

RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR
SYLLABUS PRESCRIBED FOR THE DEGREE OF THE BACHELOR OF SCIENCE
(From Academic Session 2011-12 onwards)
B.SC FIRST SEMESTER
INDUSTRIAL MICROBIOLOGY
Paper-General Microbiology

(MM Theory 70 + CCE 30)

UNIT I

Introduction to Microbiology:

History; Spontaneous generation conflicts; Germ theory of disease; Development in microbiology; Development in Industrial microbiology, Scope of microbiology; Applications of microbiology in human welfare; Development of microbiology in India and abroad: Contribution of Antony van Leeuwenhoek, Alexander Fleming, Edward Jenner, Louis Pasteur, Robert Koch, Salmen Waksman, Joseph Lister, M.S. Swaminathan, G.P. Talwar, T.S. Sadasivan, C.V. Subramaniam and R. N. Singh in Microbiology.

UNIT II

Diversity of Microbial World A:

Classification; General characteristics and structure of Bacteria (Eubacteria and Archaeobacteria); Morphology of Bacteria: Size, shape and arrangement of bacterial cells. Structures external to cell wall- Flagella, pili, capsule, sheath and prosthecae. Structures internal to cell wall- Cell membrane, nuclear material, cell wall (Protoplast and Spheroplast), spores, cytoplasmic inclusions.

Diversity of microbial world B:

Bacteria with unusual properties- Rickettsia, Chlamydia, Mycoplasma, Cyanobacteria, Actinomycetes. Microbes of extreme environments– Adaptations and industrial importance of Thermophiles, Alkalophiles and Halophiles.

UNIT III

Diversity of Microbial World A:

Classification: Brief introduction to classes of fungi; General characteristics: thallus, mycelial modification, nutrition, heterokaryosis, structure with emphasis on function of each part and components of cell; Reproduction: sexual and asexual reproduction; Economic importance of fungi.

Diversity of Microbial World B:

Classification; General characteristics; Morphology and structure: Morphological groups of phages, phage structure, phage nucleic acids; Virus host; General features of virus reproduction: Lytic and lysogenic cycle and their mechanism; DNA and RNA viruses: T4, TMV, Pox virus, Prions, Virions, Virusoid and Virioids.

UNIT IV

Microbiological Methods:

Medium optimization: Nutrient, Characteristics of growth medium, Types of media; Preparation of media; Principles and methods of sterilization of culture media: Concept of sterilization, disinfection, asepsis and sanitation. Physical methods of control- Temperature, radiation, desiccation, osmotic pressure, filtration. Chemical methods of control- Phenol, alcohol, halogens, heavy metals, dyes, detergents, aldehyde and gaseous chemosterilizers.

UNIT V

Isolation and maintenance of Microorganisms:

Pure, axenic, mixed culture, strain, isolate, clone- Definitions; Pure culture techniques: Dilution, Plating- pour plate method, spread plate method, streak plate method; Enrichment culture and micromanipulator, Maintenance and preservation of pure cultures: subculturing, overlaying, cultures with mineral oils, lyophilization, sand cultures, storage at low temperature; Major Microbial Culture Collection Centers in India.

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1. Board of Studies in Microbiology on 16/07/11 & Faculty of Life Science on 16/07/11

List of Practicals (MM: 50)

1. Precautions to work in microbiology laboratory.
2. Basic media preparation, autoclaving, cleaning and sterilization of glasswares.
3. Media preparation Liquid media – Peptone water, Nutrient broth. Solid media – Nutrient agar (Agar slant, Agar plate) Enriched Medium – Blood agar, Differential medium – Mac Conkey agar, Enrichment Medium – Selenite F broth, Selective medium – EMB
4. Culture characteristics of Microorganisms on different media.
5. Demonstration of selective and differential media.
6. Isolation of bacteria from air, water and soil by serial dilution agar plating method
7. Isolation of fungi from air, water and soil by serial dilution agar plating method
8. Isolation of bacteria by pour plate method.
9. Isolation of bacteria by streak plate method.
10. Isolation of bacteria by spread plate method.

