

**“Dissemination of Education for Knowledge, Science and Culture”
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Department of Microbiology
MSC Entrance Exam Syllabus 2025-2026

INTRODUCTION TO MICROBIOLOGY

History of microbiology and types of microorganisms

1. Spontaneous generation *vs.* biogenesis.
2. Contributions of:
 - a) Antony Von Leeuwenhoek
 - b) Edward Jenner
 - c) Louis Pasteur
 - d) Robert Koch
 - e) Joseph Lister
 - f) Alexander Fleming
 - g) Hargobindsingh Khorana.
3. Classification of microorganisms–
 - a) Whittaker's five kingdom
 - b) Carl Woese's three kingdom classification systems.
4. Taxonomic ranks
5. Beneficial and harmful activities of microorganisms

Types of Microorganisms

1. General characteristics of different groups:

- a) Acellular microorganisms- Viruses, Viroids, Prions
- b) Cellular microorganisms- with emphasis on distribution, occurrence and morphology.
 - i) Bacteria, ii) Fungi, iii) Algae, iv) Protozoa
- c) Structure of Prokaryotic and eukaryotic cell.
- d) Difference between prokaryotic & eukaryotic microorganisms

Bacterial Cell Organization

1. Cell size, shape and arrangement,

2. Reserve food materials–

- a) Nitrogenous

- b) Non-nitrogenous

Cytology Of Bacteria

3. Structure and Function of-

- a) Cell-wall
- b) Cell membrane
- c) Capsule and slime layer.
- d) Flagella and Pili
- e) Ribosomes
- f) Mesosomes
- g) Inclusion bodies
- h) Nucleoid, chromosome and plasmids
- i) Endospore

BACTERIOLOGY

General Principles of Microscopy

1. Types of microscopes:

- a) Light microscopes
- b) Electron microscopes, 2. Light microscopy:

- a) Parts
- b) Image formation
- c) Magnification
- d) Numerical aperture
- e) Resolving power
- f) Working distance

3. Ray diagram, special features and applications of:

- c) Compound Microscope
- d) Phase Contrast Microscope
- e) Electron Microscope

4. Fluorescence Microscope

Stains And Staining Procedures

- 1. Classification of stains–Acidic, Basic and Neutral 2. Principles, Procedure, Mechanism of staining-

- f) Monochrome staining
- g) Negative staining
- h) Differential staining:
- i) Gram's staining ii) Acid fast staining

3. Special staining methods

- i) Cell wall (Chance's method)
- j) Capsule (Manvel's method)
- k) Volutin granule (Albert's method)

Control Of Microorganisms I

1. Definitions of–

- a) Sterilization
- b) Disinfection
- c) Antiseptic
- d) Germicide
- e) Microbiostasis
- f) Antisepsis
- g) Sanitization

2. Mode of action and applications of- ❖ Physical agents:

- i) Temperature –Dry heat, Moist heat ii) Desiccation
- iii) Ultrasonication
- iv) Radiations– U.V. Ray, Gamma rays
- v) Filtration– Asbestos and Membrane filter

Control Of Microorganisms II

Mode of action and applications of- ❖ Chemical Agents:

- j) Phenol and Phenolic compounds ii) Alcohols (Ethyl alcohol)
- iii) Halogen compounds (chlorine and iodine)
- k) Heavy metals (Cu and Hg)
- l) Fumigation by Gaseous Agents –
 - a Ethylene oxide
 - b Beta-propiolactone
 - c formaldehyde

M) Osmotic Pressure

MICROBIAL NUTRITION AND TECHNIQUES

MICROBIAL NUTRITION

A) Microbial Nutrition

1) Nutritional requirements of microorganisms:

- a) Water;
- b) Micronutrients;
- c) Macronutrients
- d) Carbon,
- e) Energy source
- f) Oxygen and Hydrogen
- g) Nitrogen,
- h) Sulfur and Phosphorous
- i) Growth factors.

Concept of auxotroph, Prototroph and fastidious organisms based on Growth factors.

2) Nutritional types of microorganism based on carbon and energy sources.

