
AMM-206	Lab work based on Course AMM-203 and Course AMM-204	2+2
AMM-207 M#	Microbial Diversity, Management and Exploitation ***(Minor Elective)***	2
	Total	**22**
SEMESTER-III		
AMM-301	Bioprocess Technology and Engineering	3
AMM-302	Medical Microbiology	3
AMM-303	Agricultural Microbiology	3
AMM-304	Food and Dairy Microbiology	3
AMM-305	Lab work based on Course AMM-301 and Course AMM-302	2+2
AMM-306	Lab work based on Course AMM-303 and Course AMM-304	2+2
AMM-307 M#	Microbial Biogeochemistry ***(Minor Elective)***	2
	Total	**22**
SEMESTER-IV		
AMM-401	Dissertation work and Viva-voce examination	12
AMM-402	Seminar presentation	4
	Total	**16**
	Grand Total	**80**

Applied Microbiology students shall opt Minor Electives from other PG Programmes.

M.Sc. Applied Microbiology Syllabus
SEMESTER – I

AMM-101: General Microbiology

A brief idea of microbial diversity and scope of microbiology.
Principles of classification of microbes: Morphological, metabolic and molecular criteria for the classification, a brief introduction to major group of bacteria.
Structure of Gram positive and Gram negative bacteria: Cell membrane, cell wall, flagella, capsule and slime, chromosome, ribosome, plasmid and endospores.
A brief account of genetic recombination in bacteria (transformation, conjugation and transduction).
A general account of different types of viruses; structure of bacteriophages belonging to 'T' series.
Lytic cycle in T even phages and its regulation; lysogeny and its regulation in lambda phage; a brief account of viroids and prions, mycoplasma, rickettsia and chlamydia.

Suggested Readings:

1. *Pelczar* MJ, Chan ECS, *Krieg* NR (*2006*), Microbiology (*5th edition)* Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. *Powar* CB and *Daginawala* HF (*2005*), General Microbiology Vol. I & II 8th edition, Himalaya Publishing House, Mumbai.
3. Davis, B.D., *Delbecco*, R., *Eisen*, H.N. and *Ginsburg*, H.S. (*1990*) Microbiology, 5th edition, Harper & raw, New York.
4. *Madigan MT*, *Martinko JM*, Dunlap PV, Clark DP (2011), Brock Biology of Microorganisms, 13th edition, Pearson Education Inc.
5. Willey J.M., Sherwood L.M., Woolverton C.J. (2010) Prescott's Microbiology (8th edition) McGraw-Hill Higher Education.

AMM-102: Biochemical and Molecular Techniques

Electrophoresis: Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis (AGE), native-PAGE, SDS-PAGE.
Isolation and purification: (a) DNA (genomic and plasmid) (b) RNA and (c) proteins.
Isoelectric focusing (IEF) amd 2D electrophoresis: Principles, kinds of pH gradients used in IEF-free carrier ampholytes, immobilized pH gradients.
Blotting: Principles, Transfer techniques, Southern, Northern, Western and Dot blots.
Gene Cloning: Cloning vectors, molecular cloning and construction of DNA libraries.
DNA amplification: Polymerase chain reaction (PCR), RT- PCR.
Genome mapping: RFLPs, RAPD, AFLP and FISH.
Genome expression analysis: Microarray and EST.
DNA sequencing: Chemical degradation, Dideoxy nucleotide sequencing and Automated sequencing methods.
Gene silencing: RNA interference (RNAi), Mechanism of post-transcriptional gene silencing, Importance of hairpin vector, Dicer, RDRP in gene silencing, Application of RNAi.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual *(Fourth Edition)* (2012) By Michael R. Green and Joseph Sambrook, Cold Spring Harbor Laboratory Press.
2. Principles and Techniques of Practical Biochemistry *(Fourth Edition)* by Keith M. (editor); Walker John M. (editor), Wilson (author), Publisher: Cambridge University Press (1994)
3. Single- Molecule Techniques: A Laboratory Manual, by Paul R. Selvin and Taekjip Ha, Cold Spring Harbor Laboratory Press, U.S. (1st edition) (2007)

AMM-103: Microbial Metabolism

Structure and function of biomolecules: Carbohydrates, proteins, lipids.
Enzymes: Characteristics, Ribozymes, co-enzymes, kinetics-M-M equation, determination of Km and Vmax, mechanism of action - binding of substrate and lowering of activation energy, covalent catalysis, acid- base catalysis, allosteric regulation, enzyme inhibition.
Metabolism: General concepts, laws of thermodynamics, redox potential, free energy change of the reactions catabolism – anabolism, ATP as high energy phosphate compound, ATP synthesis.
Bacterial photosynthesis.
Assimilation of sulphur, phosphorus and nitrogen.

