St. Joseph's College, Bangalore.
Department of Microbiology
Syllabus for B.Sc. Microbiology
Semester – I

MB 112 – Basic Microbiology and Microbiological techniques
No. of lecture hours: 60 hours

Unit - I

History and Scope of Microbiology
Scope and relevance of microbiology as a modern science
Branches of Microbiology 1 hour

Contribution of Scientists to the field of Microbiology – Antony Von Leeuwenhoek, Francisco Redi, Edward Jenner, Lazzaro Spallanzani, Louis Pasteur, Joseph Lister, Robert Koch and Alexander Flemming. 4 hours

Unit – II

General Characteristics of Microorganisms

a. Study of a typical prokaryotic and eukaryotic cell 2 hours

b. Bacteria
Overview of a bacterial cell (morphology, ultra structure and function)
Structure and function of flagella, pili and capsule, cell wall (gram +ve and gram -ve), cell membrane, mesosomes, ribosomes, plasmids and genetic material.
Inclusion bodies and reserve food materials.
Structure of bacterial endospore. Sporulation and germination of endospore.
Reproduction in bacteria: asexual and sexual 11 hours

c. Fungi
Overview of fungal cell (ultra structure and function)
Structure and function of cell wall, cell membrane, flagella, cell organelles (Nuclear, EPR, Golgi apparatus, ribosomes),
Overview of yeast cell (ultrastructure and functions)
Reproduction in fungi: asexual and sexual 6 hours

d. Algae
General characteristics and importance.
Overview of cyanobacterial cell (Ultrastructure and Functions) 3 hours

Unit III

Structure, Reproduction, Cultivation and Significance of:
Viruses (Bacterial- lytic, lysogeny, lamda and T4; Fungal-CPV1; Algal- PCB; Plant- TMV, satellite; Animal- HIV)
Mycoplasma
Rickettsias
Actinomycetes
Prions & Viriods
Protozoan
Spirochaetes 12 hours

Unit - IV

Microbiological techniques
a. Microscopy
Light field, Dark field, fluorescence, Phase contrast and Electron microscopy (TEM and SEM), Flourescent microscope 7 hours

b. Staining Techniques
Simple staining (Negative staining)
Differential staining (Grams and acid fast staining)
Structural staining (endospore, flagella and capsular staining) and Fungal staining 2 hours

c. Sterilization techniques:
i) Factors affecting antimicrobial activity:-
Environment, organisms, physiological status of the organisms, inoculums concentration, intensity of concentration of the antimicrobial agent, temperature and time of action as factors affecting antimicrobial activity
ii) Physical methods:
Moist heat (Tyndallization, Pasteurization)
Moist heat under pressure (Autoclave)
Dry heat (Incineration, hot air over)
Filtration (Porcelain filter, diatamaous earth filter, seitz filter, sintered glass filter, membrane filter, air filters, HEPA filter)
Radiation (UV- rays, X- rays, ultrasonic rays)
iii) Chemicals (alcohols, formaldehyde, phenol hypochloride, halogens and heavy metals):
Characteristics of an ideal antimicrobial chemical agent
Evaluation of antimicrobial chemical agents- Tube dilution and agar plate techniques, Phenol co-efficient methods 12 hours

Practical I
MB $1P_1$ – Basic microbiology and Microbiological techniques

1. Safety measures in laboratory and laboratory techniques 1 unit
2. Study of compound and binocular microscopes. Use of oil immersion objective 1 unit
3. Study of apparatus- Autoclave, hot air oven, LAF, incubator, centrifuges, pH meter Membrane filter, spectrophotometer, colony counter 2 units
4. Preparation of media – NB, NA, MRBA, Potato dextrose agar 2 units
5. Pure culture techniques – pour plate, spread plate and streaking methods 1unit
6. Aseptic transfer techniques 1 unit
7. Isolation and identification of bacteria (Serial dilution, plating and colony morphology) 2 units
8. Staining of bacteria – Gram staining, negative, endospore and capsule staining 4 units
9. Study of bacterial motility by Hanging drop technique 1 unit

Semester II
MB 212 – Biophysics, Biochemistry and Microbial diversity
No. of lecture hours: 60 hours

Unit I

Biophysics

a. Scope and development of Biophysics 1 hour

b. Properties and dissociation of water
Structure, properties, hydrogen bonding, water as a solvent and ionization of water 2 hours

c. pH and Buffers pH –
pH- concept and pH scale; Buffers- concept.
Henderson- Hasselbalch equation, Biological buffer systems 2 hours

d. Isotopes and Radioactivitiy
Nature of radioactivity, Atomic structure, atomic stability and radiation, Applications of radioisotopes in the biological sciences, safety measures, Autoradiography. 4 hours