- | | |
|-----------------------|-----------------------|
| a) Autotrophs | b) Heterotrophs |
| c) Phototrophs | d) Chemotrophs |
| e) Photoautotrophs | f) Chemoautotrophs |
| g) Photoheterotrophs. | h) Chemoheterotrophs. |

Culture Media

Culture media:

- 1) Components of media
- 2) Types of media based on-
 - a) Physical state- i. Solid media, ii. liquid media, iii semisolid media
 - b) Chemical nature- i. Natural media, ii. Synthetic media iii. Complex
 - c) Function - i. Selective media ii. Differential media
iii. Enriched media iv. Enrichment media

D. Cultivation of microorganisms:

- 1) Use of culture media for cultivation.
- 2) Conditions required for growth of the microorganisms

Enrichment And Isolation Of Microorganisms From Natural Environment

Enrichment and Isolation of Microorganisms from natural environment.

- 1) Pure culture techniques–
 - a. Streak plate,
 - b. Spread plate,
 - c. Pour Plate.
- 2) Isolation and cultivation of anaerobic organisms by using media components and by exclusion of air.

B. Preservation of microbial cultures by–

- 1) Subculturing,
- 2) Overlaying cultures with mineral oils
- 3) Storage at low temperature, 4) Lyophilization.

Systematic Study Of Pure Cultures

Systematic study of pure cultures:

- 1) Morphological characteristics.
- 2) Cultural characteristics–
Colony characteristics on solid media, growth in liquid media.
- 3) Biochemical Characteristics -
 - i) Sugar fermentation ii) H₂S gas production
 - iii) Detection of enzyme activity– Amylase, Caseinase, Catalase
- 4) Serological characters
Concept of Culture collection centers

Applied Microbiology - I

Water Microbiology

A. Water Microbiology:

1. Sources of microorganisms in water.
2. Fecal pollution of water.
3. Indicators of fecal pollution
4. Routine Bacteriological analysis of water.

- a. SPC
- b. Tests for Coli forms
 - i) Qualitative test

Detection of coliforms –
 Presumptive test, Confirmed Test, Completed test.
 Differentiation between coliforms –
 IMViC test,
 Eijkman test.

- ii) Quantitative test –
 MPN
 Membrane filter technique

5. Municipal water purification process and its significance.

Food Microbiology

- A. Food Microbiology
 - a) Principles of microbial spoilage of food
 - b) Spoilage of fruits , breads and meat
 - c) General principles and methods of food preservation
 - i) Asepsis
 - ii) Removal of microorganism – trimming , filtration , centrifugation
 - iii) Dehydration method
 - iv) Irradiation
 - v) Anaerobiosis

Air Microbiology

- A] Air Microbiology:
 - i) Sources of microorganisms in air.
 - ii) Definitions of-
 - a) Infectious dust,
 - b) Droplets,
 - c) Droplet nuclei
 - iii) Sampling methods for microbial examination of air -
 - a) Solid impaction-Sieve device
 Liquid Impingement–Bead-bubbler device, Gnotobiology Introduction

Microbial Physiology

Microbial Growth

A] Growth:

- i) Definition of growth
- ii) Phases of growth

B] Measurement of growth

- i) Measurement of growth by cell number
- ii) Measurement of growth by cell mass

C] Types of Growth

- i) Continuous growth ii) Synchronous growth iii) Diauxic growth

D] Transport across cell membrane–

- i) Diffusion ii) Active transport iii) Group translocation

Effect of environmental factors on microbial growth

Effect of environmental factors on microbial growth :

i) Temperature:-

- a) Mesophiles, psychrophiles, thermophiles and hyperthermophiles.
- b) Thermal destruction of bacteria-D, F and Z values, TDP and TDT

ii) pH- Neutrophiles, Acidophiles and Alkalophiles .

iii) Osmotic pressure – Isotonic, hypotonic and hypertonic environments, xerophiles and halophiles.

iv) Heavy metals

v) Radiations-U.V rays

Microbial Metabolism

A] Basic concept of metabolism

B] Catabolism of glucose –

- i) EMP pathway ii) HMP pathway iii) ED pathway iv) TCA cycle

C] Fermentation:-

- i) Homolactic fermentation ii) Heterolactic fermentation

Bacterial electron transport chain

A] Oxidative phosphorylation

B] Bacterial electron transport chain

- i) Components of ETC ii) Flow of electrons
- iii) Mechanism of ATP generation – Chemiosmotic hypothesis

Medical Microbiology -I

Medical Microbiology

A] Definitions— Host, Parasite, Saprophytes, Commensal,
Infection, Etiological agent, Disease, Pathogen,
Opportunistic pathogen, True pathogen, Virulence, Pathogenicity, Fomite,
Incubation period, Carriers, Morbidity rate, Mortality rate, epidemiology,
etiology, Prophylaxis, Antigen, Antibody, Hapten, Vaccine, Immunity.