Suggested Readings:

1. Conn, E E, Stumpf, P K, Bruening G & Doi R Y (1987) Outlines of Biochemistry, 5th Edition, John Wiley and Sons, New York.
2. Nelson, DL & Cox, MM (2008) Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman & Co, NewYork, USA.
3. Berg, JM, Tymoczko, JL & Stryer, L. (2011) Biochemistry, Seventh Edition, Freeman & Co., New York, USA.

4. Weil, J.H. (1990) General Biochemistry, Sixth Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
5. Caldwell, Daniel R.(1999) Microbial Physiology and Metabolism, Star edition.
6. Doelle, H. W. (1975) Bacterial Metabolism (2nd Edition), Academic Press, New York– San Francisco– London

AMM-104: Microbial Genetics

Nucleic Acids: Structure, physical and chemical properties of DNA and RNA, extra-chromosomal DNA-profile, function and evolution.

DNA replication, damage and repair, spontaneous and induced mutation, reversion of mutation.

Transposition: Structure of transposons, replicative and non-replicative transposition, transposon mutagenesis.

Genetic recombination; Molecular models and mechanism, Gene conversion. Gene expression and regulation: Operons and regulons, repression and activation of *Lac operon*, feedback inhibition and regulation of virulence genes in pathogenic bacteria. Signal transduction in microbes.

Application of microbe in recombinant *DNA* Technology.

Suggested Readings:

1. Lewin's Genes X, Jones and Bartlett Publishers, Inc; 10th International edition (2009) by Jocelyn E. Krebs, Ellott S. Goldstein and Stephen T. Kilpatrick.
2. Wiley-Blackwell; 5th Edition (2010) Molecular Genetics of Bacteria, Jeremy W. Dale (Author), Simon F. Park (Author)
3. Genomes (1st edition) (1999) T.A. Brown, Garland Science.
4. Molecular Biology of the Gene, International Edition by James D. Watson, Tania A. Baker, Stephen P. Bell and Alexander Gann (2007) Pearson.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition by Bernard J. Glick, Jack J. Pasternak and Cheryl L. Patten, American Society for Microbiology (2010).

AMM-105: Lab work based on Course AMM 101 and Course AMM 102

AMM-106: Lab work based on Course AMM 103 and Course AMM 104

M.Sc. Applied Microbiology Syllabus
SEMESTER – II

AMM-201: Environmental Microbiology and Wastewater Management

Aeromicrobiology: Microorganisms in indoor and outdoor air environment, nature of bioaerosols, their fate and transport; aeroallergens and allergies.

Soil microorganisms and their significance in soil quality management.

Microorganisms in aquatic environments and their significance in water quality management.

Brief introduction to various stages of wastewater treatment: Primary, secondary and tertiary treatment.

Definition of extremophiles its domain, Energy transduction in extremephiles in general, physiology and biochemistry of various extremophiles such as thremophiles, acidophiles, alkalophiles, psychrophiles and halophiles.

Indicator microorganisms for water quality, Definition of biosensors, its various types and biotechnological significance.

Use of microorganisms as dead living cells and Immobilized cells for removal of heavy metals from wastewater.

Suggested Readings:

1. Environmental Microbiology, Academic Press; 2 edition (2008), Raina M. Maier, Ian L. Pepper and Charles P. Gerba.
2. Chemistry of the Environment, 2 edition, by Ronald A. Bailey, Herbert M. Clark, James P. Ferris and Sonja Krause, Academic Press; (2002)
3. Environmental Science and Technology-A Sustainable Approach to Green Science and Technology, CRC Press; 2 edition (2006) Stanley E. Manahan.
4. Microbial Ecology: Fundamentals and Applications Ronald M. Atlas and Richard Bartha 5th edition, Pearson Education India, (1998).

AMM-202: Immunology

Introduction to immune system: Cells and organs of immune system; hematopoiesis; Antigens, haptens, adjuvants immunoglobulins and monoclonal antibodies; B and T cell interaction.

Antigen antibody interactions and its applications.

