

**DR. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY
AURANGABAD**

Syllabus

of

B.Sc. [Microbiology]

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY
AURANGABAD**

**B.Sc. Microbiology
Effective progressively from June, 2008.**

B.Sc. I

Paper No	Title	Marks
I	Fundamentals of Microbiology	100
II	Basic Biochemistry & Microbial Physiology	100
III	Practical	100
IV	Practical	100

B.Sc. II

Paper No	Title	Marks
V	Applied Microbiology	100
VI	Immunology & clinical microbiology	100
VII	Practical	100
VIII	Practical	100

B.Sc. III

Paper No	Title	Marks
IX	Microbial genetics & Recombinant DNA Technology	100
X	Microbial Metabolism & Industrial Microbiology	100
XI	Practical	100
XII	Practical	100
Total marks		1200

B.Sc. First Year

Paper I .Fundamentals of Microbiology

Unit – I	1 Scope & relevance of Microbiology	(15)
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- i) Definition & concepts
- ii) Types of microorganism
- iii) Distribution of Microorganisms in nature

2. Development of Microbiology as a Scientific Discipline

1.1 History

- i) Early observation of microorganisms
- ii) Spontaneous generation conflict : Contribution of scientists
- iii) Recognition of the microbial role in diseases. Koch's postulates
- iv) Recognition of microbial role in fermentations.
- v) Discovery of microbial effects on organic and inorganic matter.
- vi) Pure culture concept.
- vii) Aseptic surgery

Unit – 2 General characteristics of microorganisms. (15)

2.1 General principles (Brief)

- i) Taxonomic rank
- ii) Classification system
- iii) Numerical taxonomy
- iv) Major characteristics used in taxonomy. Morphological, Physiological, Metabolic, Etiological, Genetic analysis, Molecular Characteristics .
Compositions of proteins, composition of nucleic acids, hybridization, nucleic acid sequencing, identification of organisms based on 16srRNA sequencing.

- v) Bergey's manual of determinative Bacteriology, General characteristics enlisting 19 parts with major characters & examples.

2.2 General characteristics and classification of Viruses

2.3 General characters of Fungi (including yeasts)

2.4 General characters of Actinomycetes

2.5 General characters of algae

2.6 General characteristics of Mycoplasma and Rickettsia.

2.7 Introduction to Gnotobiology/ axenic life/ space microbiology.

Unit – 3 : 3.1 Microscopy (15)

3.1 Properties of light

- i) Definitions : Magnification, resolving power, depth of focus, focal length, numerical aperture.
- ii) Objectives Low , high & oil immersion.
- iii) Oculars : function, Huygenian, Ramsden, Hyperplane & compensating.
- iv) Condensers ; Abbe, variable focus condenser, parabolic & their functions.
- v) Iris diaphragm.

3.2 Principles, construction using ray diagram, application and comparative study of :

- i) Compound Microscope
- ii) Electron Microscope

3.3 Principles, ray diagram & applications.

- i) Phase contrast microscope.
- ii) Dark field microscope.
- iii) Fluorescent microscope.

3.4 Micrometry : Basic principles, uses & application.

3.5 Stains and dyes.

- i) Definition : stain, dye, chromogen, chromophore, auxochrome, acidic and basic stains, simple and differential staining. (Gram's

and Acid fast staining) , natural stains, mordant, decolourizer, counter stains.

- ii) Brief survey of classification of dyes, knowledge of group & stains used in practical course of B.Sc. I. Physicochemical basis of staining.
- iii) Fixatives and fixation of smears.
- iv) Staining of Fungi.
- v) Use & significance of stains in Microbiology.

Unit – 4 : 4.1 Cultivation of microorganisms. (20)

- i) Media used.
- ii) Properties of a good culture medium.
- iii) Definition, concept, use and types of different culture media . Synthetic, non synthetic, natural, selective, differential, enriched , enrichment, assay, minimal, maintenance, and transport media.
- iv) Buffers in culture media.
- v) Media used for cultivation of bacteria , fungi, actinomycetes, yeasts, algae and photosynthetic bacteria. (at least two)

4.2 Cultivation of anaerobes

- i) Principle and examples.
- ii) Methods (at least 2)

4.3 Pure culture techniques

- i) Development of pure culture
- ii) Sterilization, aseptic techniques, streak, pour and spread plate methods, single cell isolation.
- iii) Significance

4.4 Control of Microbial Growth

- i) Pattern of Microbial death – concepts.
- ii) Sterilization by physical methods
 - High temperature, canning and pasteurization.
 - Low level temperature.
 - Non ionizing and ionizing radiations.
 - Bacterial filters.
 - Sterilization by chemical means; Disinfectants: effectiveness, mode of action & application. Phenolics, alcohols, halogens,

heavy metals , quaternary ammonium compounds, aldehydes. Sterilization using gases , sulfur dioxide, ethylene oxide, Beta propiolactone. Control of microorganisms using sugars, nitrates, organic acids .

- Antiseptics :- Effective agents.

Unit - 5 5.1 Structural Organization of microorganisms. (20)

5.2 Fundamental categories of microorganisms.

- i) Bacterial ,Archaeal & Eucaryotic cell concepts.
- ii) Microorganisms with prokaryotic cells: Archaeal & bacterial
- iii) Differential account of procaryotic & eucaryotic microorganisms.

