Master of Science in Microbiology
(M. Sc. Microbiology Semester System)

Revised Curriculum 2017

Tribhuvan University
Kirtipur, Kathmandu

March, 2017
Introduction

The M. Sc. Microbiology programme was started at Tribhuvan University in 1990 for the first time in Nepal at the Central Department of Microbiology, Tribhuvan University, Kirtipur. The course structure of the programme was changed in 1999 and revised in 2008 and 2009. However, the course was based on the annual examination system. The course structure of the programme was changed into semester system in 2013. Therefore, this is a revised semester system credit based course curriculum to make it more competitive and research oriented.

This revision in curriculum has been done to vertically align the M.Sc. microbiology course with the four year bachelor of science (B.Sc.) in microbiology course curriculum. The present curriculum is designed to upgrade M.Sc. microbiology degree of Institute of Science and Technology, Tribhuvan University to international level in accordance to current advances in microbiology. The new curriculum emphasizes on research based teaching learning practice. The new M.Sc. microbiology degree programme will be semester system credit based as per international trend. The present curriculum aims to produce qualified microbiologists, molecular biologists, researchers and scientists as per national and international demand. The master's degree holders will be able to use skills of modern molecular biology techniques in basic science research or in applied research areas of microbiology. The graduates will be able to work as a qualified scientist for investigating the potential uses of microorganisms to produce antibiotics, antibodies, steroids, vaccines, hormones and other products of microbial origin. The master's degree holders will be able to work as a microbiologist and research scientist in the laboratories for monitoring, identifying and helping to control infectious diseases. They will also be able to work as qualified researchers and scientists in the institutions related to food production, crop protection and soil fertility. The master's degree holders will be eligible to be the lecturers of microbiology programme offered by Institute of Science and Technology and other institutions of Tribhuvan University or other universities for teaching, mentoring and supervising bachelors and masters' level microbiology students.

Course Structure

The entire course is divided into four semesters within two academic years. The first semester course covers the disciplines of General/Advances in Microbiology, Immunology, Microbial Genetics, Microbial Biochemistry and Biotechnology and practical on these courses. The second semester offers track selection among four different disciplines of microbiology for specialization. The four disciplines from second semester include Medical Microbiology, Public Health Microbiology, Food and Industrial Microbiology and Agriculture Microbiology with their practical courses. The fourth semester is completely research oriented that includes internship based on selected track and dissertation. In the second semester, students are required to choose one of the four different disciplines offered and continue with it through the third and fourth semesters. Students are not allowed to change the discipline once they have chosen it. The selection of discipline of microbiology may depend upon the facilities available at the department. To gain exposure, students are encouraged to go for excursion after the second semester.
Eligibility and Admission Procedures

Candidates having a Bachelor’s Degree in Microbiology from Tribhuvan University or equivalent degree recognized by Tribhuvan University are eligible to apply for the M. Sc. Microbiology programme. Each applicant should appear and pass entrance examination conducted by the Central Department of Microbiology. The enrollment will be based on merit. The candidates failed to get minimum qualifying marks/pass marks in the entrance examination will not be enrolled in the program.

Hours of Instruction

1. Working days: 90 days in a semester
2. Class hours:
   - Theory: One credit is equivalent to 15 teaching hours in a semester. One theory paper of 1 credit will have 1 hour of lecture per week.
   - Practical: One credit is equal to 60 practical hours in a semester. One practical paper of 1.5 or 1 credit will have 4 hours of practical per week.

Total Credits: 64 credits within four semesters.

Attendance

Student should be regular in their classes. Students failing to maintain 80% presence are not allowed to appear in the semester-end examinations and regarded as “not qualified”. However, in case of serious illness the students with 70% attendance will be given chance to appear in the semester-end exam. In this case students have to submit an authorized medical certificate.

Normal and Maximum Duration of Study

The normal duration and the maximum duration for the completion of the requirements for the program is as follows:

- Normal duration 24 months (4 academic semesters)
- Maximum duration 60 months (10 academic semesters)

Students failing to complete the requirements in 60 months have to re-enroll.

Teaching Methodology

The general teaching methodology of the program includes interactive lectures, students’ presentations, case studies and projects.

Language of Instruction: English
Examination

Students must pass the internal assessment in order to appear for the final examination. There will be two internal assessments which will count as 40% internal evaluation. The pass marks for theory is 50% and practical subjects are 50%. Institute of Science and Technology, Tribhuvan University will conduct semester examination. The final semester examination of 1 credit theory subject will have 1 hour of duration ($3C \approx 3\text{ hrs}$) and internal assessment will have one hour of duration for all subjects.

Evaluation/Examination

The evaluation is based on the internal evaluation and final semester examination. The internal evaluation which is 40% of total evaluation is done by the department based on different criteria of evaluation listed below;

Internal evaluation (40%):
- a. Attendance: 5 marks
- b. Seminar/class test/home assignment: 5 marks
- c. Project work/case study: 5 marks
- d. Midterm exam: 10 marks
- e. Final term evaluation: 15 marks

The remaining 60% of the evaluation is done from semester examination taken at the end of the semester. The semester examination will be conducted by the office of the Dean of Science and Technology. Students are required to obtain 50% to pass internal exam (evaluation) as well as semester end examination.

Make-up/retake examination

Students failing in not more than two subjects in first, second and third semester shall appear in make-up exams in following cycle of exams. Students failing in two subjects in the fourth semester shall be given opportunity to appear in make-up exam within one month after the final result.

Grading

Total marks obtained in internal and semester-end exams shall be graded on absolute bases.

The performance of a student shall be made on four point scale ranging from 0 to 4 grades. A student must secure a minimum Grade Point Average (GPA) of 2.7 or Grade B minus (B-) in each course.
**Absolute grading scale**

<table>
<thead>
<tr>
<th>Grade</th>
<th>CGPA</th>
<th>Percentage Equivalent</th>
<th>Performance Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.0</td>
<td>90 and above</td>
<td>Distinction</td>
</tr>
<tr>
<td>A-</td>
<td>3.7</td>
<td>80-89.9</td>
<td>Very Good</td>
</tr>
<tr>
<td>B+</td>
<td>3.3</td>
<td>70-79.9</td>
<td>First Division</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
<td>60-69.9</td>
<td>Second Division</td>
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<tr>
<td>B-</td>
<td>2.7</td>
<td>50-59.9</td>
<td>Pass in individual subject</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>Below 50</td>
<td>Fail</td>
</tr>
</tbody>
</table>

The students shall receive their semester grades and academic transcript grades only in letter grades and GPA scores. Students securing only 2.7 in grade point are considered as “pass in individual subject”.

In order to pass the semester examination the student must secure a minimum of Grade ‘B’ or Cumulative Grade Point Average (CGPA) of 3.0. A student who secures CGPA less than 3 may request for the opportunity to improve the grade in two subjects. The office of the dean will provide one time opportunity to appear in semester exam. The exam of the courses to improve grade shall be held as per course cycle.

**Courses**

**Semester I**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course Title</th>
<th>Nature of Course</th>
<th>Credits</th>
<th>Evaluation (40% internal assessment)</th>
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<tbody>
<tr>
<td>MB 501</td>
<td>Advances in Microbiology</td>
<td>T</td>
<td>3</td>
<td>75 (45+30)</td>
</tr>
<tr>
<td>MB 502</td>
<td>Immunology</td>
<td>T</td>
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<td>75 (45+30)</td>
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<tr>
<td>MB 503</td>
<td>Microbial Genetics and Molecular Biology</td>
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<tr>
<td>MB 506</td>
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# Discipline I: Public Health Microbiology

**Semester II**

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<tbody>
<tr>
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<td>75 (45+30)</td>
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<td>MB 552</td>
<td>Applied Environmental Microbiology</td>
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<td>MB 553</td>
<td>Fundamentals of Epidemiology</td>
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<tbody>
<tr>
<td>MB 601</td>
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<td>MB 603</td>
<td>Emerging Infectious Diseases</td>
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<td>Public Health Laboratory</td>
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**Semester IV**

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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
Discipline II: Medical Microbiology

**Semester II**

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<tr>
<td>MB 551</td>
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<tr>
<td>MB 557</td>
<td>Systemic and Diagnostic Bacteriology-1</td>
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<tr>
<td>MB 558</td>
<td>Systemic and Diagnostic Virology-1</td>
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<td>MB 559</td>
<td>Systemic and Diagnostic Parasitology</td>
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**Semester III**

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<tbody>
<tr>
<td>MB 601</td>
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<td>Systemic and Diagnostic Bacteriology-2</td>
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<tr>
<td>MB 608</td>
<td>Systemic and Diagnostic Virology-2</td>
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<tr>
<td>MB 609</td>
<td>Systemic and Diagnostic Mycology</td>
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<td>MB 610</td>
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**Semester IV**

**Compulsory course**

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<tr>
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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
### Discipline III: Food and Industrial Microbiology

#### Semester II

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<th>Credits</th>
<th>Evaluation (40% internal assessment)</th>
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<tbody>
<tr>
<td>MB 562</td>
<td>Food Fermentation Technology</td>
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<td>3</td>
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<tr>
<td>MB 563</td>
<td>Food Biotechnology and Neutraceuticals</td>
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<td>3</td>
<td>75 (45+30)</td>
</tr>
<tr>
<td>MB 564</td>
<td>Advanced Food Microbiology</td>
<td>T</td>
<td>3</td>
<td>75 (45+30)</td>
</tr>
<tr>
<td>MB 565</td>
<td>Food Safety Management and Toxicology</td>
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<td>3</td>
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<tr>
<td>MB 566</td>
<td>Practical on (MB 562 + MB 563)</td>
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<tr>
<td>MB 567</td>
<td>Practical on (MB 564 + MB 565)</td>
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#### Semester III

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<th>Nature of Course</th>
<th>Credits</th>
<th>Evaluation (40% internal assessment)</th>
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<tbody>
<tr>
<td>MB 601</td>
<td>Research Methods and Biostatistics</td>
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<td>75 (45+30)</td>
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<tr>
<td>MB 612</td>
<td>Food Science and Nutrition</td>
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<tr>
<td>MB 613</td>
<td>Food Processing and Preservation Technology</td>
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<td>Total Quality Management and Quality Assurance</td>
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#### Semester IV

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<th>Nature of Course</th>
<th>Credits</th>
<th>Evaluation (40% internal assessment)</th>
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<tbody>
<tr>
<td>MB 655</td>
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<td>MB 656</td>
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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
### Discipline IV: Agriculture Microbiology

#### Semester II

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<th>Evaluation</th>
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<tbody>
<tr>
<td>MB 568</td>
<td>Biological Control</td>
<td>T</td>
<td>3</td>
<td>75 (45+30)</td>
</tr>
<tr>
<td>MB 569</td>
<td>Soil Microbiology</td>
<td>T</td>
<td>3</td>
<td>75 (45+30)</td>
</tr>
<tr>
<td>MB 570</td>
<td>Microbial Metabolism in Soil</td>
<td>T</td>
<td>3</td>
<td>75 (45+30)</td>
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<tr>
<td>MB 571</td>
<td>Soil Fertilizers</td>
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**Total** 16 400

#### Semester III

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<tbody>
<tr>
<td>MB 601</td>
<td>Research Methods and Biostatistics</td>
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<td>3</td>
<td>75 (45+30)</td>
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<tr>
<td>MB 617</td>
<td>Microbial Inoculants in Agriculture, Livestock and Forestry</td>
<td>T</td>
<td>3</td>
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<td>MB 618</td>
<td>Applied Soil Microbiology</td>
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<td>3</td>
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<td>MB 619</td>
<td>Microbial Diseases and Agriculture Biotechnology</td>
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**Total** 16 400

#### Semester IV

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**Total** 16 200

S/US- Satisfactory (Pass)/unsatisfactory (Fail)
### Compulsory Courses for All Disciplines

**Semester I**

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**MB 501 Advances in Microbiology**

Course Title: Advances in Microbiology  
Course No.: MB 501  
Nature of Course: Theory (3 credits)

**Objectives**
Upon the completion of the course students will have knowledge on
a. Bacterial and viral taxonomy  
b. Structure and physiology of bacteria, virus and fungi  
c. Transport system and pathways of protein secretion  
d. Growth and recovery of bacteria and bacteriophage

**Course Contents**

**Bergey's Classification of Bacteria**  
7 hrs  

**Pathways of Protein Secretion**  
5 hrs  
General secretory pathway (GSP), Type I, Type II, Type III, Type IV secretion system, Bacterial invasion mediated by cytoskeletal function, Disruption of tight junction

**Bacterial Structure and Transport Mechanism**  
5 hrs  
Overview of prokaryotic cell structure and function, Cell membrane and function, Cell wall and function, Passive diffusion, Facilitated diffusion, Active transport, Group translocation, Iron transport, ABC transporter

**Bacterial Growth, Growth Kinetics**  
4 hrs  
Lag phase, Exponential or log phase, Stationary phase, Death phase, Generation time determination, Diauxic growth

**Bacterial Metabolism**  
10 hrs  
Nutrient, Macro and Micro elements, Requirement of carbon, hydrogen and oxygen, Nutritional types of microorganisms, Free energy and reactions, Oxidation-Reduction reaction and electron carrier, Role of ATP in metabolism, Mechanism of generating ATP, Photophosphorylation, Substrate-level phosphorylation, Oxidative phosphorylation, Chemiosmotic theory, Overview of metabolism, Catabolism, Anabolism, Breakdown of glucose to pyruvate, Embden-Meyerhof pathway, Pentose phosphate pathway, Entner-Doudoroff pathway, Kreb cycle, Fermentation, Lactic acid fermentation, Ethanol fermentation, Mixed acid fermentation, Butanediol fermentation, Anaerobic respiration, Photosynthesis, Light dependent and light independent reaction
Fungi: Structure, Classification and Physiology  7 hrs
Classification, Fungal cell structure and function, Nutrition and metabolism, Reproduction and life cycle of yeast and mold

Viruses: Structure, Classification and Replication  7 hrs
Virus classification and nomenclature, Phylogenetic analysis and taxonomy of viruses and Bacteriophages, Morphology and structure of viruses, Propagation and identification of viruses and bacteriophages, Replication of viruses and bacteriophages, Virus purification and assays, Host-virus interaction