Unit II

Analytical rechniques

Principle and applications of chromatography (Paper chromatography, Thin layer chromatography, Column chromatography), Centrifugation and Electrophoresis (agarose gel electrophoresis and SDS-PAGE), Spectrophotometry. 5 hours

Unit III

Bio molecules

Amino acids and Peptides- Classification and Properties;	3 hours
Proteins – Classification of proteins based on structure and functions, Structural organization of proteins (Primary, Secondary, Tertiary and Quaternary structures)	5 hours
Enzymes – Introduction, Classification, Enzyme kinetics, Factors influencing enzyme activity, co-enzymes and co-factors, Mechanisms of enzyme regulation	6 hours
Carbohydrates – Structure, Properties and Classification.	4 hours
Lipids – Structure, Properties and Classification.	3 hours
Vitamins – Water soluble and Fat- soluble vitamins, Dietary source	2 hours
Nucleic acids - Types and Properties	4 hours

Unit – IV

Microbial Diversity

a. Microorganisms and microbial ecology (Based on temperature, oxygen requirement, salt concentration and pressure)	4 hours
b. Microbial associations (Parasitism symbiosis, commensalism, antagonism, predator and competition).	5 hours
c. Microbial systematic	
1. Bacterial Classification Bergey's manual, brief account on Numerical taxonomy, chemotaxonomy, serogical taxonomy and genetic analyses.	6 hours
2. Fungal classification – Alexopolus	2 hours
3. Viral Classification – Baltimore and ICTV	2 hours

Practical II
MB $2P_1$ – Microbial diversity and Biochemistry

1. Study of microbial interactions - antagonism (Bacteria and Bacteria; Bacteria and Fungi)	2 units
2. Isolation and identification of fungi	2 units
3. Paper chromatography	1 units
4. Preparation of buffer – citrate and phosphate buffer	2 units
5. Estimation of reducing sugars by DNSA method	2 units
6. Estimation of Protein by Lowry's method	2 units
7. Estimation of DNA by Diphenylamine method	2 units
8. Estimation of RNA by Orcinol method	2 units

SEMESTER III

MB 312 – Microbial physiology, growth and control of microorganisms
No. of lecture hours 60

Unit -I
Microbial nutrition and growth

- **a.** Nutritional requirements**:** Macronutrients, Micronutrients and trace elements. Nutritional types - Phototrophs, Chemotrophs, Autrotrophs and Heterotrophs. 2 hours
- **b.** Physical factors affecting growth- pH, Temperature, oxygen and salinity. 2 hours
- **c.** Bacterial growth curve and calculation of generation time. 3 hours
- **d.** Continuous culture system – chemostat and turbidostat. 2 hours
- **e.** Synchronous cultures. 2 hours
- **f.** Methods of estimating microbial growth. 4 hours
    1. Determination of microbial growth by cell number
    2. Determination of microbial growth by cell mass
    3. Determination of microbial number by cell activity
- **g.** Introduction to the concept of cultivation of microorganisms: Media and types of media.
- **h.** Isolation of pure cultures by streaking method. 3 hours
- **i.** Maintenance and methods of preservation of bacterial and fungal cultures. 2 hours

Unit – II
Bioenergetics and Metabolism:

- **A. Bioenergetics:**
  Entropy, enthalpy, free energy, ATP-its role in metabolism, other energy rich compounds, oxidation-reduction reactions, Electron carriers. 3hours
- **B. Metabolism:**
  a. Overview of metabolism. 1hours
  b. Carbohydrate metabolism:
    (i) Catabolism:
      - Glycolysis, Pentose phosphate pathway, TCA, ETC.
      - Fermentation reactions in microorganisms: (lactic acid, mixed acid, butanediol, butyric acid, propionic acid.)
      - Breakdown of lactose, starch, glycogen and cellulose. 10 hours

    (ii) Anabolism:
      - Gluconeogenesis
      - Photosynthesis (Cyclic and non cyclic); CO_2 fixation (C_3 and C_4)
      - Biosynthesis of Peptidoglycan. 8 hours

c. Lipid metabolism:
   (i) Catabolism:
      - Oxidation of saturate fatty acids – β oxidation pathway
   (ii) Anabolism:
      - Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) 4 hours

d. Amino acid metabolism:
   (i) catabolism:
      - Overview of catabolism of amino group.
      - Nitrogen excretion and urea cycle.
   (ii) Anabolism:
      - Overview of aminoacid biosynthesis. 4 hours