5.3 Role of Microorganisms : In transformation of organic matter.

- 1.1 In agriculture : As biofertilizers, bioinsecticides, in soil improvement (texture , water holding capacity) as geochemical agents ,microbial associations (phyllosphere, rhizosphere, mycorrhizal and nitrogen fixers)
Plant diseases : list of common plant diseases with their causative agents.
- 1.2 In human and animal health : list of common bacterial, rickettsial , fungal and viral diseases.(with causative agents) in human beings, role of normal flora of human body, antibiotics, vaccines and antisera.
- 1.3 In industries : list of microbial products (and producers) produced on industrial scale, role of contaminants, pathogens and spoilage causing microbes.
- 1.4 In food processing : common fermented food & milk products with their representative organisms. Food spoilage, list of organisms causing changes in texture, colour, aroma, taste & nutritional value of the food products. Food poisoning & food infection causing microorganisms.

Total Periods = 85

B.Sc. First Year

Paper II .Basic Biochemistry and Microbial Physiology

Unit – 1 : 1. Bacterial morphology and ultra structure. (15)

1.1 Cytology of a typical bacterial cell.

- i) Morphology – size and arrangement of bacterial cells.
- ii) Structure ,chemical compositions and functions of :
 - 1. Capsule and slime layer
 - 2. Cell wall : Gram positive and Gram negative bacteria
 - 3. Unit membrane
 - 4. Flagella : Arrangement, mechanism of flagellar movement, Chemotaxis, phototaxis, Magnetotaxis.
 - 5. Pili
 - 6. Ribosomes.
 - 7. Nuclear material, Mesosome
 - 8. Endospore – types, sporulating bacteria ,architecture of endospore, sporulation process , germination process.
 - 9. Reserved food material: Poly beta hydroxy butyric acid granules, glycogen and polyphosphate granules.

1.2 Nutritional Requirements

- i) Concept.
- ii) Common nutritional requirements – Energy sources, C,N,P,O, S, micronutrients, growth factors, water etc.
- iii) Nutritional classification on the basis of organic and inorganic compounds.

Unit – 2 : 2.1 Bacterial growth (15)

- i) Concept of Growth
- ii) Definition
- iii) Bacterial growth curve
- iv) Phases of growth
- v) Mathematics of growth
- vi) Diauxy growth
- vii) Factors influencing bacterial growth (temp, pH, oxygen and nutrients).
- viii) Synchronous growth
- ix) Continuous culture

- x) Measurement of bacterial growth

2.2 Bacterial cell division

- i) Binary fission
- ii) Chromosomal replication
- iii) Mechanism of replication and brief account of enzymes involved

Unit – 3 : 3. Microbial Biochemistry (20)

3.1 Carbohydrates

- i) Definition and classification.
- ii) Properties –optical and chemical.
- iii) Structure of glucose: ring structure, Haworth & fisher's projection, pyranoses , furanoses, isomers, mutarotation.
- iv) Triose, pentose, hexose, heptoses - examples & structures.
- v) Derived monosaccharides: glycosides, furano acids, sugar phosphates, uronic acids, sugar alcohol.
- vi) Disaccharides , glycoside linkage, lactose, maltose, sucrose.
- vii) Oligosaccharides – Trisaccharides, structure of raffinose.
- viii) Polysaccharides – Homo and heteropoly saccharides ,structures starch, cellulose, mucopolysacchrides.
- ix) Biological significance

3.2 Lipids

- i) Classification simple compounds.
- ii) Chemistry of fatty acids, unsaturated and saturated fatty acids, triglycerides, saponification alkyl ether phospho glycerides , sterols, cholesterol , protaglandins, glycol lipids.
- iii) Function of lipids.

3.3 Proteins

- i) Classification based on properties of solubility & heat. coagulability. Fibrous, globular proteins and functions.
- ii) Protein structures ; conformation & configuration ,primary structure determination, secondary structure π - helix & β - pleated sheet, tertiary & quaternary structure.
- iii) Classification of amino acids : based on acid – base properties.
- iv) Properties of amino acids – solubility, ampholyte, Zwitterions isoelectric pH .
- v) Peptide bonds – Concepts of biological peptide bond formation, types.

- vi) Enzymes – Concepts, definition, nature , active site, properties, physico-chemical factors contributing to catalytic efficiency of enzymes

3.4 Nucleic acids

- i) Structure of nitrogen bases & base pairing.
- ii) Structure of nucleosides & nucleotides, ribose, deoxyribose sugars.
- iii) DNA : properties, forms , structure, function as genetic material.
- iv) RNA : Structure, function, types (r-RNA, m-RNA, t-RNA)
- v) Comparative account of DNA & RNA.

3.5 pH & buffers.

Unit – 4 : 4.1 Water purification (20)

- Sources of contamination.
- Disinfection of potable water supplies.
- Standards for potable water.
- Brief survey of water borne diseases & preventive measures.