References
MB 502 Immunology

Course Title: Immunology
Course No.: MB 502
Nature of Course: Theory (3 credits)

Objectives
Upon completion of the course, students will be able to understand
a. Basic immunology and immunopathology of viral, bacterial, parasite, autoimmune, tumor and fungal diseases
b. Immunological techniques and assays

Course Contents

Basic Concept of Immunology 2 hrs
Immunology, Immunity; Anatomical feature and location of human lymphatic system, Role of organs, Cells, tissues and other components in immune system

Innate Immunity 3 hrs
General overview of host pathogen interaction, Non-specific defense against the microbial infections, Physical and anatomical barriers, Cells and secretory molecules, Serum components, Phagocytosis

Complements 2 hrs
Mechanism and significance of classical and alternative pathways of complement system

Cells and Tissues of Adaptive Immunity 3 hrs
Types, functions and development (maturation, activation and differentiation) of T and B cells

Antigens 2 hrs
Types and properties; Conditions of antigenicity

Antibodies and Immunoglobulins 5 hrs
Molecular structure, Classes, Subclasses, Types, Subtypes, Genetic basis of diversity

In Vitro Antigen-Antibody Reactions 5 hrs
Types, principle, procedures and applications of precipitation, Agglutination, Antibodies labelling methods; Immunofluorescence assay, ELISA, Radioimmuno assay, Immuno electrophoresis, Immuno blotting methods

Cell Mediated Immune Response 5 hrs
Cells involved in cell mediated immunity; Structure and function of MHC in antigen processing, Presentation and effector mechanism

Types and Function of Cytokines and TLR 3 hrs
Immune Disorders 5 hrs
Immunological tolerance; Hypersensitivity, Autoimmunity and Allergy; Congenital and acquired Immunodeficiency

Immunopathology of Bacterial, Viral and Parasitic Infections 5 hrs

Vaccinology 5 hrs
Overview of vaccine and vaccination, Types of vaccines- killed organism as a vaccine, Attenuated vaccine, Methods of attenuation, New experimental vaccines, Vaccine production techniques, Quality and efficacy, Adverse events following immunization, Recent developments and prospects

References
MB 503 Microbial Genetics and Molecular Biology

Course Title: Microbial Genetics and Molecular Biology   Full Marks: 75
Course No.: MB 503                                                               Pass Marks: 37.5
Nature of Course: Theory (3 credits)                                                   Semester: I

Objective
Upon the completion of the course students will have knowledge on
a. Microbial genetics and techniques and applications of molecular biology

Course Contents

Fundamentals on Genes, DNA, RNA, Genome and Genetics 2 hrs

DNA Recombination and Transfer in Prokaryote 3 hrs

DNA Replication 5 hrs
Molecular mechanism of DNA, Replication in prokaryotic and eukaryotic cells

Gene Expression 5 hrs
Molecular mechanism and stages of transcription in prokaryotes, viruses and bacteriophages, Post transcriptional modifications

Process of Protein Synthesis 5 hrs
Role of RNA and translation of the genetic code, Steps involved in translation, Post translational modification of proteins, Post translational modifications

Regulation of Gene Expression 5 hrs
Mechanism of Lac-operon and Trp operon, Control of gene expression at transcriptional, post transcriptional, translational and hormonal level

Mutations 5 hrs
Types of Mutation, Mutagenic agents: Physical, chemical and biological, Detection of mutants

Recombinant DNA Technology 8 hrs
Principle, procedures and mechanism of gene cloning, Sources of DNA for cloning, Restriction enzymes and their characteristics, Formation of the recombinant DNA, Cloning vectors, Expression vectors, Detection of the recombinant DNA, Cloning of the eukaryotic genes in bacteria

Molecular Techniques 7 hrs
Extraction and purification of plasmid and chromosomal DNA and RNA, Principle, procedures and applications of PCR based techniques and blotting techniques in Microbiology: Plasmid profiling, PCR, Real time PCR, RFLP, DNA Finger printing, Western blotting, Southern blotting, Northern blotting, PFGE, Gene sequencing, DNA microarray
References
MB 504 Biochemistry and Biotechnology

Course Title: Biochemistry and Biotechnology
Course No.: MB 504
Nature of Course: Theory (3 credits)

Objectives
Upon completion of the course, students will have knowledge on
a. General and microbial biochemistry
b. Production, purification, and product recovery of industrial products of microbial origin

Course Contents

Biochemistry

Introduction to Biomolecules
Definition, classification, sources and function: Carbohydrates, Amino Acids and Proteins, lipids and fatty acids, and nucleic acids
2 hrs

Vitamins
Absorption, sources and functions: Fat-soluble vitamins, Water-soluble vitamins
3 hrs

Enzymology
Michaelis-Menten equation, Lineweaver- Burk equation, Enzyme inhibition: Competitive inhibition, non-competitive inhibition, uncompetitive inhibition
2 hrs

Metabolism of Carbohydrates
Metabolism of dietary carbohydrate, Pathway, metabolic regulation and significance: Glycogen metabolism, Glycolysis, Gluconeogenesis, Pentose phosphate pathway shunt, Uronic acid pathway, Metabolism of Disaccharides (sucrose, maltose, lactose)
4 hrs

Krebs Cycle
Pathway, metabolic regulation and significance: Krebs cycle, Amphibolic role of cycle, Glyoxylate cycle
1 hr

Oxidative Phosphorylation
Pathway, metabolic regulation and significance: Electron transport chain and oxidative phosphorylation, Substrate level phosphorylation
1 hr

Metabolism of Amino Acids
Metabolism of dietary proteins, Metabolism of ammonia, Biosynthesis of non-essential amino acids, Catabolism of essential amino acids, Pathway, metabolic regulation and significance: Urea cycle
3 hrs
Metabolism of Lipids  
5 hrs  
Metabolism of dietary lipids, Pathway, metabolic regulation and significance: Beta-Oxidation of fatty acids and energetic, Alpha-oxidation, Omega-oxidation, Biosynthesis of ketone bodies, Biosynthesis of saturated and unsaturated fatty acids, Biosynthesis of triacylglycerol

Metabolism of Nucleic Acids  
2 hrs  
Pathway, metabolic regulation and significance: Purine and pyrimidine nucleotide (De Novo and salvage pathways), Purine nucleotide interconversion, Formation of deoxyribonucleotides.

Biotechnology

Animal and Plant Biotechnology  
4 hrs  
Vector, Gene transfer techniques in plants (based on Ti and Ri Plasmid, Intermediate and helper plasmid, Binary vector, Virus as vector), Gene transfer techniques using Agrobacterium; Animal cell culture technology, Plant cell and tissue culture technology

Microbial Production, Purifications and Product Recovery of Metabolites and Fermented Foods  
10 hrs  
Antibiotics (Benzy1 Penicillin, Streptomycin), Vitamins (Riboflavin and vitamin B12) Amino acids (Glutamic acid, Lysine, Tryptophan), Nucleic acids, Organic acids (Citric acid, Lactic acid, Kojic acid), Enzymes (Amylase, Protease, Glucose isomerase), Alcoholic beverages (Wine, Beer, Distilled liquor-whisky), Fermented Foods (Kinema, Soya sauce, Natto, Kimchi), Single cell protein

Production and Product Recovery of  
2 hrs  
Human growth hormones, Interferon, Insulin

Types, Applications and Production Process of  
3 hrs  
Microbial bio-fertilizers (Rhizobium, Azotobacter, Bacillus, Cyanobacteria, VAM)

Types, Applications and Production Procedures of  
3 hrs  
Bacterial, Fungal and viral biopesticides and bioherbicides

References

MB 505 Practical on (MB 501 + MB 502)

Course Title: Practical on (MB 501+MB 502)  
Full Marks: 50  
Course No.: MB 505  
Pass Marks: 25  
Nature of Course: Practical (2 credits)  
Semester: I

**Advances in Microbiology**

**Course Contents**

**Bacterial Morphology**
1. Microscopy and staining

**Microbial Physiology**
2. Measurement of growth of bacteria
3. Enumeration techniques
4. Biomass determination
5. Determination of bacterial growth curve in broth medium
6. Effect of environmental factors on bacterial growth
7. Degradation experiments- Cellulose, Starch, Gelatin, Casein, Tween 80
8. Conventional biochemical testing for identification of Enterobacteriaceae family
9. Biochemical identification of unknown bacteria (Gram positive, Gram negative)
10. Antimicrobial susceptibility test

**Yeast, Mold and Actinomycetes**
11. Isolation, enumeration and morphological identification of yeast and molds
12. Growth of molds in different condition
13. Isolation and characterization of Actinomycetes

**Viruses**
14. Isolation and enumeration of bacteriophage
15. One step growth curve of bacteriophage

**Immunology**

**Course Contents**
1. Handling of laboratory animals
2. Animal inoculation techniques using different routes
3. Immunization of laboratory animals antiserum harvesting
4. Purification of immunoglobulins
5. In vitro serological tests
   - Precipitation (Gel: Single and Ouchterlony double diffusion)
   - Agglutination (Slide, Tube, Latex and Haemagglutination)
   - Neutralization test
   - ELISA
   - Immunoelectrophoresis
   - Immunoflourescence technique
- Immunochromatographic technique
- Complement fixation test

6. Hypersensitivity reactions (Montoux test, Allergy test)
7. Blood grouping from forensic samples
MB 506 Practical on (MB 503 + MB 504)

Course Title: Practical on (MB 503 + MB 504)  Full Marks: 50
Course No.: MB 506  Pass Marks: 25
Nature of Course: Practical (2 credits)  Semester: I

Microbial Genetics and Molecular Biology

Course Contents
1. Nucleus staining (Prokaryotic and Eukaryotic cells)
2. Nucleic acid Extraction- Extraction and purification of chromosomal and plasmid DNA from bacteria, Extraction and purification of DNA from yeast cells, Extraction and purification of RNA from Prokaryotic and Eukaryotic cells, Extraction of DNA from biological samples (viscera, body fluids, hair, skin, nails) for forensic analysis
3. Confirmation of DNA extraction by Agarose Gel Electrophoresis
4. DNA transformation experiments
5. Detection and isolation of mutants
6. Plasmid profiling, PCR, Blotting techniques

Biochemistry and Biotechnology

Course Contents

Biochemistry
1. Preparation of different solutions and buffer
2. Titration curves of amino acids
3. Qualitative tests for characterization of carbohydrates, proteins and lipids
4. Quantitative tests for characterization of carbohydrates, proteins and lipids
5. Identification of unknown carbohydrates
6. Isolation of protein
7. Study effect of pH, temperature and effectors on enzyme activity
8. Determination of enzyme kinetics Km and Vmax
9. Quantitative determination of blood sugar, cholesterol level, total protein, albumin
10. Determination of enzyme activities: ALT, GOT, amylase
11. Extraction of glycogen from liver
12. Separation of amino acids by single and double ascending paper chromatography
13. Separation characterization of sugars, amino acids and lipids by thin layer chromatography
14. Separation of amino acids and proteins by ion-exchange chromatography
15. Identification of drugs using chromatographic techniques for drug abuse cases, samples (blood, urine)
16. Analysis of serum proteins by Electrophoresis
17. Determination of molecular weight of proteins by SDS-PAGE
18. Purification proteins by Gel filtration
19. Analysis of biomolecules/bioactive compounds using colorimetry, spectrophotometry and fluorimetry
20. Analysis of body fluids (saliva, urine, blood, CSF, semen, tears) for forensic biology

**Biotechnology**

1. Isolation and identification of *Bacillus thuriengiensis* and purification of crystal protein
2. Production, purification and characterization of industrially important enzymes of microbial origin
3. Production, separation, partial purification and characterization of antimicrobial compounds from *Bacillus* spp. and actinomycetes
4. Production and purification of organic acids using microorganisms
5. Alcohol production and quality assessment
6. Forensic analysis of alcoholic and non-alcoholic beverages
7. Field visit to industries
## Discipline I: Public Health Microbiology

### Semester II

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MB 551 Human Anatomy and Physiology

Course Title: Human Anatomy and Physiology       Full Marks: 75
Course No.: MB 551        Pass Marks: 37.5
Nature of Course: Theory (3 credits)        Semester: II

Objectives
Upon completion of the course the students will be able to understand
a. Anatomy and physiology of various human organs and systems
b. Relationship of function and physiology of various anatomical structures with diseased conditions and infections

Course Contents

Musculoskeletal System  5 hrs
Skeleton: Definition, Basic functions, Types, Classification, Gross and microscopic anatomy,
Joints: Definition, Types and function, Muscles: Definition, Functions, Gross and microscopic
anatomy

Gastro-Intestinal System  5 hrs
Different parts of the system, Functions, Gross and microscopic anatomy of the different parts,
Structure and functions of salivary glands, pancreas, liver and gall bladder

Respiratory System  5 hrs
Different parts of the system, Gross and microscopic anatomy of different parts of system,
functions of parts

Cardiovascular System  5 hrs
Gross and microscopic anatomy of different parts, functions of different parts

Blood, Reticuloendothelial and Immune System  5 hrs
Sites of formation of blood, Composition and functions of blood cells of blood and their functions,
Blood grouping, Lymph and lymphatic vessels, Different organs of reticuloendothelial system,
Gross microscopic anatomy and functions of the organs

Nervous System  5 hrs
Parts and function of the system, Gross structure and microscopic anatomy of nervous system,
Ventricular system and CSF and Meninges

Urinary System  4 hrs
Different organs of the system, Gross structure, Microscopic anatomy and functions of the organs,
Mechanism of urine formation and its composition

Endocrine System  3 hrs
Definition, Different organs of the system, Functions of the organs
Sensory Organs  4 hrs
Different organs, Structure and functions of eye, ear, nose and tongue

Reproductive System  4 hrs
Different organs in male and female, Gross microscopic anatomy and functions of the organs

References
**MB 552 Applied Environmental Microbiology**

Course Title: Applied Environmental Microbiology           Full Marks: 75
Course No.: MB 552                 Pass Marks: 37.5
Nature of Course: Theory (3 credits)           Semester: II