List of recommended books:

1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter
3. Biology of Microorganisms, Authors- Brock and Madigan.
4. Fundamental Principles of Bacteriology, Author- A.J. Salle.
5. Introduction to Microbiology, Authors- Ingraham and Ingraham.
6. Microbial Physiology, Authors- Moat and Foster.
7. Tools and techniques in microbiology by Nath and Upadhyay
8. Powar C. B. and H. F. Dagainawala (2003). General Microbiology Vol.II; Himalaya Publishing House.
9. Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S.Chand and Company Ltd.
10. H.C. Dube (2005) A Textbook of Fungi, Vikas Publishing House.

**B.Sc. SECOND SEMESTER
INDUSTRIAL MICROBIOLOGY
Paper-Tools and Techniques in Microbiology**

(MM Theory 70 + CCE 30)

UNIT I

Microscopy

Invention of Microscope; History; Light Microscopy: Principle, Construction; Theory and applications of Bright Field Microscopy (Simple and Compound); Dark Field Microscopy; Phase Contrast Microscopy; UV and Fluorescent Microscopy; Electron Microscopy: Types of Electron Microscope (TEM & SEM); Preparation of Specimen, Advantages, Limitations and Applications; Use of Software in Microscopy.

UNIT II

Instrumentation Techniques

Basic principle, construction and applications of Autoclave, Oven, Incubator, BOD, Laminar Air Flow, Colorimetry and Spectrophotometer; Centrifugation: Basic principles of sedimentation, methods and applications; Chromatography: General introduction, definition and types of chromatography, General principles underlying chromatographic technique, Working and applications of Thin Layer Chromatography.

UNIT III

Micrometry and Staining

Ocular and Stage Micrometry: principle and application; Cell Count: Haemocytometry- principle and applications, Use of Camera Lucida; Stains and Staining Techniques: Necessity of staining, Chemistry of dyes and stains, Fixation of Smears, Mordents and Intensifiers, Decolorizers; Theory of Staining: physical and chemicals; Types of Staining: Simple staining, Negative staining, Differential staining, Flagella, Cell-wall, Capsule staining, Gram staining, Acid Fast staining.

UNIT IV

Immunological Techniques

Zone phenomenon (Lattice hypothesis); Characteristics of Serological reactions; Neutralization, Precipitation: ring test, slide test and tube test, Agglutination: widal test, passive agglutination, Hemagglutination, Bacterial agglutination, Agglutination inhibition, Flocculation and Complement Fixation; Principle and applications of Radial immunodiffusion, Double immunodiffusion and Radioimmunoassay (RIA), Immunoelectrophoresis.

UNIT V

A. Biostatistics and Bioinformatics

A. Biostatistics: Principle of Biostatistics; Classification of Data; Tabulation and Graphical representation; Measure of Central Tendency: Mean, Mode, Median- merits and demerits; Measure of Dispersion Range; Mean Deviation Variance and Standard Deviation.

B. Bioinformatics: Basic Organization of Computer; Computer Hardware; Software, Bit, Byte, Computer Memory, Binary Code, Binary System; Introduction to Bioinformatics, Database and applications of Bioinformatics.

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1. Board of Studies in Microbiology on 16/07/11 & Faculty of Life Science on 16/07/11

List of Practicals (MM: 50)

1. Write the principle and components of Bright field compound microscope.
2. Write the principle and use of dissecting microscope.
3. Demonstration of principles and working of basic instruments: autoclave, incubator, hot air oven, pH meter, laminar air flow, spectrophotometer and centrifuge.
4. Preparation of smear and microscopic examinations of Fungi – *Mucor* spp., *Aspergillus* spp., *Penicillium* spp. & *Alternaria* spp. Bacteria – *Staphylococcus* spp. *Lactobacillus* spp. *Escherichia* spp. *Vibrio* spp. & *Leptospira* spp.
5. Staining techniques – Simple staining, Differential staining (Gram's, Ziehl-Neelsen), Spore and Capsular staining methods
6. Blood collection and plasma/serum separation.
7. Blood grouping – Rh typing – cross matching.
8. Agglutination reaction: Widal test
9. Paper and Thin layer chromatography.
10. SDS-PAGE electrophoresis.
11. Problems based on mean, mode and median..
12. Problems based on standard deviation and mean deviation.