4.2 Types of wastes

- i) Characteristics of solid & liquid wastes
- ii) Solid waste treatment & useful byproducts
- iii) Solid waste disposal – composting & land filled technology
- iv) Xenobiotics and biodegradation

4.3 Uptake of nutrients

- i) Passive diffusion
- ii) Facilitated diffusion
- iii) Active transport mechanism.
- iv) Group translocation
- v) Uptake of amino acids and metals

4.3.1 Introduction to metal – microbe interactions

- a) Bioremediation
- b) Bioaccumulation
- c) Biosorption
- d) Bioprecipitation

Unit 5 : 5.1 Anaerobic respiration : (in brief) (15)

NO_3 , SO_4 and CO_2 as electron acceptors.

5.2 Bacterial photosynthesis :

- i) Photosynthetic bacteria,

- ii) Photopigments and associated carriers,
- iii) Photosynthetic apparatus and its mechanism
- iv) Cyclic and non cyclic photophosphorylation ,
- v) Calvin cycle, and reductive carboxylic acid cycle for CO₂ fixation.
- vi) Differences between bacterial and plant photosynthesis.

5.3 Brief Introduction to :

- a) Bio-deterioration of paint , paper and textiles.
- b) Biosensors.
- c) Bioaugmentation
- d) Nano biotechnology
- e) Biohydrometallurgy
- f) Genetic engineering
- g) Enzymes and cell immobilization
- h) Bioinformatics

Total Periods = 85

B.Sc. First Year
Paper III .Practical

- 1) Microscopy :
 - i) Different parts of a compound microscope.
 - ii) Use and care of compound microscope .
 - iii) Visit to see an electron microscope .
- 2) Construction , operation and utility of laboratory equipments
 - i) Autoclave
 - ii) Hot air oven
 - iii) Incubator
 - iv) pH meter
 - v) High speed centrifuge
 - vi) Colorimeter/ spectrophotometer
 - vii) Anaerobic jar
 - viii) Bacterial Filters
 - ix) Laminar air flow.
- 3) Microscopic examination of bacteria:
 - i) Monochrome staining
 - ii) Negative Staining
 - iii) Gram's Staining
- 4) Hanging drop technique to demonstrate bacterial motility
- 5) Micrometry
- 6) Demonstration of presence of bacteria from – soil/ water/ air/ milk
- 7) Demonstration of yeast, fungi, actinomycetes, algae, protozoa
- 8) Qualitative tests for:
 - i)Carbohydrates – Benedict's test.
 - ii)Protein – Buiret test.
 - iii)Nucleic acid – Diphenylamine(DNA) and orcinol (RNA)tests

B.Sc. First Year
Paper IV .Practical

1) Structural staining –

- ◆ Bacterial flagella by Patel, Kulkarni and Gaikwad method
- ◆ Capsule staining – Maneval's method.
- ◆ Cell-Wall staining- Chance's method.
- ◆ Spore staining – Schaefer & Fulton's method.
- ◆ Lipid (PHB) granule staining- Burdon's method.
- ◆ Metachromatic granule staining- Albert and Neusser's method.
- ◆ Preparation of culture media.
 - i) Nutrient broth and agar
 - ii) MacConkeys broth and agar..
 - iii) Sugar media
 - iv) Potato dextrose agar
 - v) Blood agar
 - vi) Photosynthetic bacterial growth medium

2) Sterility checks for Autoclaving

3) Isolation of microorganisms from :

- i) Air
- ii) Water
- iii) Soil
- iv) Milk

4) Isolation of bacteria from mixed cultures (streak plate method)

5) Cultivation of Anaerobes

6) Effect of physical and chemical agents on growth of bacteria.

- i) pH
- ii) Temperature.
- iii) Heavy metal ions (oligodynamic action)
- iv) UV rays.
- v) Antibiotics.

B.Sc. Second Year
Paper V . Applied Microbiology.

Unit – 1 :Microbiology of air : (15)

Composition of air.
Number and kinds of microorganisms in air (indoor, outdoor)
Distribution and sources of air borne microorganisms.
Air as a carrier of microorganisms.
Droplet, droplet nuclei..
Techniques for microbiological analysis of air.
Significance of air flora in human health, hospitals , industries.
Air borne diseases - list of diseases caused by bacteria, fungi, viruses.
Air pollution.
Air sanitation – dust control, UV radiation, bactericidal vapors, filtration, laminar air flow system (HEPA filters)

Unit – 2 : Microbiology of Water and Waste water management : (15)

Water zonation – upwelling, eutrophication
Microbial communities in natural water
Determining sanitary quality of water : bacteriological evidence of faecal pollution, indicators of faecal pollution.
Significance of index organisms. Faecal and non faecal coliforms (IMViC & elevated temperature tests.).
Bacteriological examination of water.
Presumptive, confirmed, completed test, SPC, MPN, Membrane filter technique.
Water pollution : causes hazards & control of human water borne diseases (list).
Water purification methods.
Disinfection of potable water supplies.
Microbiology of Sewage :
Definition of sewage, chemical composition.
Microbiology of sewage treatment.: septic tank, evapotranspiration, Imhoff's tank
Municipal sewage treatment process : Primary, Secondary, (aerobic and anaerobic process), chemical treatment : chlorination.
Disposal of treated sewage.

Unit – 3 : Microbiology of Soil : (20)

Soil as an environment as a culture medium

Microbiota of soil-their activities

Brief account of microbial interactions :

Definition with examples :

Symbiosis, mutualism, commensalism, competition, synergism, satellitism, predation, parasitism with two examples each :

i) Microbe-microbe interactions

ii) Plant-microbe interactions

iii) Animal-microbe interactions

Microbiological examination of soil.