**Objectives**

Upon completion of the course, the students will have knowledge on
a. Principles, procedures and applications of methods used for water, soil, air and other environmental samples analysis
b. Drinking water microbiology, microbiology of solid waste and waste water, and on exploitation of environmental isolates of microorganisms in environmental biotechnology

**Course Contents**

**Drinking Water Microbiology** 10 hrs
Safe water, Physico-chemical, Microbiological parameters of water quality, Indicators of water pollution, Water quality standards (WHO and Nepal standards), Water purification: Principle, Procedures, Removal of microorganisms, Principle and procedures of drinking water treatment: Large water supply systems (Multi barrier approach), Bottled and mineral water quality assurance

**Water Microbiology and Water Pollution** 5 hrs
Over view on water pollution: Sources of pollution of river and water bodies and consequences, Types of pollutants, Eutrophication, Removal methods, Rain water harvesting

**Sewage and Industrial Effluents** 5 hrs
Composition of domestic waste, Sewage and industrial waste, Microbiology of sewage, Analysis of sewage and industrial effluents, Sewage treatment: Principles and procedures with references to removal of pollutants, Sludge treatment, Bioremediation

**Solid Waste Management** 5 hrs
Characterization of biodegradable and non-biodegradable solid waste, Types of microorganisms, Solid waste management: Collection, transportation, disposal (sanitary landfill, composting) and recycling methods

**Air Microbiology and Air Pollution** 5 hrs
Effect of meteorological and geographical condition on fate of microorganisms in atmosphere, Sources of air pollution and consequences, Types of air pollutants (chemical and microbiological), Monitoring of air quality (bacteriological and particulate matters), Methods of air pollution control

**Bioactive Compounds of Microorganisms** 5 hrs
Biopesticides, Bacterial, viral and fungal pesticides, Mechanism of action and applications, Antifungal, Antibacterial and bioactive compounds of actinomycetes, *Bacillus* and *Lactobacillus*
Medical Entomology  
10 hrs
An introduction to medically important arthropods and rodents, Insect morphology, biology and classification based on larval habitats of the vectors of Malaria, Japanese encephalitis, Lymphatic filariasis, Dengue, Chikungunya and Leishmaniasis, Different techniques and sampling equipments and tools for vector surveillance of Genera *Aedes*, *Anopheles*, *Culex* and genus *Phlebotomus*, objectives, specimen preservation, collection maintenance, Rearing of vector mosquitoes, Preservation, Use of keys to identify the taxonomic characters of certain vector species, Insecticide susceptibility test for adult and larval mosquitoes, Types and mechanisms of transmission of vector-borne diseases, Vector competence and vectorial capacity, Factors affecting vector competence, Components of vectorial capacity, Entomological indices, The combined effects of climate change, climatic factors, weather events and other factors in key vectors and vector-borne diseases, Entomological and ecological factors influencing the abundance of *Aedes (Stegomyia) aegypti* (L.) and *Aedes (Stegomyia) albopictus* (Skuse) in urban environment, Current problems and research trends in medical entomology in Nepal, Integrated Vector Management (IVM), Elements and strategies of Integrated Vector Management.

References
MB 553 Fundamentals of Epidemiology

Course Title: Fundamentals of Epidemiology              Full Marks: 75
Course No.: MB 553          Pass Marks: 37.5
Nature of Course: Theory (3 credits)        Semester: II

Objectives
Upon the completion of the course students will have knowledge on
a. Fundamentals of epidemiology
b. Scope and applications of epidemiology of infectious diseases

Course Contents

Concept of Epidemiology 2 hrs
Definitions of epidemiology, branches of epidemiology, uses of epidemiology, scope and approaches of epidemiology, differences of epidemiology and clinical medicine

Epidemiological Measurements 4 hrs
Health and disease, Indicators of health and disease, Frequency measures (Mortality, Morbidity, Incidence, Prevalence, Incidence density), Measures of effect

Epidemiological Studies 15 hrs
Cross-sectional study, Longitudinal study, Descriptive epidemiology, Analytical epidemiology-Case control and cohort studies, Experimental epidemiology, Randomized controlled trials, Quasi-experimental studies, Bias and errors in epidemiological studies, Types and sources of error, Selection and information bias, Confounding and effect modification, Screening: Criteria of a screening test, Selection and validity of a screening test (sensitivity, specificity, positive predictive value, negative predictive value, accuracy)

Health Survey and Surveillance 4 hrs
Definitions, Types and design of survey, Steps of survey, Disease surveillance systems, Disease surveillance systems in Nepal

Outbreak Investigation 4 hrs
Concept of Epidemic, Endemic, Sporadic and pandemic, Outbreak investigation, Management of disease outbreaks

Infectious Disease Epidemiology and Natural History of Disease 8 hrs
Sources and reservoir of infection, Modes of transmission, Epidemiological markers (Phenotypic, Genotypic markers), Interactions of agent, Host and environment, Biological laws of diseases, Causation, Prognosis, Risk factors, Establishing cause of disease

Management of Diseases 4 hrs
Disease prevention, Control, Elimination and eradication
Environmental and Occupational Epidemiology 2 hrs
Environment and health, Exposure and dose, Dose-effect and dose–response relationship, Risk assessment, Risk management

Concept of Clinical Epidemiology, Molecular Epidemiology, Social Epidemiology, Field Epidemiology 2 hrs

References
**MB 554 Microbial Systematics**

Course Title: Microbial Systematics                      Full Marks: 75
Course No.: MB 554                                             Pass Marks: 37.5
Nature of Course: Theory (3 credits)                          Semester: II

**Objective**
Upon completion of the course the students will be able to understand
a. Microbiology and diagnosis of medically important bacteria, viruses, parasites and fungi

**Course Contents**

**Bacteriology**  18 hrs
Classification, structure, physiology, pathogenesis, medical importance and control of bacteria: *Escherichia coli, Salmonella, Shigella, Campylobacter, Vibrio, Haemophilus, Klebsiella, Corynebacterium, Staphylococcus, Streptococcus, Clostridium, Neisseria, Treponema, Chlamydia, Mycoplasma, Mycobacterium, Bacillus*

**Virology**  10 hrs
Classification, general properties, structure, medical importance and control of viruses: *Rotavirus, Poxviruses, Herpes viruses, Adenoviruses, Picorna virus, Orthomyxovirus, Paramyxovirus, Arbovirus, Rhabdo viruses, Hepatitis virus, Retroviruses (HIV, HTLV etc), Emerging Viruses (SARS, Oncogenic virus), Structure, Classification and life cycle of Bacteriophages*

**Parasitology**  10 hrs
Classification, general structure, life cycle, medical importance and control of parasites: *Entamoeba, Giardia, Trichomonas, Plasmodium, Cryptosporidium, Cyclospora, Toxoplasma, Leishmania, Wuchereria, Blastocystis, Ascaris, Trichuris trichura, Taenia, Echinococcus, Hymenolepis nana, Fasciola hepatica, Schistosoma, Loaloa*

**Mycology**  7 hrs
Classification, general structure, physiology, medical importance and control of fungi: *Tinea, Aspergillus, Candida, Fusarium, Cryptococcus, Histoplasma, Trichophyton, Epidermophyton, Blastomyces*, fungal toxins and allergens

**References**
**MB 555 Practical on (MB 551 + MB 552)**

Course Title: Practical on (MB 551 + MB 552)  
Course No.: MB 555  
Nature of Course: Practical (2 credits)  
Full Marks: 50  
Pass Marks: 25  
Semester: II

**Human Anatomy and Physiology**

**Course Contents**

1. Anatomical observation of human skeleton and organ system
2. Microscopic observation of histological and anatomical slides
3. Experiments on human physiology

**Applied Environmental Microbiology**

**Course Contents**

1. Isolation and characterization of thermophiles, psychrophiles, halophiles, alkalophiles and acidophiles from different environments
2. Isolation and characterization of methanogenic bacteria and bio-gas production
3. Isolation and characterization of *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans*
4. Microbiological and physico-chemical analysis of sewage/industrial effluent and solid waste
5. Drinking water quality analysis (bottle water, jar water, tap water, underground water: deep boring, shallow water)-MPN, MF, total coliform count and faecal coliform count and confirmation
6. Determination of BOD and COD in river water
7. Assessment of microbiology of solid waste
8. Microbial degradation of aromatic hydrocarbon containing compounds
9. Experiments on bio leaching of metals and biotransformation of pesticides
10. Indoor and outdoor air quality analysis
11. Isolation, screening and characterization of cellulose degrading microorganisms
12. Isolation, screening and characterization of antifungal and antibacterial actinomycetes
13. Isolation, screening and characterization of pesticides degrading microorganisms
MB 556 Practical on (MB 553 + MB 554)

Course Title: Practical on (MB 553 + MB 554) Full Marks: 50
Course No.: MB 556 Pass Marks: 25
Nature of Course: Practical (2 credits) Semester: II

Course Contents

Fundamentals of Epidemiology
1. Prepare a report describing the epidemiology of major infectious diseases of Nepal

Microbial Systematics
2. Isolation and identification of medically important bacteria by conventional biochemical techniques
3. Serotyping, bacteriophage typing, biotyping and molecular typing of common medically important bacteria
4. Antibiotic susceptibility testing of bacteria
5. Determination of MIC of antibiotics
6. Serological identification-test kits, ELISA
7. Preparation of specimen for virus culture and transport media for virus isolation
8. Tissue culture and egg inoculation technique for the isolation of common medically important viruses
9. Isolation of bacteriophages, enumeration, plaque assay, characterization
10. One step growth curve experiments
11. Preparation of high titre bacteriophage stocks
12. Fungal stains preparation and staining techniques
13. Preparation of various fungal culture media and sterilization
14. Fungal culture techniques
15. Isolation and characterization of medically important fungi from clinical and environmental samples
16. Isolation and characterization of dimorphic fungi
17. Microscopic observation of medically important protozoans and helminthic parasites- *Entamoeba, Giardia, Plasmodium, Leishmania, Taenia, Ascaris* etc.
18. Stool sample collection and processing for observation of parasites by microscopy
19. Occult blot test in the stool samples
20. Stool culture techniques
Discipline I: Public Health Microbiology

 Semester III

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<td>Emerging Infectious Diseases</td>
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<td>Public Health Laboratory</td>
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MB 601 Research Methods and Biostatistics

Course Title: Research Methods and Biostatistics                                Full Marks: 75
Course No.: MB 601                                                            Pass Marks: 37.5
Nature of Course: Theory (3 credits)                                          Semester: III

Objectives
Upon the completion of the course students will have knowledge on
a. Research methods in microbiology
b. Application of biostatistical methods in microbiological research

Course Contents

Research Methods

Research Methods                                    15 hrs
Introduction and objectives of research, Criteria of good research question, Research process, Priority areas, Objectives/Hypothesis, Literature review, Critical appraisal, Meta analysis, Research designs, bias and errors in research, Ethical issues in research: Salient point of the NHRC guidelines, General ethical principles, Informed consent

Scientific Writing                                     5 hrs
Paper writing, Proposal writing, Thesis/report writing

Biostatistics

Sampling, Data Collection and Frequency Distribution  5 hrs
Sample and Sampling, Sampling design and Sample selection, Sample size and calculation, Qualitative and quantitative data collection methods, Binomial distribution, Poisson distribution, Normal distribution of data

Data Analysis and Computer Application                20 hrs
Quantitative data analysis (descriptive analysis, inferential analysis- chi square, t-test, ANOVA, correlation, 95% CI, Standard error, Odds ratio, p-value, Regression analysis), Data entry and data analysis using computer software (SPSS, STATA, SAS, Epi Info etc.)

References
**MB 602 Public Health Microbiology**

Course Title: Public Health Microbiology  
Course No.: MB 602  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: III  

**Objectives**

Upon completion of the course the students will have knowledge on

a. Epidemiology, pathogenesis, microbiology of causative organisms of infectious diseases of public health concern

b. Laboratory diagnosis, prevention and control of infectious diseases of public health concern

**Course Contents**

**Water Borne Infections**  
8 hrs  
Overview on common water-borne diseases, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of hepatitis, cholera, typhoid, amoebiasis, giardiasis, poliomyelitis, diarrhea (bacterial and viral)

**Air Borne Infections**  
8 hrs  
Overview on common air-borne diseases, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of pneumonia, diphtheria, tuberculosis, influenza, measles

**Food Borne Diseases**  
8 hrs  
Concept on food borne infections and food intoxication, Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of staphylococcal, clostridial food poisoning, salmonellosis, campylobacteriasis, travelers diarrhoea and shigellosis

**Vector Borne Diseases**  
8 hrs  
Overview on common vector-borne diseases and their vectors, Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of visceral leishmaniasis, malaria, filariasis, Japanese encephalitis, dengue and West Nile virus and plague

**Sexually Transmitted Infections (STIs)**  
8 hrs  
Overview on common STIs, Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis and prevention and controls of syphilis, gonorrhoea, chlamydial infections, HIV, herpes, hepatitis viruses, trichomoniasis

**Hospital Acquired Infection**  
5 hrs  
Concept on common nosocomial infections, Disinfection procedures of hospital environment, equipments and materials, methods of disposal of infective hospital waste and laboratory materials, monitoring of sanitation in hospital environment
References
MB 603 Emerging Infectious Diseases

Objective
Upon completion of the course the students will have knowledge on
a. Current issues and controversies on prevention and control of infectious diseases

Course Contents

Microbial Threats, Epidemiological Investigations, Pathogenicity Research, Vaccine Development and Other Strategies Tried to Control Disease Emergence and Spread of Diseases 20 hrs

Epidemic and pandemic influenza/coronaviruses (Review of the impact of previous influenza pandemics, details of responses to the influenza pandemic); Vector-borne disease (History and status of global vector borne diseases, national disease concerns including West Nile virus, tick-borne diseases, and future issues of vector borne diseases); HIV/AIDS (Review of changing natural history of infection and disease, HIV drug resistance); Tuberculosis (Review of a new and re-emerging threat to global health, implications of TB on immunocompromised populations, MDR, XDR tuberculosis and monitoring of drug resistance); Emerging pathogens (Zika virus, SARS, Ebola, monkeypox, hantavirus, E. coli O157:H7, drug resistant hospital acquired pathogens-drug resistance mechanisms and recent resistance strains of E. coli, Staphylococcus aureus, Pseudomonas aeruginosa)

Population Growth and Linkage with Poverty and Infectious Diseases 2 hrs

Global Climate Change and Infectious Disease 3 hrs

Sanitation and Related Diseases 5 hrs
History, Status of water-borne diseases and global, local, national issues and interests and future issues on water borne infectious diseases, Water safety plan

Immunization and Anti-Infectives 5 hrs
Role of vaccines and anti-infectives in public health practice and clinical medicine, Vaccine research, Development and availability, Immunization schedules, Investigation of adverse events, Efficacy

Biosafety, Biosecurity, Bioterrorism 5 hrs
Overview, Biosafety, Biosecurity and bioterrorism, Smallpox and polio, Eradication programs and reality of infectious diseases eradication

Foodborne Diseases 5 hrs
Current status of food borne diseases, Health implications, Prevention and food safety
References
Research papers based course, journals, websites of organizations (WHO, CDC, NIH etc.)
MB 604 Public Health Laboratory

Course Title: Public Health Laboratory  
Course No.: MB 604  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: III

Objective
Upon completion of the course the students will have knowledge on
a. Laboratory diagnosis of infectious diseases of public health concern.