List of recommended books:

1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter
3. Biology of Microorganisms, Authors- Brock and Madigan.
4. Fundamental Principles of Bacteriology, Author- A.J. Salle.
5. Introduction to Microbiology, Authors- Ingraham and Ingraham.
6. Microbial Physiology, Authors- Moat and Foster.
7. Tools and techniques in microbiology by Nath and Upadhyay
8. Powar C. B. and H. F. Daginawala (2003). General Microbiology Vol.II; Himalaya Publishing House.
9. Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S.Chand and Company Ltd.
10. H.C. Dube (2005) A Textbook of Fungi, Vikas Publishing House.
11. Textbook of biostatistics by B.L Agarwal
12. Textbook of biostatistics by K.Agarwal
13. Mishra and Mishra. Statistics.

**B.Sc. THIRD SEMESTER
INDUSTRIAL MICROBIOLOGY
Paper-Microbial Physiology and Metabolism**

(MM Theory 70 + CCE 30)

UNIT I

Growth and Growth Measurement

Definition of growth; mathematical expression of growth; growth curve; growth yield; factors affecting growth; nutrient, temperature, oxygen, pH, osmotic pressure; Measurement of growth by measuring cell number, cell mass and cell activity, Cell count- direct and indirect method, dry weight and wet weight method; synchronous culture; continuous culture; and batch culture.

UNIT II

Utilization of Energy

Microbial biosynthesis; methods of studying microbial biosynthesis; assimilation of Ammonia, Nitrogen and Sulphate

Utilization of energy in non-biosynthetic and biosynthetic process: Bacterial motility- flagellar and gliding. Diffusion: gaseous exchange, osmosis, plasmolysis transport of nutrients in bacteria- active transport, passive diffusion, facilitated diffusion, group translocation, Biochemical properties of membranes.

UNIT III

Energy production in Anaerobic and Aerobic process

Glycolysis; Pentose phosphate pathway; Entner Duodoroff pathway; fermentation; glucose fermentation by *E. coli*; TCA cycle; heterotrophic carbondioxide fixation; Glyoxylate cycle; catabolism of lipids: α and β -oxidation; catabolism of proteins; Aerobic respiration

UNIT IV

Bioenergetics

Principles of Bioenergetics; ΔG , endergonic and exergonic reactions; oxidation-reduction reaction; Redox-potential; oxidative phosphorylation: hypothesis; inhibitors of oxidative phosphorylation

UNIT V

Energy production by photosynthesis and microbial metabolism fueling reaction

Definition of bacterial and cyanobacterial photosynthesis; antenna of light harvesting pigments; photochemical reaction; cyclic and non cyclic photophosphorylation; role of ATP in metabolism; role of reducing power in metabolism; role of precursors of metabolism; component of Electron transport chain and arrangement of ETC in cell membrane

List of Practicals (MM: 50)

1. Enumeration of bacterial colony using colony counter.
2. Enumeration (counting) of bacteria by plate count or serial dilution agar plate technique.
3. Demonstration of O₂ evolution during photosynthesis.
4. Determination of bacterial growth by turbidity measurement (spectrophotometric method).
5. Effect of temperature on bacterial growth (TDP & TDT).
6. Effect of pH on bacterial growth.
7. Effect of osmotic pressure (salt and sugar concentration) on bacterial growth.
8. Determination of fungal growth by mycelia weight determination method.
9. Demonstration of active and passive transport mechanism.
10. Study of bacterial growth curve.

List of recommended books:

1. Powar C. B. and H. F. Dagainawala (2003). General Microbiology Vol.II; Himalaya Publishing House
2. Tortora G.J., B.R. Funke and C.L. Case, 5th edition. Microbiology: An Introduction. The Benjamin/ Cummings Publishing Co., Inc.
3. Powar C.B. Cell Biology.
4. Madigan M. T., J.M. Martinko and J. Parker, 9th edition. Brock's Biology of Microorganisms. Prentice Hall
5. Talaro K. and A. Talaro Foundations in Microbiology. Wm. C. Brown Publishers.
6. Murray R. K., D. K. Granner, P.A. Mayes and V.W. Rodwell (2003) 26th edition. Harper's Illustrated Biochemistry.
7. Moat and Foster. Physiology and Metabolism.
8. Stanier, R.Y., J.L. Ingraham, M.L. Wheelis and P.R. Painter (1987) Vth edition. General Microbiology, Macmillan Press Ltd.