Major biogeochemical cycles :

Carbon (degradation of cellulose, starch, lignin, pectin)

nitrogen, phosphorus, sulphur cycle.

General account of microbes used as biofertilizers, phosphate solubilizers.

Rhizosphere : definition, rhizosphere and non rhizosphere microflora,

R: S ratio, interactions between plant and rhizosphere flora .

Unit – 4 Microbiology of milk : (12)

Definition of and composition of milk

Sources of microorganisms in milk

Desirable and undesirable microorganism in milk

Types of microorganisms – Biochemical types, temperature characteristic types and pathogens (of bovine and human origin) ,

Changes in the flora of raw milk stored at room temp,

Microbiological examination of milk – SPC, DMC reductase tests.

Pasteurization, phosphatase test , sterilization of milk.

Cheese – microbiology and production .

Unit - 5 Microbiology of Food : (20)

Food as a substrate for microorganisms.

Major groups of bacteria, fungi, yeasts important in food microbiology.

Sources of contamination of food, factors affecting kind and number of microorganisms in food.

Microbiological examination of food: general and specific methods of examination.

Principles of food preservation :

Microbiostatic and microbicidal methods : Asepsis, removal of microorganisms, anaerobic conditions, high temp, low temp, drying, chemical preservatives, high osmotic pressure, radiation, smoking.

Microbial spoilage of foods.

Classification of foods by ease of spoilage, chemical changes caused by microorganisms in food.

Types of spoilage of canned and non canned foods with organisms involved. (tabular form).

Food borne diseases: Food infections, indicators of food pathogens associated with food, food intoxication – Staphylococcal, Clostridial Samonella and Mycotoxins..

Total Periods = 82

B.Sc. Second Year

Paper VI . Immunology & clinical microbiology

Unit – 1 : Host parasite relationship. (15)

Normal flora of human body.

Defensive mechanism of the host

Non specific factors : physiological barriers, natural cellular & humoral factors.

Infection:

Definitions: (primary infection, secondary infection, cross infection)

Sources of infection.

Modes of transmission of infectious diseases.

Process of infection : entry and spread of infection in host body

Determining factors in infection

Aggressive factors and mechanisms.

Unit – 2 : **Immunity :** (15)

Definition and classification

Innate / Acquired , Active/Passive, Cellular/Humoral , specific / non specific humoral factors of immunity : complement, interferon.

General methods of prophylaxis.

Toxoid & immune sera, Principle involved in preparation use of adjuvants.

Vaccines : types , administration of vaccines, Immunization schedule.

Antigen:

Definition, determination of antigenicity , size, chemical nature, susceptibility to tissue enzymes, foreignness, specificity .

Types of antigens : species specific antigen, Isoantigen, autoantigen, organ specific antigen , MHC antigen , Heterogenous (Heterophile) antigen , antigens in relation to bacterial cell.

Antibody :

Immunoglobulins : structure & classes,

Types of antibodies : antitoxin , precipitin, agglutinin, bacteriolysin, bacteriocidin, bacteriotropin, complement fixing, neutralizing.

Unit – 3 : Immune responses : (15)

Primary & secondary responses.

Fate of antigens in tissues

Production of antibodies : organs & cells involved, monoclonal

Antibodies, Regulation of antibody production (genetic control).

Factors influencing antibody production:

Cellular immune response – organs & cells involved, characteristics & types of T cells.

Antigen – Antibody reactions:

General features of Antigen- Antibody reactions

Mechanisms , methods & applications of:

- i) Agglutination:
- ii) Precipitation
- iii) Complement fixation
- iv) Neutralization
- v) Immunofluorescence
- vi) ELISA

Unit –4: Human Diseases (20)

Classification, habitat, morphology, staining reactions, cultural characters, biochemical characters, antigenic structure, pathogenesis.

Laboratory diagnosis, epidemiology, prophylaxis, chemotherapy wrt.

Diseases caused by:

- a) Bacteria
 - i) *Staphylococcus aureus*
 - ii) *Pneumococcus*
 - iii) *Mycobacterium tuberculosis*
 - iv) *Salmonella typhi*
 - v) *Vibrio cholerae*
 - vi) *Treponema pallidum*
- b) Viruses
 - i) HIV
 - ii) Hepatitis virus
- c) Protozoa
 - i) *Entamoeba histolytica*
 - ii) *Plasmodium spp*
- d) Fungi
 - i) *Candida albicans*

Unit 5 : Pharmaceutical Microbiology 20

Principles of chemotherapy,
Drug – microbe host interactions.
Basic mechanisms of drug action.
Drug resistance
Major antimicrobial agents: principles & uses.
GMP
Pyrogen testing
Bioburden
Routine microbiological testing of different pharmaceutical products
according to Indian pharmacopia/ British pharmacopia