Course Contents

Laboratory Safety and Quality Control  
Laboratory organization and quality control of Microbiology laboratory and laboratory safety

Common Diagnostic Methods of Identification and Typing of Bacteria  
Principle and procedures of diagnostic methods, Conventional identification methods, Microscopic methods, Serological methods, Typing methods, Methods for testing antimicrobial susceptibility

Laboratory Diagnosis of Various Clinical Conditions  
Selection, collection and transport of specimen for microbiological examination, Conventional and rapid diagnosis methods for: Bacterimia, Septicemia, Pyrexia, Meningitis, Respiratory tract infection (Lower and Upper), Urinary tract infection, Gastrointestinal tract infection, Food poisoning, Cholera, Genital Tract Infections: Bacterial vaginosis, Pelvic Inflammatory Disease (PID), Sexually transmitted infections, Eye Infection, Ear Infection, Oral Infections, anaerobic infection of oral cavity, Gas gangrene, Tuberculosis and Leprosy

Laboratory Diagnosis of Viral, Parasitic and Fungal Infections  
Specimens, methods for diagnosis of parasite, virus and fungal infections

Molecular Methods for Disease Diagnosis

Field Level Laboratory Testing Requirements

References
Course Title: Practical on (MB 602)  
Course No.: MB 605  
Nature of Course: Practical (2 credits)  

Course Contents

1. Laboratory diagnosis of vector borne diseases and identification of common insect vectors
2. Laboratory diagnosis of cholera
3. Laboratory diagnosis of enteric fever by blood culture
4. Laboratory diagnosis of gastrointestinal tract infection by stool culture
5. Sputum culture and microscopy
6. Laboratory diagnosis of blood and tissue parasites- preparation of thick and thin smear of blood sample, staining and detection of blood and tissue parasites
7. Use of rapid test kits for the diagnosis of infectious diseases- malaria, visceral leishmaniasis, filariasis, HIV, Hepatitis B, Rota virus
MB 606 Practical on (MB 603 + MB 604)

Course Title: Practical on (MB 603 + MB 604)  Full Marks: 50
Course No.: MB 606  Pass Marks: 25
Nature of Course: Practical (2 credits)  Semester: III

Course Contents
1. Laboratory diagnosis of enteric fever by blood culture
2. Laboratory diagnosis of gastrointestinal tract infection by stool culture
3. Throat swab culture
4. Sputum culture and microscopy
5. Pus culture
6. Culture of vaginal swabs
7. Microscopy of *Treponema*
8. Laboratory diagnosis of eye infections
9. Laboratory diagnosis of ear infections
10. Physiological and molecular detection of ESBL, MBL, MDR pathogens
11. Analysis of effects of climate, population growth, poverty on infectious diseases (malaria, cholera, tuberculosis, HIV infection, vectors, JE, and other emerging diseases)
### Discipline I: Public Health Microbiology

**Semester IV**

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**Total**

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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
MB 651 Hospital/Field based Internship

Course Title: Hospital/Field based Internship
Course No.: MB 651
Nature of Course: Practical (8 credits)

Objectives

Upon completion of the internship, students will be able to
a. Develop hands on skills of microbiology laboratory
b. Understand laboratory protocols and procedures
c. Understand recording and reporting of laboratory/public health data

Course Description

Student will do at least six month internship in relevant hospital/District (Public) Health Office and above or other relevant microbiology laboratories. The letter/certificate of internship from the internship institution and report of the internship in prescribed format of the department/campus/college should be submitted by the student after completion of the internship.
MB 652 Dissertation

Course Title: Dissertation
Course No.: MB 652
Nature of Course: Laboratory based Research Project (8 credits)

Objectives
Upon the completion of dissertation the students will
a. Have knowledge and skills to conduct original scientific research
b. Have deep understanding of research methods related to Microbiology
c. Be able to design an experiment, generate, analyze scientific data and conclude important findings
d. Develop scientific writing and presentation skills

Course Description

Individual students will be assigned relevant research topics related to their field of study by concerned central department/campus/college. Students will perform required field work and laboratory experiments within this semester. The research will be supervised by faculty member(s) of microbiology of concerned central department/campus/college. Students should submit research proposal on assigned topic within first week of this semester and must be approved by the institutional review board. After completion of research work, the student should write the dissertation/thesis in standard format on the basis of data/findings generated during the research works. The student will submit required number of copies of their dissertation to concerned department/campus/college for evaluation. The submitted dissertation will be approved by head of the central department/campus chief/coordinator. On the recommendation of head of department/campus chief/coordinator, the Institute of Science and Technology will appoint a related expert as an external examiner from the panel of approved examiners to evaluate the submitted dissertation. On the recommendation of external examiner, viva-voce open defense will be organized for evaluation of dissertation by concerned department/campus/college. The final evaluation of dissertation will be made by a panel of external and internal examiners, head of the department and supervisor(s). Students will be encouraged to publish the dissertation findings in peer reviewed microbiology journals in the form of original research article.
## Discipline II: Medical Microbiology

### Semester II

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MB 551 Human Anatomy and Physiology

Course Title: Human Anatomy and Physiology      Full Marks: 75
Course No.: MB 551        Pass Marks: 37.5
Nature of Course: Theory (3 credits)      Semester: II

Objectives
Upon completion of the course the students will be able to understand
a. Anatomy and physiology of various human organs and systems
b. Relationship of function and physiology of various anatomical structures with diseased conditions and infections

Course Contents

Musculoskeletal System  5 hrs
Skeleton: Definition, Basic functions, Types, Classification, Gross and microscopic anatomy,
Joints: Definition, Types and function, Muscles: Definition, Functions, Gross and microscopic anatomy

Gastro-Intestinal System  5 hrs
Different parts of system, Functions, Gross and microscopic anatomy of the different parts,
Structure and functions of salivary glands, pancreas, liver and gall bladder

Respiratory System  5 hrs
Different parts of system, Gross and microscopic anatomy of different parts of system, Functions of parts

Cardiovascular System  5 hrs
Gross and microscopic anatomy of different parts, Functions of different parts

Blood, Reticuloendothelial and Immune System  5 hrs
Sites of formation of blood, Composition and functions of blood cells of blood and functions,
Blood groups, Lymph and lymphatic vessels, Different organs of reticuloendothelial and system,
Gross, microscopic anatomy and functions of the organs

Nervous System  5 hrs
Parts and function of system, Gross structure and microscopic anatomy of nervous system,
Ventricular system and CSF, Meninges

Urinary System  4 hrs
Different organs of system, Gross structure, Microscopic anatomy and functions of the organs,
Mechanism of urine formation and its composition

Endocrine System  3 hrs
Definition, Different organs of the system, Functions of the organs
Sensory Organs 4 hrs
Different organs, Structure and functions of eye, ear, nose and tongue

Reproductive System 4 hrs
Different organs in male and female, Gross microscopic anatomy and functions of the organs

References
Objective
Upon the completion of the course students will have knowledge on
a. Structure, physiology, pathogenesis, isolation, characterization, identification and typing of medically important bacteria
b. Principles, procedures and applications of diagnostic methods useful to detect bacteria from clinical specimens

Courses Contents

Laboratory Safety and Quality Management 5 hrs
Laboratory organization and biosafety requirements of Microbiology laboratory, Quality control and management of Microbiology laboratory, Concepts of biosecurity, Bioterrorism

Methods of Identification and Typing of Bacteria 7 hrs
Principles and procedures of different diagnostic methods: Conventional identification methods including morphological, cultural and biochemical properties, Microscopic methods, Rapid and automated methods, Serological methods. Typing methods: Principle, procedure and application of biotyping, serotyping, phagetyping, Molecular typing methods, Methods for testing antimicrobial susceptibility –Kirby Bauer disc diffusion method, MIC determination, ESBL testing

Selection, Collection, Transportation and Processing of Specimens for Conventional and Rapid Laboratory Diagnosis of Bacterial Infections 5 hrs

Classification, Structure, Physiology, Pathogenesis, Medical Importance and Laboratory Diagnosis of Aerobic/Microaerophilic Gram Negative Rods and Cocci 8 hrs
Campylobacter, Helicobacter, Brucella, Legionella, Neisseria, Branhamella, Acinetobacter, Bordetella and Psuedomonas

Facultative Anaerobic Gram Negative Rods 8 hrs
Salmonella, Shigella, Yersinia, Vibrio, Aeromonas, Escherichia, Citrobacter, Enterobacter, Klebsiella, Proteus and Haemophilus

Gram Positive Cocci 3 hrs
Micrococcus, Staphylococcus, Streptococcus, Peptococcus, Peptostreptococcus and other bacteria

Gram Positive Endospore Forming Rods and Cocci 2 hrs
Bacillus, Clostridium and other bacteria
Clinical Manifestation and Laboratory Diagnosis 7 hrs
Respiratory tract infection, Urinary tract infection, Gastrointestinal tract infection: Cholera and other diarrhoeal diseases, food poisoning, Gonorrhoea, Gas gangrene, Peptic ulcer, Enteric fever

References
1. Baron EJ, Peterson LR and Finegold SM (1990), *Bailey and Scott’s Diagnostic Microbiology*, Mosby
**MB 558 Systemic and Diagnostic Virology-1**

Course Title: Systemic and Diagnostic Virology-1  
Course No.: MB 558  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: II

**Objectives**
Upon the completion of the course students will have knowledge on

a. Structure, physiology, pathogenesis, isolation, characterization and identification of medically important viruses

b. Principles, procedures and applications of diagnostic methods useful to detect viruses from clinical specimens

**Course Contents**

**Techniques of Diagnostic Virology**  
10 hrs  
Cultivation and purification of viruses, Principles and applications of serodiagnostic methods: haemagglutination and haemagglutination inhibition tests, complement fixation, neutralization, western blot, RIPA, flowcytometry and immunohistochemistry, Nucleic acid based diagnosis: Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing, Microscopic techniques: Fluorescence, confocal and electron microscopic techniques

**Selection, Collection, Transportation and Processing of Specimens for Laboratory Diagnosis of Viral Infections**  
8 hrs

**Classification, Structure, Physiology, Pathogenesis, Medical importance, Control and laboratory Diagnosis of Poxviruses**  
2 hrs
Smallpox virus

**Herpesviruses**  
7 hrs
Alphaherpesviruses Herpes Simplex and Varicella Zoster, Betaherpesviruses, Cytomegaloviruses, Human herpesviruses 6 and 7, Gammaherpesviruses Epstein Barr viruses

**Picornaviruses**  
2 hrs

**Orthomyxoviruses**  
3 hrs
Influenza virus

**Paramyxoviruses**  
3 hrs
Measles virus, Mumps virus, Human parainfluenza viruses, Human respiratory syncytial virus

**Arboviruses**  
5 hrs
Togaviridae and Flaviridae (Dengue virus, Japanese encephalitis virus, Yellow fever virus)

**Retroviruses**  
5 hrs
HIV and HTLV
References
MB 559 Systemic and Diagnostic Parasitology

Course Title: Systemic and Diagnostic Parasitology                  Full Marks: 75
Course No.: MB 559          Pass Marks: 37.5
Nature of Course: Theory (3 credits)                                          Semester: II

Objectives
Upon the completion of the course students will have knowledge on
a. Structure, physiology, pathogenesis, isolation, characterization and identification of medically important parasites
b. Principles, procedures and applications of diagnostic methods useful to detect parasites from clinical specimens

Course Contents

Parasites, Parasitism, Host Relations, Parasitic Diseases Prevalent in Nepal and World          2 hrs

Structure, Life Cycle, Pathogenesis, Laboratory Diagnosis, Including Enumeration of Important Human Parasite          25 hrs


Parasitic infections in the compromised host, Nosocomial and acquired parasitic infections, Immunology of parasitic infections, Medically important arthropods          3 hrs

Diagnostic Procedures          15 hrs
Collection, preservation and shipment of parasitological specimens for laboratory diagnosis of parasites, Macroscopic and microscopic examination of specimens, Techniques for processing and examination of stool, urogenital specimens, sputum, blood, aspirates and biopsy material. Parasite recovery: Culture methods, animal inoculation and xenodiagnosis, Fixation and special preparation of fecal parasite specimens and arthropods, Artifacts that confused with parasitic organisms, Equipment, Supplies, Safety and quality assurance recommendations for a diagnostic parasitology laboratory
References
MB 560 Practical on (MB 551+MB 557)

Course Title: Practical on (MB 551+MB 557)                      Full Marks: 50
Course No: MB 560                                                   Pass Marks: 25
Nature of Course: Practical (2 credits)                      Semester: II

Human Anatomy and Physiology

Course Contents
1. Anatomical observation of human skeleton and organ system
2. Microscopic observation of histological and anatomical slides
3. Experiments on human physiology