Immunoglobulin and TCR genes and generation of diversity: Organization of

Immunoglobulin and TCR genes; V(D)J rearrangements; somatic hypermutation and affinity

maturation; immunoglobulin gene expression and its regulation; organization of TCR genes and mechanisms of diversity.

Major histocompatibility complex: Structure and function; immunological memory; complement system; action of cytotoxic T lymphocytes.

Immunology in health and disease- Immunological disorders, graft transplantation and rejection concept of immunotherapy.

Suggested Readings:

1. Essentials of Clinical Immunology 5th Edition by Helen Chapel, Mansel Haeney, Siraj Misbah and Neil Snowden, Wiley-Blackwell (2006).
2. Roitt's Essential Immunology: Includes Free Desktop Edition (Essentials) 12th Edition by Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt Wiley-Blackwell (2011).
3. Immunobiology: The Immune System in Health and Disease, 6th Revised edition by Charles A. Janeway, Paul Travers, Mark Walport and Mark J. Shlomchik, Churchill Livingstone; (2004)
4. Clark WR (1991). The experimental foundations of modern immunology, John Wiley and Sons Inc. New York.
5. Kubey J. (2007) (6^{th} edition). Immunology, W.H. Freeman and Co., New York.

AMM-203: Microbial Genomics

DNA/gene manipulating enzymes: Endonuclease, Exonuclease, Ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase.

Genomes: Size, physical structure, genome analysis, gene duplication.

Genomics: Basic concept and its application in health and agriculture.

DNA damage and repair: Damaging agents, Thymine dimer, 6-4 photoproducts, photoreactivation, excision repair.

Programmed cell death (apoptosis): Inducing factors, molecular mechanisms, malfunctioning and significance.

Recombinant DNA Technology: Production of transgenic plants, genetically modified crops.

Functional genomics and mapping of genome: Basic concept, Simple sequence length polymorphism (SSCP), Serial analysis of gene expression (SAGE), Single nucleotide polymorphism (SNP), Denaturing gradient gel electrophoresis (DGGE).

Metagenomics: Basic concept and importance.

Suggested Readings:

1. Microbial Functional Genomics by Jizhong Zhou, Dorothea K. Thompson, Ying Xu and James M. Tiedje.
2. Cell and Molecular Biology by Karp G.
3. Molecular Cell Biology by Lodish, Berk, Kaiser, Krieger, Scott, Bretscher, Ploegh and Matsudairia.
4. Bacterial Genomes and Infectious Diseases by Ricky V.L. Chan, Philip M. Sherman and Billy Bourke.
5. Metagenomics by Ronald Cohn Jesse Russell.

AMM-204: Microbial Enzyme Technology

Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme reactors.

Immobilized enzymes: Physical and chemical methods of immobilization, immobilization supports, kinetics of immobilized enzymes.

Enzyme catalysis in apolar medium, reverse micellar entrapment of enzymes and its applications.

Application of enzymes: synthesis of chemicals using enzymes, food technology and medicine.

Enzymes in diagnostic assays.

Enzyme electrodes, immunoenzyme techniques.

Commercial products of microbes: Antibiotics, biopolymers, biosensors, biopesticides Production of biofuels.

Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiplasmodial, anti-inflammatory compounds.

Suggested Readings:

1. Methods in Enzymology. Volume 22 - Enzyme purification and related techniques.Edited by William B. Jakoby. Academic Press, New York.
2. Allosteric Enzymes - Kinetic Behaviour. 1982. by B.I. Kurganov. John Wiley and Sons.Inc., New York.
3. Biotechnology. Volume 7 A - Enzymes in Biotechnology. 1983 Edited by H. J. Rehm and G. Reed. Verlag Chemie.

4. Hand Book of Enzyme Biotechnology by Wiseman.
5. Enzymes as Drugs Edited by John S.Holcenberg and Joseph Roberts , John Wiley & Sons New York.
6. Methods of Enzymatic Analysis by Hans Ulrich, Bergmeyer, Academic Press.
7. Methods in Enzymology by W.A. Wood, Academic Press.
8. Advances in Enzymology by Alton Meister, Interscience Publishers.
9. Topics in Enzyme and Fermentation Biotechnology by L.N. Wiseman, John Wiley and Sons.