Unit - III

Antibiotics and other chemotherapeutic agents:

a. Definition and classification of antibiotics. 1 hour
b. History of chemotherapy 1 hour
c. Antibiotic chemotherapeutic agents : Mode of action of 5 hours
Penicillins/Cephalosporins/Streptomycin/Tetracyclines/Erythromycin/Chloramphenicol/ Polymyxin and Bacitracin/ Antifungal – Nystatin, Greseofulvin, Amphotericin B)
d. Determining the effectiveness of chemotherapeutic agents 1 hour
e. Development of Resistance to antibiotics. 2 hours

Practical-III

MB $3P_1$-– Microbial physiology, growth and control of microorganisms

1. Nutritional requirement – Growth on various carbon and nitrogen sources. 2 units
2. Effect of pH and temperature on growth of bacteria. 2 units
3. Bacterial growth curve (Spectrophotometric method) and generation time. 2 units
4. Determination of Fungal growth- (linear growth of fungi) 2units
5. Counting of yeast cells by using a haemocytometer 2 units
6. Measurement of fungal spores by micrometry. 2 units
7. Biochemical tests used for the identification of bacteria, IMViC, fermentation of carbohydrates (any three), starch hydrolysis, Gelatin fermentation, TSI, catalase and oxidase. 3 units
8. Evaluation of antibiotics by Kirby Bauer's method. 2 units

Semester IV
MB 412 – Microbial Genetics, Molecular Biology and Recombinant DNA Technology
No. of lecture hours 60

Microbial Genetics and Molecular Biology:

Unit – I

a. History and scope of Genetics 2 hours
b. Structural details of DNA, Forms of DNA (A,B,Z and H) 2 hours
c. Structure and types of RNA 2 hours
d. Genetic organization in prokaryotes and eukaryotes 2 hours

Unit – II

a. **DNA replication in prokaryotes**: Messelson's and Stahl's experiment, Models of DNA replication, Mechanism of DNA replication. 4 hours
b.Mutations: Types of mutations, Spontaneous mutations and induced mutations by physical and chemical mutagens. Mutations for economic benefit of man. 4 hours
c. DNA repair: Photoreactivation and nucleotide excision repair. 1 hour
d. Transposition in prokaryotes: structure of Is and Tn elements in prokaryotes and mechanism of transposition. 2 hours
e. Gene transfer mechanisms in bacteria: Transformation, Conjugation and Transduction 3 hours

Unit – III

a. Central dogma of molecular biology 1 hour
b. Transcription in prokaryotes: Promoters, RNA polymerase and mechanism of transcription. 3 hours
c. Translation in prokaryotes: Mechanism of translation. 2 hours
d. Regulation of gene expression in prokaryotes: Operon concept- Lac operon. 2 hours

Unit – IV

Recombinant DNA technology

History and fundamentals of r-DNA technology 1 hour
Tools for rDNA technology -DNA manipulative enzymes: Restriction enzymes, Ligases and other DNA modifying enzymes 2 hours

Gene cloning vectors: Salient features, Plasmids – properties, types, pBR322 and pUC18, Phage DNA-insertional and replacement vectors(Lambda), Cosmids-properties, YAC.
4 hours

In vitro construction of r-DNA molecules: Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria).
Cutting of DNA molecules- Physical methods, enzymatic methods & Joining of DNA molecules - Homopolymer tails, Linkers, Adapters. 4 hours

Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, *Agrobacterium* mediated DNA transfer, Electroporation, Microinjection, Liposome fusion, Microparticle bombardment. 6 hours

Blotting techniques 4 hours
Construction of gene libraries: Genomic and cDNA libraries. 2 hours
Polymerase chain reaction (PCR) and its applications. 2 hour

Applications of rDNA technology:

(i) Medicine: Diagnosis of tuberculosis; Antisence therapy for cancer; synthetic insulin for diabetes; subunit vaccine against Herpes Simples virus; DNA fingerprinting in forensic medicine.
(ii) Agriculture: Bt-based genetic transformation of plants; genetic manipulation of fruit ripening.