Systemic and Diagnostic Bacteriology-1

Course Contents
1. Isolation and identification of medically important facultative anaerobic and microaerophilic bacteria following conventional culture methods
2. Serotyping, and molecular typing of medically important bacteria
3. Antibiotic susceptibility testing of the bacterial isolates in above experiments
4. Serological/Immunological tests for detection of bacterial infections-
   ▪ RPR
   ▪ TPHA
   ▪ ASO titre
   ▪ Widal test
   ▪ Direct/Indirect immunofluorescence test
   ▪ precipitation test
   ▪ Mantoux test
   ▪ ELISA
   ▪ Western blot
   ▪ CFT
   ▪ RIA
5. Laboratory diagnosis of enteric fever
6. Laboratory diagnosis of GIT infections including cholera, diarrhea, dysentery, peptic ulcer
7. Laboratory diagnosis of upper and lower respiratory tract infection
8. Laboratory diagnosis of urinary tract infection
9. Laboratory diagnosis of STI including, gonorrhea, syphilis
10. Investigation of nosocomial infections in hospital environment, detecting the point sources of infection
MB 561 Practical on (MB 558 + MB 559)

Course Title: Practical on (MB 558 + MB 559) Full Marks: 50
Course No.: MB 561 Pass Marks: 25
Nature of Course: Practical (2 credits) Semester: II

Systemic and Diagnostic Virology-1

Course Contents
1. Propagation of viruses: Tissue culture and egg inoculation technique for the isolation of common medically important viruses, Routes of inoculations in embryonated eggs
2. Preparation of virus stocks: Plaque assay and determination of TCID50
3. Detection of virus/viral gene/viral antigen/antiviral antibody by ELISA, Immunofluorescence assay, Haemagglutination, Agar gel diffusion, Polymerase Chain Reaction
4. Use of rapid test kits for the diagnosis of viruses
5. Demonstration of Electron Microscopy
6. Preparation of high titre bacteriophage stocks and one step growth curve experiments

Systemic and Diagnostic Parasitology

Course Contents
1. Microscopic observation of medically important protozoans and helminthic parasites- Entamoeba, Giardia, Plasmodium, Leishmania, Taenia, Ascaris etc.
2. Stool sample collection and processing for observation of parasites by microscopy, Copro-Antigen detection (intestinal parasites)
3. Occult blood testing in the stool sample
4. Laboratory diagnosis of blood and tissue parasites- preparation of thick and thin smear of blood sample, staining and detection of blood and tissue parasites
   - Malaria
   - Kala-azar (Visceral leishmaniasis)
   - Lymphatic filariasis
5. Laboratory diagnosis of vector borne diseases and identification of common insect vectors
   - Mosquitoes: Anopheles, Aedes, Culex
   - Sand flies: Phlebotomus
6. Culture and enumeration of intestinal and blood parasites for research purpose
7. Fixation of slides containing parasitic specimens for referral
8. Packaging of parasitic specimens for transportation following IATA regulation for referral
9. Molecular techniques in diagnosis of parasitic infections
10. Modern rapid and ELISA based techniques used in the sero-diagnosis of parasitic infections
## Discipline II: Medical Microbiology

### Semester III

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MB 601 Research Methods and Biostatistics

Course Title: Research Methods and Biostatistics  
Full Marks: 75
Course No.: MB 601  
Pass Marks: 37.5
Nature of Course: Theory (3 credits)  
Semester: III

Objectives
Upon the completion of the course students will have knowledge on
a. Research methods in microbiology
b. Application of biostatistical methods in microbiological research

Course Contents

Research Methods

Research Methods  
15 hrs
Introduction and objectives of research, Criteria of good research question, Research process, Priority areas, Objectives/Hypothesis, Literature review, Critical appraisal, Meta analysis, Research designs, bias and errors in research, Ethical issues in research: Salient point of the NHRC guidelines, General ethical principles, Informed consent

Scientific Writing  
5 hrs
Paper writing, Proposal writing, Thesis/report writing

Biostatistics

Sampling, Data Collection and Frequency Distribution  
5 hrs
Sample and Sampling, Sampling design and Sample selection, Sample size and calculation, Qualitative and quantitative data collection methods, Binomial distribution, Poisson distribution, Normal distribution of data

Data Analysis and Computer Application  
20 hrs
Quantitative data analysis (descriptive analysis, inferential analysis- chi square, t-test, ANOVA, correlation, 95% CI, Standard error, Odds ratio, p-value, Regression analysis), Data entry and data analysis using computer software (SPSS, STATA, SAS, Epi Info etc.)

References
MB 607 Systemic and Diagnostic Bacteriology-2

Course Title: Systemic and Diagnostic Bacteriology-2   Full Marks: 75
Course No. MB 607                                                   Pass Marks: 37.5
Nature of Course: Theory (3 credits)                                  Semester: III

Objectives
Upon the completion of the course students will have knowledge on
a. Structure, physiology, pathogenesis, isolation, characterization, identification and typing of medically important bacteria
b. Principles, procedures and applications of diagnostic methods useful to detect bacteria from clinical specimens

Course Contents

Classification, Structure, Physiology, Pathogenesis, Medical Importance and Laboratory Diagnosis of Gram Negative Rods and Cocci 7 hrs
Acetobacter, Kingella, Moraxella, Comomonas, Alcaligens, Francisella, Providencia, Gardenella, Pleisomonas, Hafnia, Morganella, Serratia, Pasteurella and other bacteria

Gram Negative Anaerobic Rods and Cocci 2 hrs
Bacteroides, Veillonella and other bacteria

Gram Positive Non Sporing Rods 3 hrs
Lactobacillus, Listeria, Corynebacterium and other bacteria

Actinomycetes, Nocardia and Related Bacteria 2 hrs

Mycobacterium 4 hrs
Mycobacterium tuberculosis, MOTT, Mycobacterium leprae

The Spirochaetes: Leptospira, Treponema, Borrelia 4 hrs

Rickettsia: Coxiella, Riketssia, Chlamydia 4 hrs

Mycoplasma 1 hr

Clinical Manifestation and Laboratory Diagnosis 15 hrs
Genital tract infections-Bacterial vaginosis, Pelvic Inflammatory Diseases (PID), Sexually transmitted infections- Syphilis, Chlamydial infection, Eye infection, Ear infection, Oral infections: Mandibular abscess, Gingivitis, and anaerobic oral infections, Tuberculosis, Leprosy, Bacteremia, Septicemia (Meningitis, Endocarditis)

Emerging Bacterial Diseases, Bioterrorism, Biosecurity 3 hrs
References
1. Baron EJ, Peterson LR and Finegold SM (1990), Bailey and Scott’s Diagnostic Microbiology, Mosby
3. Topley WWC and Wilson GS (1990), Parker MT and Collier LH (Editor), Topley and Wilson’s Diagnostic Bacteriology, Hodder Arnold.
MB 608 Systemic and Diagnostic Virology-2

Course Title: Systemic and Diagnostic Virology-2  
Course No.: MB 608  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: III

Objectives
Upon the completion of the course students will have knowledge on
a. Structure, physiology, pathogenesis, isolation, identification and characterization of medically important viruses
b. Principles, procedures and applications of diagnostic methods useful to detect viruses from clinical specimens

Course Contents

Classification, Structure, Physiology, Pathogenesis, Medical Importance and Laboratory Diagnosis of
Rhabdoviruses  3 hrs

Hepatitis Viruses  5 hrs

Coronaviruses, Toroviruses and Arteriviruses  3 hrs

Human Enteric RNA Viruses  2 hrs
Calciviruses and Astroviruses

Reoviruses, Rotaviruses, Orbiviruses and Coltiviruses  4 hrs

Adenoviruses, Parvoviruses, Papovaviruses  2 hrs

Bunyaviruses, Arenaviruses, Filoviruses  3 hrs

Prions  4 hrs

Emerging Viral Infections and Their Early Diagnosis  9 hrs

Immunoprophylaxis of Viral Diseases  10 hrs
Types of viral vaccines, Vaccines recommended in Nepal, Other viral vaccines, Antiviral drugs

References
**MB 609 Systemic and Diagnostic Mycology**

Course Title: Systemic and Diagnostic Mycology

Course No.: MB 609

Nature of Course: Theory (3 credits)

**Objectives**

Upon the completion of the course students will have knowledge on

a. Structure, physiology, pathogenesis, isolation, characterization and identification of medically important fungi

b. Principles, procedures and applications of diagnostic methods useful to detect fungi from clinical specimens

**Course Contents**

**Techniques of Diagnostic Mycology**

- Direct microscopic examination and culture
- Serological diagnosis
- Histological diagnosis
- Principles and applications of molecular methods in the diagnosis of fungal infections

**Selection, Collection, Transportation, Processing and Preservation of Specimens for Laboratory Diagnosis of Fungal Infections**

- 3 hrs

**Laboratory Diagnosis of Fungal Diseases**

- 4 hrs

- Cutaneous, Subcutaneous, Systemic, Opportunistic mycoses, Fungal sinusitis

**Classification, Structure, Physiology, Pathogenesis, Medical Importance, Control and Laboratory Diagnosis of**

- Trichophyton, Epidermatophyton, Microsporum, Mycetoma, Chromoblastomycosis, Phaeohyphomycosis, Sporotrichosis, Zygomyces: Lobomycosis, Rhinosporidiosis

**Classification, Structure, Physiology, Pathogenesis, Medical Importance and Laboratory Diagnosis of**

- Candida, Fusarium, Chromomycosis, Aspergillus, Cryptococcus, Blastomyces, Histoplasma, Coccidioidomyces, Paracoccidioidomycoses, Penicillium, Pneumocystis jirovecii infections

- 16 hrs

**Fungal Toxins and Allergies**

- 2 hrs

**Antifungal Agents**

- 3 hrs

Potential targets and modes of action of antifungal agents, Antifungal agents in clinical practice, Susceptibility testing, Antifungal drug resistance, Monitoring antifungal therapy

**References**

Course Title: Practical on (MB 607)  
Course No: MB 610  
Nature of Course: Practical (3 credits)  
Full Marks: 50  
Pass Marks: 25  
Semester: III  

Systemic and Diagnostic Bacteriology-2

Course Contents

1. Isolation and identification of medically important anaerobic bacteria by conventional methods
2. Microscopic and culture methods for diagnosis of *Mycobacterium tuberculosis*
   - AFB staining: Ziehl-Neelsen, Rhodamine Auramine stain, etc
   - AFB culture: LJ media, Middle Brook, etc
   - Molecular diagnosis of *Mycobacterium*
3. Antibiotic susceptibility testing of anaerobic bacteria and *Mycobacterium*
4. Laboratory diagnosis of gas gangrene
5. Laboratory diagnosis of meningitis
6. Laboratory diagnosis of ocular infections
7. Laboratory diagnosis of ear infections
8. Laboratory diagnosis of oral/dental infections
9. Laboratory diagnosis of syphilis
MB 611 Practical on (MB 608 + MB 609)

Course Title: Practical on (MB 608 + MB 609)                  Full Marks: 50
Course No: MB 611                                      Pass Marks: 25
Nature of Course: Practical (2 credits)                        Semester: III

Systemic and Diagnostic Virology-2

Course Contents
1. Laboratory diagnosis of HIV infection using rapid, ELISA and molecular methods
2. Laboratory diagnosis of HBV infection using rapid and ELISA methods
3. Laboratory diagnosis of HCV using rapid and ELISA methods
4. Laboratory diagnosis of Japanese encephalitis virus infection
5. Laboratory diagnosis of Dengue virus infection using, rapid, ELISA and molecular methods
6. Laboratory diagnosis of Measles and Rubella viruses using ELISA methods

Systemic and Diagnostic Mycology

Course Contents
1. Preparation of fungal stains and performing the staining following the techniques
   • LPCB
   • KOH
2. Fungal culture including preparation of media for culture and preparation of sugar fermentation tests useful for identification of fungal organisms
3. Isolation and characterization of medically important fungi from clinical specimens
4. Isolation and characterization of dimorphic fungi
5. Fixation of slides containing fungal elements for referral
6. Packaging of parasitic and fungal specimens for transportation following IATA regulation for referral
7. Molecular techniques in diagnosis of fungal infections
8. Modern rapid and ELISA based techniques used in the diagnosis of fungal infections
Discipline II: Medical Microbiology

**Semester IV**

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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
MB 653 Hospital based Internship

Course Title: Hospital based Internship  Full Marks: X
Course No.: MB 653  Pass Marks: S/US
Nature of Course: Practical (8 credits)  Semester: IV

Objectives

Upon completion of the internship, the students will be able to

a. Develop hands on skills of clinical microbiology laboratory
b. Understand laboratory protocols and procedures
c. Understand recording and reporting of laboratory data

Course Description

Student should do at least six month internship in relevant hospital or other relevant diagnostic microbiology laboratories. The letter/certificate of internship from the internship institution and report of the internship in prescribed format of the department/campus/college should be submitted by the student after completion of the internship.
**MB 654 Dissertation**

Course Title: Dissertation  
Course No.: MB 654  
Nature of Course: Laboratory based Research Project (8 credits)

**Objectives**
Upon the completion of dissertation the students will
a. Have knowledge and skills to conduct original scientific research
b. Have deep understanding of research methods related to Microbiology
c. Be able to design an experiment, generate, analyze scientific data and conclude important findings
d. Develop scientific writing and presentation skills

**Course Description**

Individual students will be assigned relevant research topics related to their field of study by concerned central department/campus/college. Students will perform required field work and laboratory experiments within this semester. The research will be supervised by faculty member(s) of microbiology of concerned central department/campus/college. Students should submit research proposal on assigned topic within first week of this semester and must be approved by the institutional review board. After completion of research work, the student should write the dissertation/thesis in standard format on the basis of data/findings generated during the research works. The student will submit required number of copies of their dissertation to concerned department/campus/college for evaluation. The submitted dissertation will be approved by head of the central department/campus chief/coordinator. On the recommendation of head of department/campus chief/coordinator, the Institute of Science and Technology will appoint a related expert as an external examiner from the panel of approved examiners to evaluate the submitted dissertation. On the recommendation of external examiner, viva-voce open defense will be organized for evaluation of dissertation by concerned department/campus/college. The final evaluation of dissertation will be made by a panel of external and internal examiners, head of the department and supervisor(s). Students will be encouraged to publish the dissertation findings in peer reviewed microbiology journals in the form of original research article.
## Discipline III: Food and Industrial Microbiology