Total Periods = 85

B.Sc. Second year

Paper VII. Practical

- 1) Microbial sampling of air from various sources – indoor , outdoor , hospital . Assessment of air quality by solid , liquid impingement techniques and enumeration using plating and turbidimetry..
- 2) Bacteriological examination of water for potability::
- 3) Presumptive, confirmed, completed test. MPN,SPC.
- 4) Measurement of chloride, phosphate and nitrate in water.
- 5) Testing (water/ sewage) for physicochemical parameters including BOD, COD, biomethanation.
- 6) Isolation of coliphages from sewage and estimation of phage titre.
 - i) Isolation of *E coli* & identification by IMVIC
 - ii) Cultivation of phages
 - iii) Preparation of phage stocks
 - iv) Estimation of phages w.r.t. time.
- 7) Winogradsky's column for study of soil microflora.
- 8) Enumeration and isolation of soil microorganisms : Enrichment culture technique for isolation of bacteria, fungi, protozoa, actinomycetes & algae from soil.
- 9) Determination of R:S ratio.
- 10) Demonstration of IAA production using soil fungi.
 - i) Extraction from filtrate.
 - ii) qualitative tests.
 - iii) quantitative estimation.
- 11) Demonstration of : i) Ammonification, ii) Nitrification, iii) Denitrification, iv) Nitrate reduction, v) Sulfate reduction.
- 12) Isolation & study of *Rhizobium* sp from root nodules of leguminous plants.
- 13) Isolation & study of *Azotobacter* sp. from soil.
- 14) Bacteriological analysis of milk:
 - i) SPC
 - ii) DMC
 - iii) Reductase test.
- 15) Determination of efficiency of pasteurization by phosphatase test.
- 16) Isolation of microorganisms from common food items; curd, bread, pickles, spoilt food.

- 17) Bacteriological examination of food:
- 18) Visit to waste treatment plants, dairies , food industries, agricultural universities.

B.Sc. Second Year
Paper VIII .Practical

- 1) Preparation of media for cultivation of pathogenic bacteria.
 - i) Mannitol salt agar.
 - ii) Wilson and Blair's medium
 - iii) Monsur's medium
 - iv) Lowenstein- Jenson's medium
 - v) Corn- meal agar.
- 2) Staining techniques
 - i) Acid fast staining
 - ii) Blood stainingWBC count- total & differential .
- 3) RBC count by haemocytometer.
- 4) Isolation & study of normal flora of skin, nose, throat.
- 5) Agglutination tests:
 - i) Slide agglutination
 - ii) Blood grouping
 - iii) Widal test
 - iv) RPR test.
- 6) Precipitation test:
 - i) Single radial immunodiffusion
 - ii) Immuno electrophoresis.
 - iii) Separation of serum proteins by electrophoresis
- 7) Detection of specific antigen by ELISA
- 8) Study of pathogens:
 - i) *Staphylococcus aureus*
 - ii) *Salmonella typhi*
 - iii) *Vibrio cholerae*
- 9) Demonstration of haemolysin & coagulase tests.
- 10) Sterility testing of injectibles, suspensions and powders.
- 11) Determination of antibiotic resistance of bacteria.
- 12) Microbiological examination of pharmaceutical products as per IP\ USP\ BP.
- 13) Visits to related industries & institutes.

B.Sc. Third Year

Paper – IX. Microbial Genetics and Recombinant DNA Technology.

Unit – 1 : (12)

- Genetic material (DNA / RNA) ,properties of DNA
- History of molecular biology and genetic engineering.
- DNA as genetic material – experimental proof – Griffith's experiment , Hershey -Chase experiment.
- DNA replication – models of replication , experimental evidence for semi conservative replication, enzymology of replication, mechanism of DNA replication.
- Post replication modifications (methylation); role of restriction endonucleases, hsd, dam, dem system of methylation.

Unit – 2 : Gene expression and regulation. (15)

- Transcription – structure of RNA polymerases, mechanism of transcription , post transcriptional modification.
- Salient features of Genetic code .
- Translation : activation of amino acids, charging of RNA,
 - a) initiation,
 - b) elongation and
 - c) termination
- Regulation of gene expression at the level of transcription :
 - vi) lac operon
 - vii) tryp operon
 - viii) ara operon

Unit – 3 : Mutation and Repair (20)

- Spontaneous mutations (replica plating , fluctuation test).
- Gene mutation – definition, mutation rate, types of mutations. (lethal, subvital, supervital).
- Action of mutations.
- Induced mutations – physical and chemical mutagens – UV rays, X-rays, base analogues ,agents modifying nitrogenous bases. (Nitrous acid, DMS, EMS, EES) , Agents producing distortions in DNA (proflavin , acridine orange),Intercalating agents (ethidium bromide)..
- Base pair substitutions and frame shift mutations.
- Suppressions – true reversion versus genetic suppression (intragenic and intergenic suppressions) .

- Auxotrophic and lethal mutations.
- Repair mechanisms – light repair (photoreactivation, dark repair , excision repair, recombination and SOS repairs.)

Unit – 4 : Bacterial Recombinations. (20)

- General features : fate of exogenote , restriction and modification of foreign DNA, integration of exogenote and endogenote, segregation of recombinant cells.
- Homologous recombination – discovery , nature of transforming principle, competent factors, steps involved in transformation..
- Conjugation – discovery , structure and properties of plasmids (F, R, Col plasmid) plasmid incompatibility.
- Process of conjugation – F , Hfr and F' mediated transfers.
- Gene mapping by conjugation.
- Transduction – Mechanisms of generalized and specialized transduction (properties of T₄ and lambda phages), helper phages, co-transduction.
- Abortive transduction.
- Phage conversion.