Environment: GEMs in bioremediation. 5 hours

Practical-IV
MB $4P_1$ – Microbial Genetics, Molecular Biology and Recombinant DNA Technology

1. Mutagenesis 2 units
2. Isolation of Genomic DNA from bacterial cells and separation of isolated genomic DNA by agarose gel electrophoresis 2 units
3. Plasmid DNA isolation 2 units
4. Restriction digestion of DNA 2 units
5. Ligation of the restricted DNA 2 units
6. Separation of proteins by SDS-Page (Sodium dodecyl sulphate-Polyacrylamide gel electrophoresis) 2 units
7. Bacterial transformation by $CaCl_2$ method. 2 units

Semester V-Paper VI
MB 5212 – Agricultural and Environmental Microbiology
No. of lecture hours: 45 hours

Unit-I

Diversity of soil flora, rhizosphere, Mycorrhiza 7 hours
Role of microorganisms in humus formation
Biogeochemical cycles: Carbon, Nitrogen, Phosphorus, Sulphur

Role of microorganisms in iron oxidation (Microbial leaching)

Unit-II

Plant pathology 5 hours

Classification of plant diseases based on symptoms (with one example of each) downy mildew, rust, and mosaic. Epidemiology of plant diseases.

General methods of plant diseases control

a) Eradication
b) Chemical control
c) Biological control

Unit-II

Preparation of Bioinoculants: 6 hours

Biochemistry of symbiotic and non symbiotic nitrogen fixation and phosphate solubilization

Production of Bioinoculants

Methods of application, Comparison with chemical fertilizers

Biopesticides 2 hours

Anaerobic Digesters

Raw materials, organisms involved and their activity, cultivation of methanogens, Biochemical mechanisms of gas production, application of biogas 2 hours

Biodegradation of herbicides (2,4-D) and pesticides (DDT) and Biodeterioration 3 hours

Environmental Microbiology

Unit-IV

Air Microbiology 6 hours

Microflora of air, methods of air sampling, air pollution, biological indicators of pollution, air sanitation and air-borne infections

Unit-V

Water microbiology 8 hours

Bacteriology of potable and recreational water

Bacteriological analysis of water, indices of fecal pollution

Detection of bacterial pathogens

Analysis of water - Physico-chemical and biological parameters

Waste water treatment methods - primary, secondary and tertiary treatments 2 hours

Unit-VI

a. Biodegradation of organic matter (lignin, cellulose, hemicellulose and pectin) 2 hours

b. Bioremediation - Bioremediation and waste management. An emerging Biotechnology using microorganisms, need and scope of bioremediation. 2 hours

PRACTICAL-VI

MB $5P_2$- Agricultural and Environmental Microbiology

1. Isolation and study of microflora from rhizosphere and rhizosplane 2 units
2. Study of *Rhizobium* from legume root nodules 1 unit
3. Isolation and identification of actinomycetes 1 unit
4. Identification of leaf spot of groundnut, late blight of potato, Blast of rice, Downy mildew of grapes, black rust or wheat rust - *Puccinia graminis*, Red rot of sugarcane, Tobacco mosaic, Citrus canker, Tomato leaf curl, Sandal spike. 2 units
5. Fungi type study- *Penicillium, Cladosporium, Rhizopus, Trichoderma, Fusarium, Aspergillus,* Yeast, *Alternaria.* 2 units
6. Isolation and identification of microorganisms from water.
7. Isolation of air microflora. 3 units
8. Potability of water (MPN Test) 2 units

Semester VI – Paper VII
MB 6112 – Food and Fermentation Technology
No. of lecture hours: 45 hours

Unit - I

Food Microbiology

Food preservation 4 hours

Principles of food preservation

Use of chemical preservatives, Canning, Freezing and Dehydration, Use of Radiations

Food sanitation and control agencies

Unit – II

Principles and types of food spoilage 5 hours

Chemical and physical properties of food affecting microbial growth – pH, water activity, redox potential, nutrients, antimicrobial compounds

Sources of spoilage microorganisms and their role

Change in colour and flavor, degradation of carbohydrates, proteins and fats, change in organoleptic properties.

Unit –III

Microbial food infection and food poisoning 6 hours

a. *Staphylococcus aureus*

b. *Salmonella*

c. *Bacillus cereus*

d. *Clostridium botulinum*

e. *Clostridium perfringens*

Organisms causing food infection, their sources and prevention

Mycotoxins – Aflatoxin B1, G1 – structure, detection, mode of action and detoxification.