### Semester II

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<th>Course code</th>
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<td>Food Fermentation Technology</td>
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<tr>
<td>MB 563</td>
<td>Food Biotechnology and Nutraceuticals</td>
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<td>MB 564</td>
<td>Advanced Food Microbiology</td>
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<td>MB 565</td>
<td>Food Safety Management and Toxicology</td>
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MB 562 Food Fermentation Technology

Course Title: Food Fermentation Technology        Full Marks: 75
Course No.: MB562   Pass Marks: 37.5
Nature of Course: Theory (3 credits)       Semester: II

Objective
Upon completion of this course, the students will be able to
a. Understand the role, function, and implication of microorganisms in the bio-processing, preservation, safety and nutritional enrichment of food resources

Course Contents

Fermentation and Biochemical Engineering          15 hrs
Principles of fermentation, Fermentation process, Bioengineering and Bioreactor Design: Basic concepts in Bioengineering: Dimensions and units, Equilibrium and rate, Coefficients for mass and heat transfer, Volumetric coefficient and mass balance, Bioreactor design, Batch, Fed-batch, Continuous culture, Solid state, Submerged fermentation, Fermentation system design, Sterilization for fermentation

Microbiology of Fermented Foods               15 hrs
Production of cultures for food fermentation: General principles of culture maintenance and preparation (Bacterial cultures, Yeast cultures, Molds cultures), Indigenous food fermentation (microbiology, production, biochemical changes) and improvements: Fermented vegetables: _Gundruk, Sinki, Tama, Sauerkraut_; Milk products: _Chhurpi, Yoghurt, Cheese_; Alcoholic beverages: _Cider, Brandy, Sake, Jaand, Rakshi, Chhyang_; Soyabean products: Soya sauce, Miso, Tempe, Kinema, Natto, Sufu, Tofu

Food and Enzymes from Microorganisms          6 hrs
Microorganisms as food: Fats from microorganisms, Baker’s yeast; EPS (Xanthan gum, dextran), Biofilms, Food flavour (diacetyl), Glucose isomerase

Isolation and Improvement of Industrial Microorganisms      9 hrs
Bacteria: Lactic Acid Bacteria (_Lactobacillus_), Acetic acid bacteria (_Acetobacter_), _Bacillus_ spp, _E. coli_; Yeast: _Saccharomyces cerevisae_ (in _Murcha_); Lipolytic and proteolytic microorganisms; Molds: _Aspergillus oryzae, Aspergillus niger, Rhizopus_ spp, Microbial starters for food fermentation: _Ragge, Luckpang, Bubod, Murcha, Koji, Nuruk_

References
1. Banwart GJ (1987), _Basic food Microbiology_, 1st Edition, SK Jain for CBS Publisher and distributors, Delhi
3. Carl SP (1979), _Microbiology of Food Fermentations_, AVI Publishing Company
5. Ayers JC, Mundt JO and Sandine WE (1980), _Microbiology of Foods_, W. H Freeman and Company
**MB 563 Food Biotechnology and Neutraceuticals**

Course Title: Food Biotechnology and Neutraceuticals  
Course No.: MB 563  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: II

**Objective**

Upon completion of this course, the students will be able to

a. Use application of biotechnological techniques and tools for improvement of biotechnological food processes

**Course Contents**

**History of Food Biotechnology**  
10 hrs
- History of food biotechnology, Tools of food biotechnology, Application of biotechnology for improvement of food products (dairy, winery, brewery, meat), GM foods (Plant and animal), GMOs (Production, uses and impacts), Evaluation of GM food, patenting

**Functional Foods and Neutraceuticals**  
15 hrs
- Food and nutrition, Nutritional quality of foods, Lantibiotics, Probiotics, Prebiotics, Production of functional foods (dairy, meat, soya, fruit products), omega-3-fatty acids

**Metabolic Engineering and Microbial Proteomics**  
10 hrs
- Comprehensive models, Regulation of metabolic pathways, Metabolic engineering, Metabolic pathway synthesis, Metabolic flux analysis, Metabolic control analysis, Proteomics of *Corynebacterium glutamicum, Lactococcus lactis, Bacillus subtilis*

**Methods and Processes in Biotechnology**  
10 hrs
- Methods and application of molecular cloning, Analytical methods in structure elaboration of fermented products: Low molecular weight compounds (bioactive compound), qPCR, Microarrays, MALDI-TOF MS, DNA sequencer, Amino acid analyzer, Lyophilizer

**References**

2. Okafor N (2007), *Modern Industrial Microbiology and Biotechnology*, Science Publisher, USA
MB 564 Advanced Food Microbiology

Course Title: Advanced Food Microbiology                     Full Marks: 75
Course No.: MB 564                                           Pass Marks: 37.5
Nature of Course: Theory (3 credits)                         Semester: II

Objectives
Upon completion of the course the students will be able to understand
a. Fundamental facts and principles of microbiology dealing with foods
b. Application of knowledge of food microbiology for assuring safe food supplies

Course Contents

Microorganisms Associated with Food                       5 hrs
Types of microorganisms in food, Sources and survival, Growth of microorganisms and factors affecting growth

Food Contamination and Food Spoilage                        15 hrs
Contamination and spoilage of sugars and sugar products, Fish and fish products, Dehydrated foods, Spices and other condiments, Canned foods, Milk and milk products, Meat and meat products, Poultry products, Eggs and egg products, Beverages, Fruit and fruit products, vegetables and vegetable products, Cereals and cereal products, Chocolate and confectionery

Predictive Food Microbiology                                10 hrs
Primary Models, Secondary Models, Model Fitting and Uncertainty, Predictive Microbiology in Quantitative Risk Assessment, Predictive Mycology

Analytical Food Microbiology                                 15 hrs
Sampling techniques, Separation and concentration of samples, Culture methods, Electrical methods, ATP bioluminescence, Microscopy techniques: DEFT and flow cytometry, Immunological techniques: Immunochromatography, Enzyme linked immunofluorescent assays and agglutination techniques, ELISA: Genetic techniques: PCR, NASBA, Hybridization, Microarrays, Molecular subtyping methods, New biosensors for microbiological analysis of food

References
MB565 Food Safety Management and Toxicology

Course Title: Food Safety Management and Toxicology Full Marks: 75
Course No.: MB 565 Pass Marks: 37.5
Nature of Course: Theory (3 credits) Semester: II

Objectives
Upon completion of the course the students will be able to understand
a. Principle of food poisoning and diseases caused by microbial infection and intoxication
b. The mechanism and control measures food poisoning and contaminating microbes

Course Contents

Food Safety Management Systems 5 hrs
Fundamentals and elements of food safety management system, Risk and control in food supply chain, Food assurance systems

Food Poisoning and Disease 20 hrs
Food-borne infections and intoxication; Microbiology, Epidemiology, Pathogenesis, Laboratory diagnosis, Prevention and control of food poisoning by microorganisms: Bacterial food poisoning: *Staphylococcus*, *Listeria*, *Clostridium*, *Shigella*, *Bacillus cereus*, *Campylobacter*, *Salmonella*, *Escherichia coli*, *Vibrio*, *Yersinia enterocolitica*, Toxigenic fungi and mycotoxins, Food borne viruses, Toxigenic algae, *Rickettsia*, Parasites, Spongiform encephalopathies and seafood toxicants

Investigation of Food Borne Disease Outbreak 5 hrs
Epidemiology, Outbreaks of food poisoning, Field investigation of disease outbreak, Laboratory testing, Interpretation and application of results, Preventive measures

Food Toxicology 10 hrs
Science, Principles and methodology of toxicology, Determination of Toxicants in Foods, Biotransformation, Toxic Phytochemicals, Analysis of Chemical Toxicants and Contaminants in Foods, Generation and Interpretation of toxicological data

Food Adulteration 5 hrs
Detection of possible adulterants in food supply chain, Test kits and application in daily monitoring of food quality and safety

References
1. Helferich W and Winter CK (2001), *Food Toxicology*, CRC Press, USA
3. WHO/IPCS (2001), *Safety evaluation of certain mycotoxins in foods*
4. WHO/IPCS (2004), *Safety evaluation of certain food additives and contaminants*
6. WHO/ IPCS (1990), *Principles for the Toxicological Assessment of Pesticide Residues in Food*
MB 566 Practical on (MB 562+MB 563)

Course Title: Practical on (MB 562+MB 563)                       Full Marks: 50
Course No.: MB 566                                                  Pass Marks: 25
Nature of Course: Practical (2 credits)                               Semester: II

Course Contents

1. Isolation and screening of fermentative yeast from murcha
2. Preservation of industrially important bacteria, yeast and molds
3. Preparation of Gundruk, Sauerkraut
4. Isolation and screening of lactic acid bacteria from indigenous fermented food
5. Preparation of yoghurt using pure culture of lactic acid bacteria
6. Preparation of tofu, kinema, jaand
7. Immobilization of enzyme
8. Screening of probiotic lactic acid bacteria
9. Preparation of wine, cider
10. Screening of lactic acid bacteria for bacteriocin production
11. Preparation of functional foods
12. Identification of lactic acid bacteria using PCR
MB 567 Practical on (MB 564+MB 565)

Course Title: Practical on (MB 564+MB 565)           Full Marks: 50
Course No.: MB 567                                Pass Marks: 25
Nature of Course: Practical (2 credits)        Semester: II

Course Contents

1. Determination of microbial quality of milk
2. Determination of microbial quality of cheese, yoghurt
3. Determination of microbial quality of meat and meat products
4. Determination of microbial quality of eggs
5. Determination of microbial quality of fruits and beverages
6. Isolation of internal flora from various dried foods
7. Water quality analysis
8. Screening of toxigenic Aspergillus spp
9. Qualitative and quantitative determination of aflatoxin using chromatography
10. Detection of Salmonella spp, Clostridium perfringens, Bacillus cereus, Listeria spp from various food
11. Isolate and identify various parasites from vegetables
12. Detection of various adulterants in milk
13. Determination of pesticide residue in food samples
### Discipline III: Food and Industrial Microbiology

**Semester III**

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<th>Course code</th>
<th>Course Title</th>
<th>Nature of Course</th>
<th>Credits</th>
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<td>Research Methods and Biostatistics</td>
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<td>MB 612</td>
<td>Food Science and Nutrition</td>
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<td>MB 613</td>
<td>Food Processing and Preservation Technology</td>
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<td>MB 614</td>
<td>Total Quality Management and Quality Assurance</td>
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MB 601 Research Methods and Biostatistics

Course Title: Research Methods and Biostatistics  Full Marks: 75
Course No.: MB 601  Pass Marks: 37.5
Nature of Course: Theory (3 credits)  Semester: III

Objectives
Upon the completion of the course students will have knowledge on
a. Research methods in microbiology
b. Application of biostatistical methods in microbiological research

Course Contents

Research Methods

Research Methods  15 hrs
Introduction and objectives of research, Criteria of good research question, Research process, Priority areas, Objectives/ Hypothesis setting, Literature review, Critical appraisal, Meta analysis, Ethical issues in research: Salient point of the international guidelines, General ethical principles, Informed consent

Scientific Writing  5 hrs
Paper writing, Proposal writing, Thesis/report writing (Seminar presentations)

Biostatistics

Sampling, Data Collection and Frequency Distribution  5 hrs
Sample and Sampling, Sampling design and Sample selection, Sample size and calculation, Qualitative and quantitative data collection methods, Frequency distribution

Data Analysis and Computer Application  20 hrs
Quantitative data analysis (descriptive analysis, inferential analysis- chi square, t-test, ANOVA, correlation, 95% CI, Standard error, Odds ratio, p-value, Regression analysis), Data entry and data analysis using computer software (SPSS, STATA, SAS, Epi Info etc.)

References
MB 612 Food Science and Nutrition

Course Title: Food Science and Nutrition
Course No.: MB 612
Nature of Course: Theory (3 credits)

Objective
Upon completion of this course the students will be able to
a. Understand basic concepts of food engineering, food chemistry and human nutrition

Course Contents

Unit Operations 5 hrs
Fundamentals, Dimensions, Engineering units, Material balances, Energy balances, Thermodynamics

Food Chemistry 15 hrs
Introduction to the chemical, physical and biochemical properties of food, Carbohydrates, Proteins, Lipids, Vitamins, Minerals, Pigments and colors, Flavors, Food additives: Non nutritive sweeteners, Antioxidants, Food Emulsifiers, Pectin, Chelating agents, Preservatives; Food rheology and texture; Chemical and Biochemical changes in foods: Maillard reaction, Lipid oxidation, Enzymatic browning, Protein denaturation

Human Nutrition 25 hrs

Nutrition Science: Role of Macro and Micro nutrients on human health, Nutritional importance of different food groups, Loss of nutrients during food processing, Calculation of energy value of foods, NPU, BV, NPR, Anti nutritional compounds in foods

Nutrition Assessment: Nutritional Survey/ Assessment, Dietary assessment, Determining nutritional status, Nutrition during life stages, Nutritional requirement for general population, Basic of Menu Planning and Therapeutic diet, Microbial assessment of essential amino acids and vitamins

Clinical Nutrition: Malnutrition: Overnutrition (Obesity), Undernutrition, Causes of malnutrition, Nutrient Deficiency Disorders: PEM, VAD, IDA, IDD, Preventive measures

References
MB 613 Food Processing and Preservation Technology

Course Title: Food Processing and Preservation Technology Full Marks: 75
Course No.: MB 613 Pass Marks: 37.5
Nature of Course: Theory (3 credits) Semester: III

Objective
Upon completion of this course the students will be able to
a. Have knowledge and perform experiments dealing with preservation, processing and quality aspects of foods

Course Contents

Principles of Food Preservation 15 hrs
Control of microorganisms: Introduction, Control of microorganisms by retarding growth: Low temperature storage, Drying, Chemicals added to food, Control of microorganisms by destruction: Gas treatments, Heat treatment, Control of microorganisms by irradiation, Recent developments in food preservation technology: High pressure, Inactivation by High Intensity Pulsed Electric Field (HIPEF), Microwave, Ohmic heating, Hurdle technology