**B.SC FOURTH SEMESTER
INDUSTRIAL MICROBIOLOGY
Paper- Molecular biology, Microbial Genetics and Biochemistry**

(MM Theory 70 + CCE 30)

UNIT I

Nucleic acid: structure of DNA and RNA, replication of DNA, synthesis of RNA and their types. Genetic code, concept of genes. Protein synthesis: transcription and translation, Operon concept, gene regulation in eukaryotes, Britten Davidson model of gene expression.

UNIT II

Genetic recombination in bacteria, transformation, transduction and conjugation, genetic mapping, extrachromosomal genetic material, plasmid, cosmid, transposons, overlapping genes, silent genes. Plasmid- Structure, properties and types of plasmids.

UNIT III

Mutation: Evidence for spontaneous nature of mutation. Molecular basis of mutation- Types of mutation. Mutagenic agents-Physical and chemical. Mutation rate, DNA damage and repair mechanism, Photoreactivation, Excision, Mismatch, SOS repair and Dealkylation repair. Auxotrophs, Prototrophs and Ames test.

UNIT IV

Carbohydrates: Chemical structures, nature and properties. Classification and importance in biological cells.

Amino acids and Proteins: Amino acids- Classification and general properties. Structure, Zwitter ion nature. Proteins- Classification, Structure and function. Primary, secondary, tertiary and quaternary structure.

Lipids: Saturated and unsaturated fatty acids. Structure, classification, properties and function of lipids. Distribution and functions of lipids in microorganisms.

UNIT V

Enzymes: classification. Co-enzymes, co-factors, mechanism of enzyme action, competitive and non competitive inhibition, allosteric regulation of enzymes, isoenzymes, factors contributing to catalytic efficiency of enzymes.

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1. Board of Studies in Microbiology on 16/07/11 & Faculty of Life Science on 16/07/11

List of Practicals (MM: 50)

1. Isolation of antibiotic resistant bacteria
2. Estimation of alkaline phosphatase activity
3. Measurement of alpha amylase activity in extracellular fraction of microbial cultures.
4. Measurement of cellulase activity by viscometric techniques
5. Determination of cellulase activity by reducing sugar assay test
6. Determination of amylase activity.
7. Determination of lipase activity.
8. Isolation of DNA
9. Effect of mutagen on the growth of bacteria.
10. Effect of UV light on the growth of bacteria.

List of recommended books:

1. Principles of Biochemistry, Author- A.L. Lehniger
2. Fundamentals of Biochemistry, Author- J. L. Jain
3. Biochemistry, Author- Voet and Voet.
4. Microbial Genetics, Authors- Freifelder.
5. Textbook of Microbiology, Authors- Dubey and Maheshwari.
6. Powar C. B. and G. R. Chatwal(1994). Biochemistry, 3rd Edition; Himalaya Publishing House, New Delhi.
7. Powar C. B. and H. F. Dagainawala (2003).General Microbiology Vol.I; Himalaya Publishing House
8. Jain, J.L., S. Jain and N. Jain (2005) 6th Edition. Fundamental of Biochemistry. S. Chand and Co.
9. Rama Rao, A.V.S.S. (2000) 8th Edition. Textbook of Biochemistry. UBS Publisher Ltd.

**B.SC FIFTH SEMESTER
INDUSTRIAL MICROBIOLOGY**

Paper- Environmental, Agricultural and Food Microbiology

(MM Theory 70 + CCE 30)

UNIT I

Our Environment: Soil, water and air. Concept of environment in relation to microbes, environment included physiological adaptation in microbes, nature of microbial population in soil, water and air. Ecological groups of microorganisms on the basis of temperature, oxygen and nutrition. Biogeochemical cycling- carbon, nitrogen, phosphorous and sulphur.

UNIT II

Population interaction: Neutralism, Commensalisms, Synergism. Mutualism, Antagonistic relationship, Symbiotic association, VAM and its importance. Nitrogen fixation by symbiotic and non-symbiotic microbes, use of microbes as biofertilizers, mass cultivation of *Rhizobium* and *Azotobacter*, use of Blue Green Algae as biofertilizer.

UNIT III

Liquid waste disposal, types of waste, characteristics of solid and liquid waste, sewage treatment: Primary, Secondary and tertiary treatment. solid waste disposal, methods of disposal of agricultural waste. Waste treatment and useful byproducts: solid saccharification and gasification.