AMM-205: Lab work based on Course AMM 201 and Course AMM 202

AMM-206: Lab work based on Course AMM 203 and Course AMM 204

AMM 207M: Microbial Diversity, Management and Exploitation
(Minor Elective)

The microbial world: Major domains and their general characteristics; application of *rRNA* phylogenetic methods.
General concepts regarding biodiversity: Definition, diversity/species richness and species abundance.
Monitoring microbial diversity: Structural, genetical and physiological diversity, species concept in microbial world.
Microbial diversity and ecosystem function: Population, Guilds and Community and syntrophism.
Management and exploitation of microbial diversity.
Use of microbes in environmental bioremediation.

Suggested Readings:

1. Microbial Diversity by Colwd, D. 1999, Academic Press.
2. Microbial Life in Extreme Environments. Edited by D. J. Kushner. Academic Press.
3. Microbiology of Extreme Environments. Edited by Clive Edward. Open University Press. Milton Keynes.
4. Microbial Ecology. Fundamentals and Applications by Ronald M. Atlas and Richard Bartha. 4th Edition, Pearson Education India, 1998.
5. Brocks Biology of Microorganisms, 8th Edition, (International Edition - 1997) by Michael T. Madigan, John M. Martinko and Jack Parker, Prentice Hall Internation Inc.

M.Sc. Applied Microbiology Syllabus
SEMESTER – III

AMM 301: Bioprocess Technology and Engineering

An introduction to fermentation processes- Range of fermentation process, microbial biomass.
Microbial growth kinetics- Batch culture, continuous culture, industrial applications of continuous culture processes, fed-batch culture.
The isolation, preservation and improvement of industrially important and useful microorganisms. Industrial fermentation- typical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle, buffers, precursors and metabolic regulators, oxygen requirement.
Media sterilization, sterilization of fermenter, sterilization of the feed.
Inocula for industrial fermentation- development of inocula for yeast, bacteria, fungi and actinomycetes, the inoculation of fermenters.
Design of fermenter, basic functions, construction, aeration and agitation, oxygen requirements of industrial fermentation.

Suggested Readings:

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman, McNeul and Harvey.
2. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
3. Fermentation Biotechnology: Industrial Perspectives by Chand.
4. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.
5. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
6. Bioprocess Engineering Principles by Doran, Acad. Press, London.
7. Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N, Y.

AMM 302: Medical Microbiology

General topics on Medical Microbiology: History and development, Koch's postulates, classification of medically important bacteria. Infection: source, modes of transmission, portal of entry into the susceptible host and prevention. Bacterial pathogenicity, identification of bacteria: staining methods, culture methods, biochemical tests and other recent methods. Sterilization and disinfection. Normal microbial flora, antimicrobial agents, drug resistance and drug sensitivity test.

Systematic Microbiology: Diseases caused by Gram positive cocci - sore throat, pneumonia etc., Diseases caused by Gram negative cocci - meningitis, gonorrhoea etc. Diseases caused by Gram positive bacilli - Tuberculosis, Diphtheria, Tetanus, Gas gangrene etc., Diseases caused by Gram negative bacilli of Entrobacteriaceae - Enteric fever, Bacillary dysentery, UTI etc.

Diseases caused by other Gram negative bacilli - Cholera, Plague, Whooping cough, Wound infection, Septicemia etc. Sexually Transmitted Diseases. Diseases caused by mycoplasma, Chlamydia, Rickettsia. Overview of Medical Mycology, Important Fungal Diseases – Superficial, Subcutaneous, Systemic and Opportunistic Mycosis. Overview of Medical Parasitology, Important Protozoan Diseases- Malaria, Leishmaniasis, Amoebiasis, Giardiasis etc. Important Helmenthic Diseases- Ascariasis, Ankylostomiasis, Filariasis, Taeniasis, Echinococcosis, Schistosomiasis etc. Overview of Medical Virology, Important Viral Diseases– Herpesvirus, Poliovirus, Rabies virus, Arboviruses Hepatites, HIV etc. Opportunistic Microbial Infection, Water, Milk and Food borne diseases, Microbial Vaccine.

Suggested Readings:

1. Greenwood D (2007). Medical Microbiology. I.K. International.
2. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
3. Talaro KP and Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.
6. Nester E.W, Anderson DG and Nester MT (2006). Microbiology. A Human Perspective. McGraw Hill.
7. Harvey, R.A., Champe, P.C. and Fisher, B.D. 2007. Lippincott's Illustrated Reviews : Microbiology. Lippincott Williams and Wilkins, New Delhi/New York.