Methods of Preservation of Food and Fruit Products 20 hrs
Cereal grains and meals, Flour, Bread, Cakes and other bakery products, Biscuits, Crackers, Macaroni, Noodles, Pasta, Sucrose, Maple sap and syrup, Honey, Candy, Egg products, Poultry and poultry products, Milk and milk products, Meat and meat products, Fruit based products (jam, jellies, sauce, juices, marmalade, tomato paste) and Vegetable, Beverages

Food Packaging 10 hrs
Principle of food packaging, Food packing materials chemical and physical properties, Interaction between food and the packaging materials, Evaluation of packaging materials and system: Selection of packing materials including edible packaging materials, Modified atmospheric and flexible packaging materials, Shelf life evaluation of packaging products

References
1. Potter NP (1987), Food Science, CBS Pub, India
2. Fellows PJ (1990), Food Processing technology – Principles and Practices, Ellice Harwood Ltd, UK
3. Rahman MS (1999), Handbook of Food Preservation, Marcel Dekker, Inc, NY
5. Prescott CS and Proctor EB (1937), Food Technology, Mc-Graw Hill Book company
Objectives

Upon completion of this course, the students will be able to
a. Understand quality system certification and quality assurance technique for improvement of quality and safety of food products

Course Contents

Quality Systems, Regulations and Certification  

Quality Assurance and Food Sanitation and Hygiene  
Principle of food quality control, Microbiology in food plant sanitation: Bacteriology of water, Sewage and waste treatment and disposal, Microbial quality of food products, Good Agriculture Practices (GAP), Good Hygienic Practice (GHP), Good Manufacturing Practice (GMP), Hazard Analysis of Critical Control Points (HACCP) and HACCP modules for perishable foods, Risk analysis: Risk assessment, Risk management and risk communication, Health of employees, Good Laboratory Practice (GLP), Principle of laboratory accreditation, Principle of reference material, Principle of quality assurance, Principle of quality auditing, Conventional systems

Total Quality Management (TQM) Principles  
Evolution of TQM, TQM Models, Customer satisfaction, Customer perception of quality, Customer complaints, Service quality, Customer retention, Employee involvement, Motivation, Empowerment, Teams, Recognition and reward, Continuous process improvement, PDCA cycle

Statistical Process Control (SPC)  
Control chart and importance, Procedures for creating X Bar and R charts, Procedures for constructing attribute charts, Chart patterns using control chart as quality management tool, Seven tools of quality, Pareto diagram, Scatter diagram, Ishikawa diagram, Implementation of quality control program, Six sigma, Samples: Sampling plans, Samples from different distribution, Sample size, Sampling technique, Types of samples, Types of inspection, Sampling risk
References
Course Title: Practical on (MB 612)  
Course No.: MB 615  
Nature of Course: Practical (2 credits)  
Full Marks: 50  
Pass Marks: 25  
Semester: III

Course Contents

1. Calculation on mass balance for preparation of sugar syrup
2. Determination of chlorophyll, carotene from various food samples
3. Determination artificial colours in food
4. Analysis of fats and oils (acid value, saponification number, iodine value, peroxide value)
5. Determine protein content in food using Kjeldal
6. Calculation of energy value of food
7. Determination of BMI value
8. Determination of SO₂, Benzoic acid in food
9. Assay of amino acids and vitamins in food
10. Determination ascorbic acid, sugar content of fruit juice
Course Title: Practical on (MB 613+MB 614)  
Full Marks: 50
Course No.: MB 616  
Pass Marks: 25
Nature of Course: Practical (2 credits)  
Semester: III

Course Contents

1. Determination of D value of bacteria
2. Preparation of cake, jam, ketchup and their quality evaluation
3. Determination of water absorptiveness, NaCl, chemical resistance of packaging materials
4. Identification of various plastics
5. Shelf life evaluation of packaging products
6. Determination of fat, SNF, protein, lactose content in milk
7. Design HACCP module for pasteurized milk, meat and other perishable food product
8. Determination of moisture content, ash content, crude fat of food
9. Determination of antioxidants in food
Discipline III: Food and Industrial Microbiology

**Semester IV**

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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
MB 655 Industry based Internship

Course Title: Industry based Internship  
Course No.: MB 655  
Nature of Course: Practical (8 credits)  
Full Marks: X  
Pass Marks: S/US  
Semester: IV

Objectives

Upon completion of the internship, the students will be able to
a. Develop hands on skills of microbiology laboratory
b. Understand laboratory protocols and procedures
c. Understand recording and reporting of food industries data

Course Description

Student will do at least six month internship in relevant food industries/institutions or other relevant food microbiology laboratories. The letter/certificate of internship from the internship institution and report of the internship in prescribed format of the department/campus/college should be submitted by the student after completion of the internship.
MB 656 Dissertation

Course Title: Dissertation  
Course No.: MB 656  
Nature of Course: Laboratory based Research Project (8 credits)

Full Marks: 200  
Pass Marks: 100  
Semester: IV

Objectives
Upon the completion of dissertation the students will

a. Have knowledge and skills to conduct original scientific research
b. Have deep understanding of research methods related to Microbiology
c. Be able to design an experiment, generate, analyze scientific data and conclude important findings
d. Develop scientific writing and presentation skills

Course Description
Individual students will be assigned relevant research topics related to their field of study by concerned central department/campus/college. Students will perform required field work and laboratory experiments within this semester. The research will be supervised by faculty member(s) of microbiology of concerned central department/campus/college. Students should submit research proposal on assigned topic within first week of this semester and must be approved by the institutional review board. After completion of research work, the student should write the dissertation/thesis in standard format on the basis of data/findings generated during the research works. The student will submit required number of copies of their dissertation to concerned department/campus/college for evaluation. The submitted dissertation will be approved by head of the central department/campus chief/coordinator. On the recommendation of head of department/campus chief/coordinator, the Institute of Science and Technology will appoint a related expert as an external examiner from the panel of approved examiners to evaluate the submitted dissertation. On the recommendation of external examiner, viva-voce open defense will be organized for evaluation of dissertation by concerned department/campus/college. The final evaluation of dissertation will be made by a panel of external and internal examiners, head of the department and supervisor(s). Students will be encouraged to publish the dissertation findings in peer reviewed microbiology journals in the form of original research article.
**Discipline IV: Agriculture Microbiology**

**Semester II**

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MB 568 Biological Control

Course Title: Biological Control  Full Marks: 75  
Course No.: MB 568  Pass Marks: 37.5  
Nature of Course: Theory (3 credits)  Semester: II

Objectives  
Upon completion of the course the student will be able to  
a. Have detail knowledge about the soil borne microbial and nematode diseases of plant  
b. Distinguish between pathogenic and deficiency disease in plant  
c. Understand the mechanism of genetic trait transfer in soil borne and pathogenic microbes

Course Contents

Microbial Interaction 8 hrs  
Inter specific relationship, Neutralism, Commensalism, Synergism, Antagonism, Mutualism, Parasitism, Competition, Ammensalism, Predation, Effects of Synchronism and Cometabolism in microorganisms

Biological Control of Pests 10 hrs  
Introduction and origin of herbivores insects and importance of their management, Natural controls, Biological controls, Biorational controls, Biotechnological controls, Host plant resistance, Microbial controls, Rationale of biological control, Status and constraints of biological control works in Nepal, Major biocontrol agents of insect parasitoids, predators, pathogens and weed feeding arthropods, Approaches of biocontrol (inoculation, augmentation, inundation and conservation and encouragement), Desirable attributes of biocontrol agents, Biology of insect parasitoids within insect arthropods, Tritrophic interactions between crops, pests and biocontrol agents

Insect Pathogens 3 hrs  
Important groups of insect pathogens, Major characteristics of insect pathogens (specific to insect pathogens)

Microbial Insecticides (Fungi) 4 hrs  
Insect pathogenic fungi (Metarhizium anisopliae) and (Beauveria bassiana) useful against crop pests, Target insects, Mode of infection, General life cycle, Host symptoms, Major fungal based microbial insecticides (exotic and indigenous) useful to insect control

Microbial Insecticides (Bacteria) 4 hrs  
Insect pathogenic bacteria (Bacillus thuringiensis), Target insects, Mode of infection, life cycle, Host symptoms, Major microbial insecticides based on insect bacteria

Microbial Insecticides (Virus) 4 hrs  
Insect pathogenic virus (Nuclear polyhedrosis virus and granulosis virus), Target insects, Mode of infection, Host symptoms, Life cycle, Major microbial insecticides based on insect virus
Microbial Insecticides (Nematodes and Protozoa)  

Insect pathogenic nematodes (Steinernematids and Heterorhabditis) and protozoa, Target insects, Mode of infection, Host symptoms, Major microbial insecticides based on insect nematodes and protozoa, Role of EPNs, Problem associated with EPNs uses

Approaches in Biological Control  

Environmental friendly microbial and botanical products available in Nepal, Steps for quality control and improving biological control agents, Storage techniques and method of application and release of biocontrol agents, Types/Principles of biological control, Evaluation of natural enemies and pesticide selectivity: Introduction to pesticide selectivity, Pesticide side effects in natural enemies, Selective pesticide application, Some commercially available biocontrol agents and their places in Integrated Pest Management (IPM)

References

MB 569 Soil Microbiology

Course Title: Soil Microbiology          Full Marks: 75
Course No. MB 569                   Pass Marks: 37.5
Nature of Course: Theory (3 credits)        Semester: II

Objectives
Upon completion of the course, the students will be able to
a. Understand the formation of soil
b. Have basic knowledge about the soil plant microbes inter-relationship
   c. Have knowledge about the mineral transformation and residual pesticide in soil

Course Contents

Properties of Soil          10 hrs
Soil Quality: Elements of soil formation and laterization, Pseudolization, Physical and chemical
properties of soil: Components of soil and their importance for plant and microbial growth
(Mineral matter, Organic matter, Soil moisture, Soil atmosphere, O/R potential)

Microbes in Soil   7 hrs
Bacteria \((\text{Actinomycetes} \text{ and others})\), Fungi, Algae, Bacteriophages, Protozoa, Nematodes

Ecological Group of Microorganisms      5 hrs
Based on oxygen requirement: aerobes, microaerophiles, anaerobes; Based on carbon source: autotrophs, heterotrophs; Based on temperature: psychrophiles, mesophiles, thermophiles, hyperheterrophiles, super heterophiles, barophiles; Based on nutrition: saprophytism, parasitism, Symbiosis, Habitat, Ecological niche

Decomposition of Different Components of Plants         7 hrs
Decomposition of cellulose, hemicelluloses, pectin, inulin and lignin

Plant Microbial Interactions       6 hrs
Interaction in above ground parts: Destructive association- bacterial, algal, fungal, mycoplasma
diseases; Beneficial association: phylloplane microflora, morphological and physiological
characteristics of phylloplane microflora: nutrition, radiation, pH, temperature, floral part
microflora, stem nodule

Interaction on below ground parts: Destructive association- bacterial, fungal, nematode diseases;
Beneficial association: cyanobacterial, bacterial associative interaction, plant growth promoting
rhizobacteria (PGPR); Legume rhizobium symbiosis; actinomycetes non-legume symbiosis;
fungal symbiosis: mycorrhiza; Rhizosphere and rhizoplane microorganisms, increase microbial
activity in rhizosphere, rhizosphere effect

Biogeochemical Cycles         10 hrs
Role of different soil microorganisms in Carbon, Nitrogen, Phosphorus and Sulphur cycles
References
8. Subba Rao NS. *Soil microorganism and plant growth*
MB 570 Microbial Metabolism in Soil

Course Title: Microbial Metabolism in Soil  
Course No.: MB 570  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: II

Objectives
Upon completion of the course the student will be able to
a. Understand physiology of soil borne and pathogenic microorganisms
b. Understand contributing factors affecting growth of microbes in soil

Course Contents

Degradation of Pesticides, Insecticide, Herbicide and Fungicide in Soil  
15 hrs
Process of degradation of pesticides, Insecticide, Herbicide and fungicide in soil and their effect on soil microbes, like Rhizobium and other in biogeochemical cycle
Degradation of DDT, Aldrin, Heptachlor, Lindane, Aliphatic acids, Phenylcarbamates, Phenylureas, Thiocarbamates, PCNB, Chloroneb, Murcurial fungicides
Degradation pathways, Detoxication, Degradation and conjugation formation with the steps (defusing, activation, detoxification, addition reaction and degradation reaction and transformation of 2-4-D)

Physiology and Biochemistry of Soil Microorganisms  
5 hrs
Enzymes, nutrition, growth and multiplication of microbes: Pectinolytic, Lignolytic, Lipolytic, Cellulolytic enzymes of soil microbes

Factors Affecting Growth and Population of Microbes  
10 hrs
Factors affecting growth of soil microbes in raining, Drought, Arid condition, Change of microbial population, Dominance in microbial flora according to climatic condition

Synthesis of Cell Constituents, Secondary Metabolites of Microbes Influencing Plant Growth  
15 hrs
Carbohydrate, Protein and lipid synthesis, Indole acetic acid, Gibberellins, Cytokinins, Ethylene, Antibiotics, Toxins, Mycotoxins

References
1. Rangaswami G and Bagyaraj DJ (2004), Agricultural Microbiology, Prentice Hall Private Ltd
2. Alexander M (1961), An Introduction to Soil Microbiology, Wiley Eastern Ltd
3. Tisdale SL, Nelson WL and Beaton JD (1985), Soil Fertility and Fertilizers, Macmillan Technology and Engineering
**MB 571 Soil Fertilizers**

Course Title: Soil Fertilizers  
Course No.: MB 571  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: II

**Objectives**

Upon completion of the course the student will be able to

a. Understand the effect and utilize the commercial inorganic, organic fertilizer and biofertilizer
b. Use organic green manuring for better yield of crop

**Course Contents**

**Chemical Fertilizers**  
5 hrs  
Use of commercial Nitrogen, Phosphorous and Potassium chemical fertilizers. Impact of indiscriminate use of these fertilizers on soil and crop plants

**Biofertilizers**  
2 hrs  
Importance of Biofertilizers in the present context

**Microorganisms used in Biofertilizers**  
23 hrs  

**Organic Fertilizers**  
10 hrs  
Farm Yard Manures, Night soil, Oil cakes, bone meal, aerobic and anaerobic composting, and vermicomposts