B] Virulence factors-production of endotoxins, exotoxins, enzymes, ability to escape from phagocytosis.

G] Normal flora of human body& its significance -

- i) flora of skin, throat, GI tract & Urinogenital tract.
- ii) Beneficial and harmful aspects of normal flora

Concept of antibiosis

Types of infection , Diseases and mode of Transmission

A] Types of infections—

Chronic, acute, primary ,secondary, reinfection,
Iatrogenic, congenital, local, generalized, Covert, Overt, Simple, Mixed,
Endogenous, Exogenous, Latent, Pyogenic, Nosocomial.

B] Types of diseases—

- i) Epidemic—e.g. Influenza, Cholera
- ii) Endemic—E.g. Common cold, Typhoid
- iii) Pandemic—E.g. SARS ,Corona
- iv) Sporadic—E.g. Polio

C] Modes of transmission of diseases -

- i) Air-borne transmission, ii) Vehicle transmission
- iii) Contact transmission iv) Vector borne transmission

D] General principles of prevention and control of microbial diseases

Immunology

A] Immunity i) Definition

- ii) Innate Immunity-types, factors influencing innate immunity
- iii) Acquired Immunity—Active & passive

B] Non Specific defense mechanisms of the vertebrate body

- i) First line of defense

ii) Second line of defense

Organs of Immune system-Types of Primary and secondary lymphoid organs

Antigen and Antibodies

A] Antigen-Chemical nature, types of antigens, factors affecting antigenicity.

B] Antibody-Structure , properties and functions, types of antibodies.

C] Theories of antibody production.

D] Mechanism of antigen–antibody reaction–Lattice hypothesis.

E] Types of antigen antibody reaction-Agglutination & Precipitation.

Immune Response: Primary and secondary immune responses

Microbial Genetics -I

Basic concepts of genetics

]Basic concepts of genetics–

i)Basic terminologies–Gene,genome, genotype, phenotype, mutagen, recon, muton, cistron, split genes.

ii)Forms of DNA

iii)Genetic code–definition and properties of genetic code.

iv)Organization of Chromosomal DNA in *E.coli*

Mutation

Mutation:-

i) Basic Concepts of Mutation: Base pair substitutions, Frame shift , missense, nonsense, neutral, silent, pleiotropic and suppressor mutations.

ii) Spontaneous mutation–Definition and basic concepts.

iii)Induced mutations–

Definition and mechanism of mutagenesis by–

a) Baseanalogues :

- 5-Bromouracil and
- 2- aminopurines

b) Mutagens modifying nitrogen bases- Nitrous acid

- Hydroxyl amine
- Alkylating agents

c)Mutagens that distort DNA– □ acridine dyes,UV light

Gene transfer in bacteria

A] Gene transfer in bacteria.

- i) Fate of exogenote in recipient cell.
- ii) Modes of gene transfer–
 - a) Transformation.
 - b) Conjugation
 - c) Transduction

DNA Repair and plasmid

A] DNA repair :

- i) Photo reactivation ii) Dark repair mechanism (Excision repair)

B] Plasmids–

- i) Natural–Properties, types, structure & applications
- ii) Artificial -pBR 322- structure and applications

Immunology

1. Cells of Immune system –

- a. Haematopoiesis-characteristics & types of stem cells.
- b. Classification of cells of immune system – lymphoid & myeloid cells.
- c. Structure & function of lymphoid cells – T cell & T cell subsets, NK cells, B cells & dendritic cells
- d. Structure & function of myeloid cells- Granulocytes, monocytes & macrophages.