Unit – 5 : Transposition and Recombinant DNA technology (20)

- Transposition – Discovery , structure and types of bacterial transposons, mechanism of transposition, spread of antibiotic resistance, mutation due to transposition.
- Gene cloning - Strategy of vectors – plasmid and phage vectors, DNA manipulating enzymes, outline of gene cloning – enzymes involved, cloning vectors, gene transfer techniques.
- Nucleic acid and protein blotting techniques: southern blott , western blott. PCR, applications of genetic engineering in the field of industry , agriculture, environment and human health.
- Ethical issues of genetic engineering .

Total periods = 87

B.Sc. Third Year

Paper – X .Microbial metabolism and industrial microbiology.

Unit I : Enzymes : (15)

Definition, properties , specificity, active site, activation of enzymes, mechanism of enzyme action (lock and key, induced fit, ping – pong).

Nomenclature and classification of enzymes.

Factors affecting catalytic activity of enzymes, (pH , temp, enzyme concentration , substrate concentration, metal ions, time)

Michaelis – Menten equation : derivation and significance.

Types of enzymes : extracellular, intracellular, constitutive, inducible

Enzyme inhibition : Irreversible, reversible competitive, non competitive uncompetitive and metabolite antagonism, feedback inhibition.

Elementary knowledge and use of iso-enzymes, immobilized enzymes and allosteric enzymes,.Significance of oligomeric enzymes.

Commercial uses of enzymes (any five) – (Food, leather, textile, environment , pharmaceutical and clinical).

Structures and types of co-enzymes

Unit – 2 : Definition : Anabolism, catabolism, metabolism (15)

Bioenergetics : Chemical links between catabolism and biosynthesis, energy coupling through ATP and through pyridine nucleotides, the central role of ATP-ADP system.

Modes of energy yielding metabolism : definition and nature of fermentation, respiration and photosynthesis.

Fermentation of carbohydrates :

EMP, HMP, ED, phosphoketolase pathway, (pentose and hexose).

Alcoholic, homolactic, mixed acid, butanediol, butyric, acetone-butanol, fermentations.

Aerobic respiration :

RETC : location,function, components, redox carriers, oxidative phosphorylation, artificial electron acceptors, bacterial cytochrome systems, TCA cycle, glyoxylate cycle, Anapleoratic sequences .

Unit – 3 : Catabolism of saturated (16 C fatty acid) and unsaturated fatty acids (20) 6 C) by β oxidation .

Degradation of proteins and amino acids: Proteolysis , putrefaction.

Transformation of amino acids : oxidation, reduction, decarboxylation, deamination etc. (one example of each).

Nucleic acid catabolism.

DNA , RNA depolymerization, degradation of nitrogenous bases.

(mention end products without pathway).

Biosynthesis of nucleic acid

DNA synthesis. (nucleotide synthesis)

Carbohydrates synthesis : Peptidoglycan.

Unit – 4 : Industrial Microbiology : (15)

Design of typical fermenter

Screening methods : Primary, Secondary.

Strain improvement methods.

Preservation methods (Lyophilization, freezing, mineral oil)

Inoculum development

Fermentation media : raw materials, media formulation, pretreatment ,
sterilization, contamination and its control, inoculum media ,buffers,
antifoam agents and precursors.

Scale up of fermentations.

Increasing product yield.

Phage contamination and control

Dual fermentations

Batch, continuous and solid state fermentations.

Bioassay of penicillin and VitB₁₂.

Unit – 5 : Typical fermentation processes : (15)

Antibiotic fermentations : Penicillin

Organic solvent : Ethyl alcohol fermentation

Amino acid fermentation : L-lysine (direct and indirect method)..

Vitamin fermentation Vit B₁₂.

Organic acid – Citric acid

Enzymes – α - amylase (Bacterial and fungal).

Baker's yeast production.

Vaccines – Genetic recombinant vaccines.

Biofertilizers (Azo - Rhizo and PSB)

CH₄ fermentation

Total periods = 80

B.Sc. Third Year
Paper – XI Practical

- 1) Isolation of *E. coli* plasmid DNA
- 2) Separation of plasmid DNA by agarose gel electrophoresis.
- 3) Isolation of genomic DNA from *E. coli*.
 - i) Purification of DNA by phenol extraction method.
 - ii) Concentration of DNA by ethanol precipitation.
 - iii) Separation of DNA using agarose gel electrophoresis.
- 4) Characterization of genetic marker of known bacterial strains.
- 5) Simple cloning using plasmid DNA as vector.
- 6) Restriction analysis of *E. coli*.
- 7) Measurement of β -galactosidase activity using IPTG over a period of 2 hrs.
- 8) Determination of one step growth curve of bacteriophage.
- 9) Replica plating for isolation of streptomycin resistance spontaneous mutant of *E. coli*.
- 10) Isolation of *lac* mutants of *E. coli*. (Lac) by UV induced mutagenesis and chemical mutagens.
- 11) UV damage and photoreactivation.
- 12) Study of transformation in *E. Coli*.
 - i) Preparation of competent *E. Coli*.
 - ii) Enumeration of transformed cells.
 - iii) Determination of plasmid transfer efficiency.
- 13) Study of conjugation in *E. Coli*. (plate method.)
- 14) Transformation of competent cells of *E. Coli*. using plasmid DNA as vector.
- 15) Demonstration : Polymerase chain Reaction (PCR)