UNIT IV

Physical and chemical characteristics of soil, soil microflora. Soil fertility and management of agricultural soil, Rhizosphere and Phyllosphere. Influence of available nitrogen on soil fertility, importance of crop rotation. Soil management: management practices. Control of plant diseases : Chemical control, biological control its mechanism and importance, Pesticides and their impacts and effect on soil fertility. concept of integrated pest management technology.

UNIT V

Food spoilage: Physical and microbial spoilage of food and food products, spoilage of stored products, fruits and vegetables, microbial spoilage of milk, milk products and meat. Food born diseases.

Food preservation methods: asepsis, pasteurization, canning, dessication, low temperature, anaerobiosis, filtration, chemical preservation of food- salt and sugar, organic acids, use of sulphur dioxide, ethylene and propylene oxides, wood smoke.

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1. Board of Studies in Microbiology on 16/07/11 & Faculty of Life Science on 16/07/11

List of Practicals (MM: 50)

1. Total count of bacteria from water.
2. Determination of MPN of fecal contaminants in water.
3. Measurement and confirmation of *E. coli* in water.
4. Study of Rhizobium bacteria from root nodules.
5. Study of symbiotic and non-symbiotic blue green algae.
6. Study of effect of fungicides on microbes.
7. Study of food spoilage microbes from sweets and bakery products.
8. Study of antagonistic activities against microbes.
9. Study of the effect of the preservatives on the growth of microbes.
10. Study of UV radiations on microbes.
11. Study of the effects of agrochemical on soil inhabiting microbes.
12. Study of effect of food preservatives like salt, sugar, and organic acids on microbes.

List of recommended books:

1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter
3. Biology of Microorganisms, Authors- Brock and Madigan.
4. Textbook of microbiology-Dubey and Maheshwari
5. Soil microbiology by Subba Rao
6. Food microbiology by James M.J
7. Food microbiology by Adam
8. Dairy microbiology by Parihar and Parihar
9. Introductory food microbiology by H.A Modi
10. Soil and microbes by Waksman and Starkey.
11. Plant pathology by Mehrotra.
12. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
13. Food Microbiology by Frazier.

**B.SC SIXTH SEMESTER
INDUSTRIAL MICROBIOLOGY**

Paper- Fermentation Technology and Government Regulations

(MM Theory 70 + CCE 30)

UNIT I

Fermentation equipments and production process, principle types of fermentors – batch fermentors, continuous, stirred tank fermentor, tubular fermentor, fluidized bed fermentor, solid state fermentation, computer control of fermentation process and strain improvement process.

UNIT II

Industrial production and applications of organic acids: Lactic acid, acetic acid and citric acid. Enzymes: Amylase, protease, and amino acids- L-lysine and glutamic acid.

UNIT III

Industrial production of alcohol, wine, beer and Production and applications of antibiotics- Penicillin and Streptomycin

Industrial production and applications of vitamins- Vitamin B12 and riboflavin

UNIT IV

Importance of microorganisms in dairy industry. Production of cheese, buttermilk and in bakery industries- Leavening of bread, Indian fermented foods. Microbes as source of single cell proteins (SCP) and its production and applications. Mushroom and its advantages.

UNIT V

Role of international organization in biotechnology. Government programmes for biotechnology development. Government regulations of recombinant DNA Research. Hazardous industrial waste, mycotoxin hazards in the production of fungal products. Regulation for disposal of biohazardous materials, Patenting of products in industries.

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1. Board of Studies in Microbiology on 16/07/11 & Faculty of Life Science on 16/07/11

List of Practicals (MM: 50)

1. Measurement of production of citric acid by *Aspergillus niger*.
2. Measurement of production of alcohol by yeast.
3. Demonstration of transformation of steroids.
4. Demonstration of IAA production by microbes.
5. Demonstration of enzyme production by microorganisms.
6. A Amylase
7. B Cellulase
8. C Gelatinase
9. Demonstration of mushroom cultivation.
10. Demonstration of lab fermentor.
11. Microscopic study of industrially important microorganisms like Spirulina, Cyanobacteria, Yeast etc.

List of recommended books:

1. Industrial Microbiology by A.H Patel
2. Industrial Microbiology by L.S Casida
3. Industrial microbiology by Stanburry.
4. Textbook of biotechnology by H.D Kumar.
5. Fermentation technology by Whittakar.
6. General microbiology, vol. II ,by Powar and Daginawala.