**Different types of Green Manures**  
5 hrs  
Leguminous and non leguminous green manuring plants, *Azolla*

**References**

7. Subba Rao NS. *Biofertilizers in Agriculture*
Course Title: Practical on (MB 568 + MB 569)  
Course No.: MB 572  
Nature of Course: Practical (2 credits)  
Full Marks: 50  
Pass Marks: 25  
Semester: II

Course Contents

1. Estimation of organic carbon in soil
2. Estimation of organic nitrogen, phosphorus in soil
3. Estimation soil texture by sieve method and water holding capacity
4. Isolation of nitrate reducers in soil
5. Isolation of fungal organism by buried slide technique
6. Estimation of total nitrogen by kit method
7. Isolation and identification of microorganisms from phyllosphere, rhizoplane and rhizosphere
8. Isolation of antibiotic producing microbes from soil
9. Isolation and identification of *Bacillus thuringiensis* from soil
10. Production of *B. thuringiensis* as a biological control agent
MB 573 Practical on (MB 570+MB 571)

Course Title: Practical on (MB 570+MB 571)  
Course No.: MB 573  
Nature of Course: Practical (2 credits)

Full Marks: 50  
PassMarks: 25  
Semester: II

Course Contents
1. Screening and identification of cellulolytic organism in soil per gram of soil
2. Screening and identification of proteolytic organism in soil per gram of soil
3. Screening and identification of lipolytic organism in soil
4. Screening and identification of xylan degrading organism in soil
5. Isolation and identification of Azotobacter in soil
6. Evaluation of Azotobacter fixed nitrogen by Kjeldahl method
7. Isolation and identification of Rhizobium in soil
8. Evaluation of rhizobium by seed inoculation
9. Isolation and identification of Mycorrhiza in soil
10. Evaluation of effect of Mycorrhiza by inoculation
11. Isolation and identification of Actinomycetes in soil
12. Evaluation of soluble phosphorus due to Actinomycetes by pot method
13. Isolation of amino acid producer from soil
**Discipline IV: Agriculture Microbiology**

**Semester III**

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<th>Course Title</th>
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<td>Research Methods and Biostatistics</td>
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<td>MB 617</td>
<td>Microbial Inoculants in Agriculture, Livestock and Forestry</td>
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<td>Applied Soil Microbiology</td>
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<td>Microbial Diseases and Agriculture Biotechnology</td>
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**Total**  16  400
MB 601 Research Methods and Biostatistics

Course Title: Research Methods and Biostatistics
Course No.: MB 601
Nature of Course: Theory (3 credits)

Full Marks: 75
Pass Marks: 37.5
Semester: III

Objectives
Upon the completion of the course students will have knowledge on
a. Research methods in Microbiology
b. Application of biostatistical methods in microbiological research

Course Contents

Research Methods

Research Methods 15 hrs
Introduction and objectives of research, Criteria of good research question, Research process, Priority areas, Objectives/ Hypothesis setting, Literature review, Critical appraisal, Meta analysis, Ethical issues in research: Salient point of the international guidelines, General ethical principles, Informed consent

Scientific Writing 5 hrs
Paper writing, Proposal writing, Thesis/report writing (Seminar presentations)

Biostatistics

Sampling, Data Collection and Frequency Distribution 5 hrs
Sample and Sampling, Sampling design and Sample selection, Sample size and calculation, Qualitative and quantitative data collection methods, Frequency distribution

Data Analysis and Computer Application 20 hrs
Quantitative data analysis (descriptive analysis, inferential analysis- chi square, t-test, ANOVA, correlation, 95% CI, Standard error, Odds ratio, p-value, Regression analysis), Data entry and data analysis using computer software (SPSS, STATA, SAS, Epi Info etc.)

References
MB 617 Microbial Inoculants in Agriculture, Livestock and Forestry

Course Title: Microbial Inoculants in Agriculture, Livestock and Forestry  Full Marks: 75
Course No.: MB 617         Pass Marks: 37.5
Nature of Course: Theory (3 credits)                                        Semester: III

Objectives
Upon completion of the course the student will be able to
a. Understand how to prepare microbial inoculants in mass scale
b. Carry out different methods of using the inoculants on seed and soil
c. Have knowledge of crop response to microbial inoculants

Course Contents

Importance of Microbial Inoculants in Agriculture, Livestock and Forestry  2 hrs

Types and Methods of Mass Production of Bacterial Inoculants    18 hrs
Azotobacter inoculants
Azospirillum inoculants
Rhizobial inoculants
Blue Green Algal inoculants
Mycorrhizal inoculants
Frankia inoculants

Methods of Inoculation          12 hrs
Liquid inoculants
Carrier based inoculants and choice of carriers
Seed inoculation
Soil inoculation
Nursery inoculation of forestry tree seedlings
Inoculation of pasture grasses for livestock developments
Factors affecting survival microbial inoculants

Crop Responses due to Different Microorganisms Inoculations on Agricultural Crops,
Forest Trees and Livestock Pasture Grasses  13 hrs

References
1. Rangaswami G and Bagyaraj  DJ (2004), Agricultural Microbiology, Prentice Hall Private Ltd
2. Tisdale SL, Nelson WL and Beaton JD (1985), Soil Fertility and Fertilizers, Macmillan Technology and Engineering
7. Subba Rao NS. *Biofertilizers in Agriculture*
MB 618 Applied Soil Microbiology

Course Title: Applied Soil Microbiology  
Course No.: MB 618  
Nature of Course: Theory (3 credits)  
Full Marks: 75  
Pass Marks: 37.5  
Semester: III

Objectives
Upon completion of the course the student will be able to
a. Understand the role of major soil flora and fauna in crop productivity
b. Apply the role of soil microorganisms in soil health
c. Conserve and exploit soil micro-organisms

Course Contents

**Organic Waste Decomposition**  
10 hrs  
Composition of litter, Carbon assimilation and immobilization, Organic waste dynamics in soil, Factors affecting organic matter decomposition – litter quality, temperature, aeration, soil pH, inorganic chemical moisture, microbial biomass as an index of soil fertility, soil fertility

**Agriculture Waste Management and Bioconversion**  
25 hrs

**Recycling of agriculture waste as fertilizer:** organic compost, composting, factors affecting composting, role of compost; vermicomposting, process of vermicomposting

**Recycling of agriculture waste as food:** edible mushroom culture, fungi involved in mushroom culture – *Agaricus* spp., *Volvoriella* spp., process and practice of safe mushroom growing practice (free from toxic mushrooms); single cell protein, Microorganism used in SCP, production and factors affecting the manufacture of SCP

**Recycling of agriculture waste as fuel:** biogas, microorganisms involved in methanogenesis (biogas production), biogas production, factors affecting methane formation

**Recycling of agriculture waste as feed:** Single cell protein: *Saccharomyces, Spirulina*; production of SCP from agricultural waste

**Microorganisms in Miscellaneous Roles**  
10 hrs

Microbiology of air in relation to crop disease, Microbiology of water in relation to crop disease, Insect microbiology: Beneficial insects in crop disease controls (Bugs, Praying Mantis), Microbiology of wood degradation and silage production, Microbiology of jute and hemp curing, Microbiology of deterioration of leather and other products

References
3. Subba Rao NS. *Soil Microbiology*
MB 619 Microbial Diseases and Agricultural Biotechnology

Course Title: Microbial Diseases and Agricultural Biotechnology  Full Marks: 75
Course No.: MB 619        Pass Marks: 37.5
Nature of Course: Theory (3 credits)            Semester: III

Objectives
Upon completion of the course the student will be able to
a. Understand the use of biotechnology in agriculture
b. Apply the biotechnology to identify microbial plant diseases
c. Introduce to new techniques used in agricultural biotechnology

Course Contents

**Plant Viruses, Their Transmission and Detection**  5 hrs
Tobamovirus group – Tobacco mosaic virus, Potex virus group – Potato virus X (PVX), Potyvirus group – potato virus Y (PVY), Tymovirus group – cucumber mosaic virus (CMV), Tomato spotted witt virus (TSWV), Cauliflower mosaic virus (CaMV), Patato leaf roll virus (polerovirus), Rice tungro virus, mosaic disease of sugarcane; Transmission of plant viruses: mechanical transmission, vegetative and graft transmission, pollen transmission, seed transmission, nematode transmission, fungal transmission, insect vector transmission, dodder transmission Effect of virus on plant: external and internal symptoms Viroids, virusoids and satellites

**Bacterial Plant Diseases and Detection**  8 hrs
Characteristics, symptoms, identification and control of Fire blight of pome fruits, Soft rot of vegetables, Angular leaf spot of cucumber and cotton, Bacterial leaf blight of rice, Bacterial wilt of banana, Pierce's disease of grape, Citrus variegation chlorosis, Citrus greening disease

**Fungal Plant Diseases and Detection**  10 hrs
Characteristics, symptoms, identification and control of Cereal rusts, Cereal smuts, Ergot of rye and wheat, Late blight of potato, Powdery mildew of grapes, Downy mildew of grapes and tobacco, Karnal bunt of wheat, Soyabean rust, Citrus black spot, Vascular wilt of banana.

**Nematodal Plant Diseases**  2 hrs
Characteristics, symptoms, identification and control of Sugar beet cyst nematode, Soyabean cyst nematode, Burrowing nematode affecting bananas.

**Green Revolution**  2 hrs
Green revolution, Benefits, disadvantages and limitations of green revolution

**Transgenic Plants**  3 hrs
Genetically modified plants: Production of disease resistant and stress resistant plants

**Ecological Consideration in Release of Transgenic Plants**  2 hrs
Public acceptance, Benefits of transgenic plants
Biosafety Issues 2 hrs
Biosafety issues in use of transgenic plants

Patents 2 hrs
National legislation, patents of indigenous microbes and plants

Tissue Culture 6 hrs
Explant culture, callus formation and culture, organogenesis, root culture, shoot culture, cell culture, somatic embryogenesis, protoplast culture

Indigenous Fermentation Products of Nepal 3 hrs

References
1. Dubey RC and Maheshwari DK (2013). A textbook of Microbiology, S Chand
2. Subba Rao NS. Soil Microbiology
3. Walia RK and Bajaj HK. Text book on Introductory Plant nematology
4. Dropkin VH. Introduction to Plant Nematology
MB 620 Practical on (MB 617 + MB 618)

Course Title: Practical on (MB 617 + MB 618)  
Full Marks: 50
Course No.: MB 620  
Pass Marks: 25
Nature of Course: Practical (2 credits)  
Semester: III

Course Contents

1. Identification and mass multiplication of selected Bacterial inoculants: *Azotobacter*, *Azospirillum*, *Azomonas*
2. Isolation and identification of *Rhizobium leguminosarum*, *R. trifolii*, *Bradyrhizobium japonicum* 
3. Mass production techniques of selected Microbial inoculants: *Azotobacter*, *Azospirillum* and *R. trifolii*
4. Different types of carriers and their quality assessment 
5. Preparation of carrier based inoculants 
6. Study of inoculation response of bacterial fertilizers in laboratory 
7. Study of inoculation response of bacterial fertilizers in pot cultures 
8. Composting of garden waste 
9. Vermicomposting kitchen wastes 
10. Study of quality of different organic fertilizers 
11. Mushroom culture 
12. Production of single cell protein
MB 621 Practical on (MB 619)

Course Title: Practical on (MB 619)  
Course No.: MB 621  
Nature of Course: Practical (2 credits)  
Full Marks: 50  
Pass Marks: 25  
Semester: III

Course Contents

1. Detection of fungal disease in plant by macroscopic observation
2. Study of symptoms of cereal, vegetable, fruit, legume diseases - Fungal
3. Study of symptoms of cereal vegetable, fruit, legume diseases - Bacteria
4. Study of symptoms of cereal vegetable, fruit, legume diseases – Nematodes
5. Identification of stem, root, and leaf diseases of crops and vegetables
6. Isolation of fungi from diseased plant
7. Detection of fungal disease in plant by agar gel diffusion
8. Detection of fungal disease in plant by ELISA
9. Dot immunoblotting assay
10. Tissue culture (meristem culture)
Discipline IV: Agriculture Microbiology

**Semester IV**

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S/US- Satisfactory (Pass)/unsatisfactory (Fail)
MB 657 Agriculture based Internship

Course Title: Agriculture based Internship     Full Marks: X
Course No.: MB 657        Pass Marks: S/US
Nature of Course: Practical (8 credits)      Semester: IV

Objectives

Upon completion of the internship, the students will be able to
a. Develop hands on skills of microbiology laboratory
b. Understand laboratory protocols and procedures
c. Understand recording and reporting of agricultural data

Course Description

Student will do at least six month internship in relevant agriculture industry/institution or other relevant agriculture microbiology laboratories. The letter/certificate of internship from the internship institution and report of the internship in prescribed format of the department/campus/college should be submitted by the student after completion of the internship.
MB 658 Dissertation

Course Title: Dissertation  
Course No.: MB 658  
Nature of Course: Laboratory based Research Project (8 credits)

Objectives
Upon the completion of dissertation the students will

a. Have knowledge and skills to conduct original scientific research
b. Have deep understanding of research methods related to Microbiology

a. Be able to design an experiment, generate, analyze scientific data and conclude important findings
b. Develop scientific writing and presentation skills

Course Description

Individual students will be assigned relevant research topics related to their field of study by concerned central department/campus/college. Students will perform required field work and laboratory experiments within this semester. The research will be supervised by faculty member(s) of microbiology of concerned central department/campus/college. Students should submit research proposal on assigned topic within first week of this semester and must be approved by the institutional review board. After completion of research work, the student should write the dissertation/thesis in standard format on the basis of data/findings generated during the research works. The student will submit required number of copies of their dissertation to concerned department/campus/college for evaluation. The submitted dissertation will be approved by head of the central department/campus chief/coordinator. On the recommendation of head of department/campus chief/coordinator, the Institute of Science and Technology will appoint a related expert as an external examiner from the panel of approved examiners to evaluate the submitted dissertation. On the recommendation of external examiner, viva-voce open defense will be organized for evaluation of dissertation by concerned department/campus/college. The final evaluation of dissertation will be made by a panel of external and internal examiners, head of the department and supervisor(s). Students will be encouraged to publish the dissertation findings in peer reviewed microbiology journals in the form of original research article.