B.Sc. Third Year
Paper – XII .Practical

- 1) Preparation of buffers and reagents.
- 2) Study of enzymes :- α -amylase, caseinase, catalase, deaminase, desulfurase, gelatinase, lecithinase, oxidase.
- 3) Effect of pH , temp, substrate concentration on α - amylase activity.
- 4) Demonstration of nitrate reduction and sulphate reduction.
- 5) Demonstration of decarboxylation of amino acid.
- 6) Isolation of photosynthetic bacteria by column method
- 7) Primary screening for :
 - i) Starch hydrolyzers.
 - ii) Organic acid producers.
 - iii) Antibiotic producers.
- 8) Production, detection and estimation of :
 - i) Ethanol using *S cerevisiae* var, ellipsoideus.
 - ii) Glutamic acid by *Brevibacterium* spp.
 - iii) Citric acid by *Aspergillus* spp.
 - iv) α -amylase using *Aspergillus oryzae*
 - v) Penicillin by *Pencillium* spp.
- 9) Paper / TLC : Chromatographic separation and identification of fermented products (amino acids).
- 10) Separation of proteins using agarose gel electrophoresis.
- 11) Bioassay of Penicillin.
- 12) Bioassay of Vit B₁₂ / Folic acid.
- 13) Study tour and report presentation.

Reference books

B.Sc. I Year

1. Bernard D. Davis, Renato Dulbecco, Herman N. Eisen, Harold S. Ginsberg: Microbiology: Introductory Immunology & Molecular Genetics: Harper & Row, Publishers Inc.
2. Bisen P.S., Varma K . : Handbook of Microbiology CBS Publishers & Distributors, Delhi. Introduction to viruses : Vikas Publishing House Pvt. Ltd., New Delhi.
3. Black J. G.: Microbiology : Principles & Explorations , John Wiley & Sons Inc. New York.
4. Dubey H. C. : A textbook of fungi, Bacteria & Viruses, Vikas Publishing House Pvt. Ltd. Delhi.
5. Dubey R.C. and D.K. Maheshwary, A text book of Microbiology S Chand & Co. New Delhi.
6. Frobisher, Hinsdill , Crabtree , Goodheart : Fundamentals of Microbiology : W. B . Saunders Company , U .S.A , Toppan Company Ltd ., Japan .
7. Luria : General Virology
8. Modi H . A .: Elementary Microbiology (Fundamentals of Microbiology) Vol. I & II Ekta Prakashan , Nadiad , Gujrat .
9. Parasher Y . K .: Modern Microbiology : Campas Books International , New Delhi
10. Pelczar Michael J .,Jr.\E.C.S. Chan : Elements of Microbiology : McGraw .Hill International Book Company , New Delhi.
11. Pelczar Michael J ., Jr. E.C.S Chan, Noel R. Krieg : Microbiology .Concepts & applications – McGraw Hill Inc.
12. Pelczar Michael J ., Reid R . D. & chan E .C. S.: Microbiology , Tata McGraw Hill Publishing Co. Ltd., New Delhi.
13. Powar C. B. & Daginawala H. F.: General Microbiology Vol I & II Himalaya Publishing House Bombay .
14. Prescott L . M., Harley J. P., & Klein Donald A .: Microbiology , W. M .C., Brown Publishers
15. Purohit S.S : Microbiology : Fundamentals and Applications : Agro- Botanical Publishers, Bikaner, India.
16. R.A Atlas : Microbiology – Fundamentals & Applications McMilan.
17. Singh R.P., Microbiology Kalyani Publication

18. Stanier Roger Y., Adelberg Edward A., Ingraham John L. : General Microbiology , Prentice – Hall, Englewood Cliffs, New Jersey.
Publishing Co. Ltd., New Delhi.
19. Tauro P, Kapoor K.K., Yadav K. S. : Introduction to Microbiology : Wiley Eastern Ltd., New Delhi.
20. Tortora G. J. Funke B. & Case Christine L : Microbiology: An Introduction : The Benjamin Publishing Co . New York.
21. Yadav Manju, Microbiology Discovery Publishing House , New Delhi
22. Ronald M . Atlas , A. E. Brown , K. W. Dobra, L. Miller (1986) : Basic Experimental Microbiology , Times Mirror\ Mosby College Publication.
23. Gunasekaran : Introduction to Microbial techniques.
24. Handbook of microbiological Media – Himedia.
25. Dubey , Maheshwari : Practical Microbiology.