Unit – IV

Dairy Microbiology

a. Definition, composition and types of milk – skimmed, toned and whole 1 hour

b. Microbiological analysis of milk, Rapid platform test. 2 hours

Sources of microbial contamination of milk, microflora in raw milk.

Dye reduction test – MBRT and Resazurin Test.

Total bacterial count, brucella ring test and test for mastitis
c. Pasteurization of milk 1 hour
Methods of pasteurization – LHT, HTST, UHT.
Tests for determination of efficiency of pasteurization
d. Spoilage of milk
Succession of microorganisms in milk 1 hour
Colour and flavor detects, Sweet curdling, Stormy fermentation, Ropiness, Biochemical fermentation.

Unit – V

Milk products 4 hours

Long term preservation of milk (preparation of milk powder, condensed, sweetened milk, sterilized milk, emphasis on the microflora
Cheese – Types and production (Cheddar and Cottage)
Yoghurt – Types and production and acidophilous milk
Other traditional fermented milk products – names and organisms associated (tabulation only)

Unit – VI

Fermentation technology

History, scope and development of industrial microbiology, isolation and screening of industrially important microorganisms (isolation, screening and maintanence) 2 hours
Strain improvement methods 1 hour
Culture collection, centres , Types of industrial fermentation processes: batch, continuous, surface, submerged and SSF. 3 hours
Raw materials, media components and formulation, antifoaming agents, precursors, inducers and inhibitors, buffering agents etc. 3 hours
Sterilization of media and raw materials 1 hour
Inoculum preparation – bacteria and fungi 1 hour
Fermentor: Basic structure, construction and basic and types -
(stirred, airlift, fluidized bed) 3 hours
Control of process parameters – temperature, pH, O-R potential, aeration, agitation, contamination. 3 hours
Down-stream processing steps – Recovery of fermented broth 3 hours
Quality control assurance 1 hour

PRACTICALS – VII

MB $6P_1$ – Food and Fermentation Technology

1) Enumeration of bacteria by SPC and DMC	1 unit
2) MBRT and Resazurin tests	1 unit
3) Estimation of lactic acid and fat content in the milk	1 unit
4) Estimation of lactose in milk whey	1 unit
5) Production and detection of aflatoxins from fungi	2 units
6) Isolation and identification of bacteria and fungi from spoilt fruits and vegetables	2 units
7) Isolation and identification of bacteria and fungi from stored and fermented foods	3 units
8) Study of fermentors (demonstration)	1 unit
9) Estimation of total and volatile acidity in alcoholic beverages	1 unit
10) Alcohol estimation (Alcoholometry)	1 unit
11) Study of food borne pathogens	1 unit
12) Industrial visit	

St.Joseph's College (Autonomous) Bangalore

Department of Microbiology

Syllabus for B.Sc. Microbiology

Theory (2012-2015)

Semester I

Paper I - **MB 112:-** Basic Microbiology and Microbiological techniques

Semester II

Paper II - **MB 212:-**Biophysics, Biochemistry and Microbial diversity

Semester III

Paper III - **MB 312:-**Microbial physiology, growth and control of microorganisms

Semester IV

Paper IV - **MB 412:-**Microbial genetics, Molecular biology and Recombinant DNA technology

Semester V

Paper V – **MB 5112**:- Immunology and Medical Microbiology

Paper VI - **MB 5212**:- Agricultural and Environmental Microbiology

Semester VI

Paper VII - **MB 6112**:- Food and Fermentation Technology

Paper VIII- **MB 6212**:- Microbial and cell culture technology

St. Joseph's College (Autonomous) Bangalore

Department of Microbiology
Syllabus for B.Sc. Microbiology

Practicals (2012-2015)

Semester I

Practical paper I - **MB IP$_1$ –** Basic Microbiology and microbiological techniques

Semester II

Practical Paper II - **MB 2P$_1$:-** Biophysics, Biochemistry and Microbial diversity

Semester III

Practical Paper III - **MB 3P$_1$:-** Microbial physiology, growth and control of microorganisms

Semester IV

Practical Paper IV - **MB 4P$_1$:-** Microbial genetics, Molecular biology and Recombinant DNA technology

Semester V

Practical Paper V - **MB 5P$_1$:-** Immunology and Medical Microbiology

Practical Paper VI - **MB5 P$_2$:-** Agricultural and Environmental Microbiology

Semester VI

Practical Paper VII - **MB 6P$_1$:-** Food and Fermentation Technology

Practical Paper VIII - **MB 6P$_2$:-** Microbial and cell culture technology