2. Membrane receptors for antigen and their role in antigen recognition

- a. B cell surface receptor for antigen (BCR)
- b. T cell surface receptor for antigen (TCR)
- c. NK receptors

3. Molecular mechanism of antibody production.

- a. Processing and presentation of antigen by Antigen presenting cell.
- b. Interaction of APC with TH Cell.
- c. Interaction of B cell and TH Cell
- d. Clonal proliferation and differentiation of activated B cell.
- e. Role of follicular dendritic cells in selection of high affinity B cell.
- f. Role of cytokines in proliferation and differentiation.

4. Cytokines -

- a. Properties, types and function of cytokines produced by TH cell and Macrophages

5. Immunological tolerance:

- a. Tolerance induction in adults and neonates by drug and monoclonal antibody
- b. Cellular mechanism of immunological tolerance.
- c. Termination of tolerance.

1. Complement –

- a. Nature and Properties of Complement
- b. Complement activation by classical and alternate pathway.
- c. Biological consequences of complement activation.

2. Monoclonal antibodies -

- a. Basic concepts - Mouse, Human and Humanized antibodies.
- b. Production of monoclonal antibodies by hybridoma technology.
- c. Production of Humanized Monoclonal antibodies by recombinant DNA technology.
- d. Applications of monoclonal antibodies in diagnosis, treatment and research.

Medical Microbiology

1. Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission and pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by –

- a. *Mycobacterium leprae*
- b. *Clostridium perfringens*
- c. *Treponema pallidum*

2. Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission and pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by –

- a. *Pseudomonas aeruginosa*
- b. *Vibrio cholerae*
- c. *Leptospira interrogans*

3. Morphology, cultural and biochemical characteristics, antigenic structure, modes of transmission and pathogenesis, symptoms, laboratory diagnosis, prevention and control of diseases caused by -

a. Protozoa: *Plasmodium falciparum* (malaria)

b. Viruses:

i. Hepatitis A & B virus

ii. Rabies virus

iii. Dengue virus

c. Fungi: *Candida albicans*

4. Chemotherapy

a. General principles of chemotherapy

b. Mode of action of Penicillin, Streptomycin, Bacitracin, sulphonamide and Quinolones on microorganisms

c. Antiviral drug: AZT

d. Antifungal drugs: Ketoconazole

e. Antiprotozoal drugs: Metronidazole

f. Mechanism of drug resistance

g. Chemoprophylaxis

5. Immunoprophylaxis – Vaccines and Immune Sera

a. Vaccines - live attenuated, heat killed, subunit, conjugate and DNA vaccines

b. Immune Sera – examples with applications

Industrial Microbiology

1. Food Microbiology

a. Food as a substrate for microorganisms.

b. Food borne diseases –

i. Role of microorganisms in food borne diseases

ii. Food poisoning - Staphylococcal

ii. Fungal (aflatoxin)

iii. Food infections – Salmonellosis

iv. Food spoilage and its preservation

2. Industrial Microbiology

a. Strain Improvement

- b. Scale up of fermentations
 - c. Microbiological assays
 - d. Preservation of industrially important microorganisms - Methods, Culture collection centres
3. Industrial production of -
- a. Grape wine - Definition, types, production of table wine (Red and White), microbial defects of wine
 - b. Penicillin - Organisms used, Inoculum preparation, Fermentation media, Fermentation conditions, Extraction and Recovery. Concept of semi synthetic penicillin
 - c. Fermentation media, Fermentation conditions, Extraction and Recovery.
4. Probiotics-
- a. Concept, Production by using *Lactobacillus* and applications
 - b. Probiotic Foods - Definition, types, microorganisms and health benefits
5. Downstream processing & product recovery -
- a. Centrifugation
 - b. Flocculation
 - c. Filtration
 - d. Solvent extraction
 - e. Distillation
 - f. Precipitation
 - g. Crystallization
 - h. Chromatography.
6. Testing of sterility, pyrogen, carcinogenicity, toxicity and allergens

Microbial Biochemistry

1. Enzymes -
- a. Definition, properties, structure, specificity, classification and mechanism of action (Lock & Key, Induced fit hypothesis)
 - b. Allosteric enzymes - Definition, properties, models explaining mechanism of action.
 - c. Ribozymes –concept, significance.