Reference books for B.Sc II year

- 1 . Odum , Eugene P: Fundamentals of Ecology , Natraj Publishers , Dehradun.
2. R. Campbell : Microbial ecology Vol. V, Black well Scientific publications, Oxford, London .
3. L. L. Somani , S. C. Bhandari , S. N . Saxena , K. K. Vyas, : Biofertilizers, : Scientific Publishers , Jodhpur.
4. Rao N. S. Subba : Recent advances in biological nitrogen fixation , Oxford\IBH , New Delhi.
5. Banwart G . J. (1989) , Basic food microbiology , CBS Publications.
6. Frazier W. C., Westhoff D. C : Food Microbiology , Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. James M . Jay : Modern food microbiology : CBS Publishers & Distributors, Delhi.
8. Mahanta K. C.: Dairy Microbiology , Omsons Publications , New Delhi.
9. Ananthnarayan R. , C. K. Jayaram Panikar : Textbook of Microbiology, Orient Longman Ltd., Madras.
10. Bhatiya Rajesh and Ichhpujani Rattan Lal : Textbook of Medical Microbiology Forward publishing Company , Delhi.,
11. Chakraborty P.: A textbook of Microbiology , New Central Book Agency (P) Ltd, Calcutta .
12. Chopra H. L. : Textbook of Medical Microbiology , Seema publications , New Delhi.

13. Chatterjee K. D. Parasitology : Protozoology and Helminthology, Chatterjee Medical , Calcutta.
14. Cruickshank R., Duguid J. P., Marmion B. P. , Swain RHA, Medical Microbiology Vol. II, The practice of Medical Microbiology , ELBS & Church – Hill Livingstone New York.
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21. Satoskar R. S & Bhandarkar S. D . : Pharmacology & Pharmocotherapeutics : part I & II popular Prakashan Bombay.
22. Dr. B. J. Wadher & Dr. G.L. Bhoosreddy : Manual of Diagnostic Microbiology, Himalaya publishing house, Bombay.
23. Handbook of Microbiological Media – Hi- Mediaa .
24. Talwar & Gupta : A handbook of practical & chemical Immunology : II edition , 1992, CBS publication.

Reference books for B. Sc . III year

1. A.H. Rose : Chemical Microbiology : An Introduction to Microbial Physiology , Butterworth world student , London .
2. Campbell Peter N. & Smith Anthony D. : Biochemistry illustrated, Churchill Livingstone, New York.
3. Das Debajyoti : Biochemistry.
4. Deb A. C .: Fundamentals of Biochemistry , New central Book Agency, Calcutta.
5. Lehninger Albert L .: Principles of Biochemistry , CBS publishers , Delhi.
6. Lehninger Albert L: Biochemistry, Kalyani Publishers, New Delhi.
7. Moat Albert G. & Foster John W.: Microbial Physiology, John Wiley & Sons, Inc.
8. Moat A G. : Microbial Biochemistry.

9. Steiner R. F. : Life Chemistry : An introduction to Biochemistry , D van Nostrand Co. Inc. London .
10. Stryer Lubert : Biochemistry, W. H. Freeman and Co., San Francisco.
11. T. Palmer : Understanding Enzymes.
12. A. H. Patel : Industrial Microbiology, McMillan (India) Ltd., Bombay.
13. Casida L. E. Industrial Microbiology , Wiley Eastern Ltd. , New Delhi.
14. Prescott & Dunn : Industrial Microbiology McGraw Hill Co. Ltd.,
15. Bis swanger Hans : Practical Enzymology , Wiley – VCH Verlag Gmbh & Co.
16. Chatwal Anand : Instrumental methods : Chemical analysis , Himalaya publishing House.
17. Plummer David : An introduction to practical Biochemistry , Tata McGraw Hill Book Co. Ltd., New Delhi.
18. Jayaraman J. : Laboratory Manual in Biochemistry, New Age , International publishers,
19. Tikekar P. G. : Practical Biochemistry for Medical students, Purvi Pustak Kendra, Bombay.
20. Avinash and Kakoli Upadhyay, MOLBIO, Himalaya Publications
21. Barry J. M. & Barry F. M : Molecular biology.
22. Freifelder David: Microbial Genetics, Jones & Bartlett, Publication Inc.
23. Gardner Eldon, Simmon Michael & Snustad Oeter : Principles of Genetics, John Wiley & Sons , New York.
24. James D. Watson : Molecular Biology of the Gene, W. A. Benjamin, Inc.
25. Joshi P.:Genetic Engineering & its applications, Agrobious, Jodhpur (India)
26. Nilima Rajvaidya and D. Markandey, Genetical and Bochemical applications of Microbiology, APH publishing Co. New Delhi.
27. Singh B. D.: Biotechnology : Kalyani publishers, Delhi.
28. Strickberger M.: Genetics, prentice Hall of India Pvt. Ltd., New Delhi.
29. Walkar J. M & Gingold A. B. : Molecular Biology & Biotechnology, Panima publication, New Delhi.

List of Instruments required for Microbiology

Research Microscope
Compound Microscope
(with 100 X objectives)
Laminar air flow
Laboratory Shaker
Digital Incubator
Digital Hot Air Oven
Digital Autoclave
Waterbath shaker
Hot Plate
Vortex Mixer
Mixer
Air Sampler (Hi-Meida)
Magnetic SIRRER
Chromatography Chamber
Colorimeter
Electronic Balance (Monopan)
Analytical Balance
Hemocytometer
Hemoglobinometer
Hair Dryer
Anaerobic Jar
Colony Counter
Seitz Filter/ Milipore filter with vacuum pump
High speed Centrifuge Machine (15,000 RPM)
Refrigerator
Digital PH Meters
Electrophoresis unit (vertical/ horizontal) with power pack
UV – Visible spectrophotometer
BOD incubator
Deep freezer (-10 °C)
Glass distillation unit
Computer with printer (Pentium 4)