AMM 303: Agricultural Microbiology

Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial diversity: significance and conservation; effect of agricultural practices on soil organisms.

Biological nitrogen-fixation: The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen-fixation.

Rhizobium-Legume Association; Symplasmids, N2 fixation by non-leguminous plants.

Chemical transformation by microbes: Organic matter decomposition, nutrient mineralization and immobilization; transformation of carbon and carbon compounds.

Biodegradation of herbicides and pesticides.

Biofertilizer: Mass cultivation of microbial inoculants; green manuring; algalization; *Azolla*.

Microbial products and plant health: Plant growth promoting rhizobacteria (PGPR); significance of mycorrhizae.

Microbial herbicides; biological control.

Suggested Readings:

1. Gallon JR & Chaplin AE (1987) An Introduction to Nitrogen Fixation, Cassel Educational Limited, London.
2. Smith RJ, Lea PJ & Chaplin JR (1999) Nitrogen Fixation. In : Plant Biochemistry & Molecular Biology, Second Edition edited by Lea PJ & Leegood RC, John Wiley & Sons, New York, pp. 137-162.
3. Rai A.N (1990) A Handbook of Symbiotic Cyanobacteria, CRC Press, Boca Raton, Florida, USA.
4. Postgate J R (1987) Nitrogen Fixation, second edition, Arnold, London.
5. Stacey G, Burris RH & Evans HJ (1992) Biological Nitrogen Fixation. Chapman & Hall, New York.
6. Sprent JI & Sprent P (1990) Nitrogen Fixing Organisms: Pure and Applied Aspects. Chapman & Hall, London.
7. Kannaiyan S, Kumar K & Govindrajan K (2007) Biofertlizers Technology, Saujanya Books, New Delhi.

AMM 304: Food and Dairy Microbiology

Microbiology of food, Fermented food, wine, bakery products, cereals, and milk products.

Microbial spoilage of food products including cereals, fruits, vegetables, meat, fish, and dairy products.

Principles of food preservatives, Chemical food preservatives.

Mushroom cultivation, Single cell proteins.

Microbiological examination of milk and milk products, source of their contamination and control.

Starter cultures

Microbiological legal standards of selected food and milk products.

Food poisoning and microbial toxins produced in food items and dairy products.

Suggested Readings:

1. Applied Dairy Microbiology (2nd Edition) Revised and expanded edited by Elmer H. Marth 2005.

2. Milk and Dairy Product Technology, Edgar Spreer (Dresden, Germany) Tranlated by Axal Mixa, Brijbasi Art Press Ltd., 2005.
3. Food Microbiology. 2nd Edition, Adams MR and Moss MO. (1995).
4. Basic Food Microbiology by Banwart George J.
5. Advances in Applied Microbiology by D. Pearlman, Academic Press.

AMM-305: Lab work based on Course AMM 301 and Course AMM 302

AMM-306: Lab work based on Course AMM 303 and Course AMM 304

AMM-307M: Microbial Biogeochemistry
(Minor Elective)
The role of microbes in biosphere: microbes and the origin and evolution of life on earth, Microbial diversity- Structural, Physiological and genetical, Species Concept.
Structure and organisation of microbial communities.
Exploration and quantification of the microbial diversity; Cultivation and non-cultivation approaches; complementarities between cultivation and non-cultivation approaches;
Microbial crusts: Formation, composition and function.
Microbial aspects of biogeochemical cycling of C, N, P and S.
Survival strategies of microbes in extreme habitats.
Microbial leaching: Copper, Gold, Uranium.

Suggested Readings:
1. James E. Zajic (1969) Microbial Biogeochmistry, Academic Press, New York.
2. Fenchel & King & Blackburn (1998) Bacterial Biogeochmistry (2nd Edition), Academic Press.
3. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P. (2011) Brock Biology of Microorganism (13th edition) Pearson Education Inc.
4. Willey, J.M., Sherwood, L., Woolverton, C.J. (2010) Prescott's Microbiology (8th edition) McGraw Hill.

M.Sc. Applied Microbiology Syllabus
SEMESTER – IV

AMM-401: Dissertation work and Viva-voce examination
The dissertation work will be carried out by the students in the 4th Semester at BHU or any other university/institute and this would include submission of dissertation and Viva-voce examinations.

AMM-402: Seminar presentation
Seminar presentation shall be evaluated separately by the internal as well as external examiners.