- d. Isozymes- definition, properties, example.
- e. Factors affecting catalytic efficiency of enzymes
 - i. Proximity and orientation
 - ii. Strain and distortion.
 - iii. Acid base catalysis
 - iv. Covalent catalysis
- f. Enzyme kinetics - Derivation of Michaelis-Menten equation, Lineweaver Burk Plot, Significance of K_m and V_{max} .
- g. Regulation of enzyme synthesis.
 - i. Positive control - Ara operon
 - ii. Negative control - Lac operon
 - iii. Catabolite repression
- 2. Extraction & purification of enzymes.
 - a. Methods of extraction of intracellular and extracellular enzymes.
 - i. Choice of source and biomass development
 - ii. Methods of homogenization - cell disruption methods
 - iii. Purification of enzymes on the basis of -
 - Molecular size
 - Solubility differences
 - Electrical charge
 - Adsorption characteristic differences
- 3. Assay of enzymes - Based on substrate and product estimation.
- 4. Immobilization of enzymes - Methods & applications
- 5. Basic concepts of -
 - a. Glyoxylate bypass
 - b. Phosphoketolase pathway
- 6. Assimilation of -
 - a. Carbon
 - b. Nitrogen with respect to N_2 and NH_3 (GOGAT)
 - c. Sulphur
- 7. Prokaryotic Biosynthesis of -
 - a. RNA
 - b. DNA

- c. Proteins
- d. Peptidoglycan

Virology

1. The Structural properties of viruses
 - a. Capsids, Nucleic acids and envelope.
 - b. Structure of T4 bacteriophage, TMV and HIV, Viroids & prions.
 - c. One step growth experiment.
2. Isolation, cultivation and Purification of viruses
 - a. Isolation and cultivation of viruses-
 - i. Animal virus- Tissue culture, chick embryo and live animals.
 - ii. Plant virus– Protoplasts culture technique, Insect tissue culture
 - iii. Bacteriophages-Plaque method.
 - b. Purification of viruses using physico-chemical properties
 - i. Density gradient centrifugation
 - ii. Precipitation
3. Methods of Enumeration of viruses
 - i. Latex droplet method (Direct microscopic count)
 - ii. Plaque and pock method.
4. Lysogeny - Definition of lysogeny and temperate phage, types, lysogeny by lambda phage
- adsorption & penetration, genetic map for lysogenic interaction, expression of λ genes, establishment of repression, maintenance of repression, integration of λ genome in host chromosome.
5. Reproduction of animal viruses - Adenovirus
6. Reproduction of plant viruses – TMV
7. Reproduction of T4 phages
8. Oncogenesis:
 - a. Definition of oncogenesis
 - b. Types of cancer

- c. Characteristics of cancer cells.
- d. Tumor suppressor genes and protooncogenes
- e. Hypothesis about cancer.
 - i. Somatic mutation hypothesis
 - ii. Viral gene hypothesis
 - iii. Provirus theory, Protovirus theory, Oncogene theory.
 - iv. Defective immunity hypothesis.

Microbial Genetics

1. One cistron - one polypeptide hypothesis.
2. Molecular mechanism of gene expression
 - a. Concept of operon
 - b. Pribnow box
 - c. Genetic regulation in tryptophan operon
3. Mutations
 - a. Expression of mutations -
 - i. Time course of phenotypic expression.
 - ii. Conditional expression of mutation.
 - b. Suppressor mutations (with examples) - Genetic and non-genetic.
4. Methods of isolation and detection of mutants based on -
 - a. Relative survival
 - b. Relative growth
 - c. Visual detection
5. Genetic complementation - Cis-trans test
6. Extrachromosomal inheritance:
 - a. Kappa particles.
 - b. Transposable elements - general properties and types.
7. Techniques in Molecular Biology –
 - a. DNA sequencing (Sanger's method)
 - b. DNA Finger printing
 - c. PCR
 - d. Blotting techniques- Southern, Western, Northern
8. Genetic engineering

- a. Introduction
- b. Tools of genetic engineering –
 - i. Enzymes
 - ii. Vectors-phage, plasmid and cosmid
 - iii. DNA probe – methods of preparation and detection.
 - iv. Linkers and adaptors
 - v. Cloning organisms - (Bacteria and Yeasts)
 - vi. Genomic library and cDNA library
- c. Techniques –
 - i. Isolation of desired DNA segment- Shotgun Method, cDNA synthesis, Chemical synthesis
 - ii. Construction of r-DNA using appropriate vector- Use of restriction enzymes, Linkers, Adaptors Homopolymer tails
 - iii. Transfer to cloning organisms (Bacteria and Yeasts)
 - iv. Selection of recombinant bacteria and yeasts – Blue and white screening, Colony hybridization technique.
- d. Application of genetic engineering in –
 - i. Medicine-
 - ii. Agriculture
 - iii. Industry
 - iv. Environment
 - v. Understanding biology

Agricultural Microbiology

- 1. Soil Microbiology.
 - a. Physical characters.
 - b. Chemical characters.
 - c. Types of microorganisms in soil and their role in soil fertility.
 - d. Microbiological interactions - Symbiosis, Commensalism, Amensalism, Parasitism, Predation.
- 2. Role of microorganisms in elemental cycle
 - a. Carbon cycle.

- b. Nitrogen cycle
 - c. Phosphorous cycle
 - d. Sulfur cycle
- 3. Manure and Compost
 - a. Methods of Production -
 - i. Green manure and farm yard manure
 - ii. City compost- Windrow and pit method.
 - iii Vermicompost
- Optimal conditions for composting with reference to - Composition of organic waste, Availability of microorganisms, Aeration, C:N:P ratio, Moisture content, Temperature, pH, Time.
- 4. Types, production, methods of application and uses of -
 - a. Biofertilizers
 - i. Nitrogen fixing - Azotobacter, Rhizobium, Azospirillum.
 - ii. Phosphate Solubilizing Microorganisms.
 - b. Biopesticides
 - i. *Bacillus thuringiensis*
 - ii. *Tricoderma spp.*
- 5. Biodegradation by bacteria & fungi-
 - a. Cellulose
 - b. Pesticides
- 6. Plant Pathology
 - a. Common symptoms produced by plant pathogens
 - b. Modes of transmission of plant diseases.
 - c. Plant diseases -
 - i. Citrus Canker
 - ii. Tikka disease of groundnut
 - iii. Bacterial Blight of Pomegranate.

Environmental Microbiology

- 1. General characteristics of waste-

- a. Liquid waste - pH, electrical conductivity, COD, BOD, total solids, total dissolved solids, total suspended solids, total volatile solids, chlorides, sulphates, oil & grease.
 - b. Solid waste- pH, electrical conductivity, total volatile solids, ash.
 - c. Standards as per MPCB
2. Sewage Microbiology
 - a. Physico-chemical and biological characteristics
 - b. Treatment methods-
 - i. Physical treatment: Screening, Sedimentation
 - ii. Biological treatment: Trickling filter, Activated sludge process, Oxidation ponds, Anaerobic digestion (Bio methanation), Septic tank.
 - iii. Chemical treatment - Chlorination
3. Characteristics of waste generated by
 - a. Sugar Industry
 - b. Dairy Industry
4. Characteristics and treatment of waste generated by Hospitals
5. Eutrophication
 - a. Classification of lakes
 - b. Sources
 - c. Consequences
 - d. Control
6. Biological safety in laboratory
 - a. Good Laboratory Practices
 - b. Bio safety levels (BSL)
7. Environmental monitoring
 - a. Definition and purpose
 - b. Cleanroom- Concept, classification, prevention of contamination in clean rooms
 - c. Routine Environmental monitoring programme in pharmaceutical industries-
Air monitoring, Surface monitoring and Personnel monitoring.
 - d. Bioburden test
8. Environmental Impact Assessment- Concept and brief introduction
9. Bioremediation and Bioleaching
 - a. Bioremediation

- i. Definition
 - ii. Types
 - iii. Applications.
- b. Bioleaching
 - i. Introduction
 - ii. Microorganisms involved
 - iii. Chemistry of Microbial leaching
 - iv. Laboratory scale and pilot scale leaching
 - v. In situ leaching - Slope, heap
 - vi. Leaching of Copper and Uranium