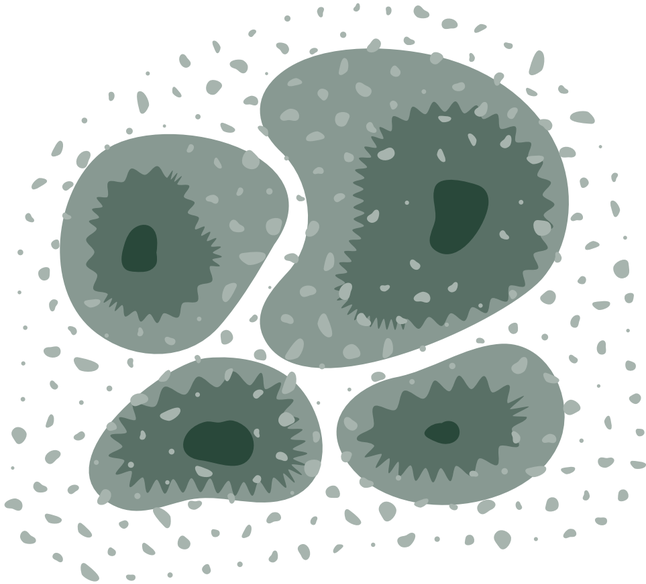
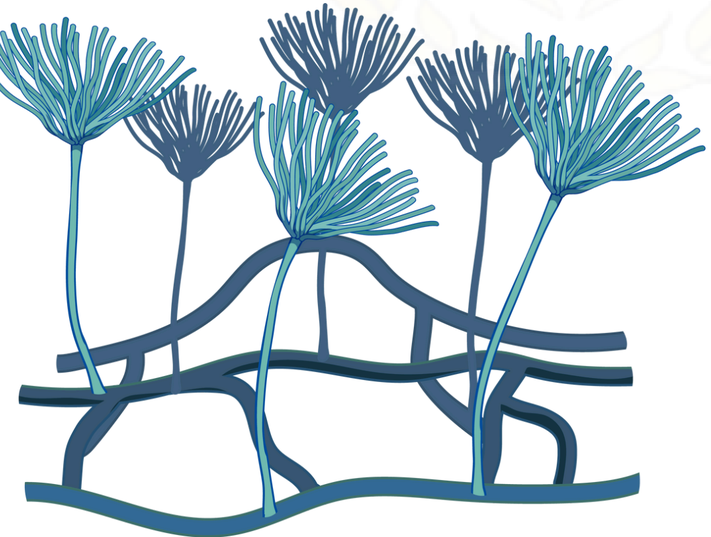
EDU SERUMX COLLEGE OF PARAMEDICAL



MICROBIOLOGY

BMLT- 1st year

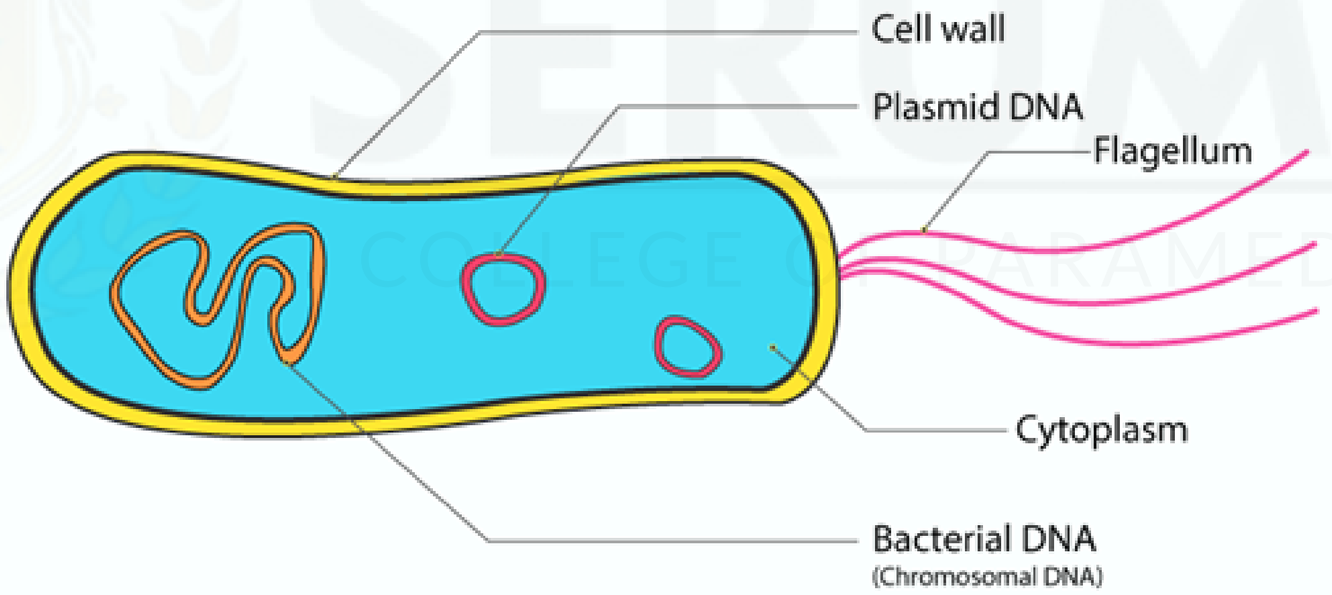


TOPIC:

- General characteristics and classification of bacteria and fungi.
- Growth and nutrition of microbes.

General characteristics and classification of bacteria

Bacteria are unicellular organisms belonging to the prokaryotic group where the organisms lack a few organelles and a true nucleus



General Characteristics of Bacteria

Unicellular: Bacteria are single-celled prokaryotic organisms.
Cell Wall: Made of peptidoglycan (except in Mycoplasma).
No Nucleus: They lack a true nucleus and membrane-bound organelles.

Shapes:
Cocci – Spherical
Bacilli – Rod-shaped
Spirilla – Spiral-shaped
Vibrio – Comma-shaped

Reproduction: Mainly by binary fission (asexual).
Mobility: Some bacteria have flagella for movement.
Nutrition: Can be autotrophic or heterotrophic.
Gram Staining: Classified as Gram-positive or Gram-negative based on cell wall properties

Based on habitat:

- Thermophiles: thrive at high temperatures
- Acidophiles: grow best in acidic environments with a low pH (usually below 5).
- Alkaliphiles: prefer alkaline environments with a high pH (usually above 9)
- Osmophiles: grow in environments with high sugar concentrations
- Barophiles: thrive under high pressure
- Cryophiles: grow optimally at cold temperatures

Classification of Bacteria

Bacteria can be classified into various categories based on their features and characteristics.
The classification of bacteria is mainly based on the following:

By Shape:

- Cocci: Spherical-shaped bacteria (e.g., Streptococcus).
- Bacilli: Rod-shaped bacteria (e.g., Escherichia coli).
- Spirilla: Spiral or helical-shaped bacteria with rigid bodies (e.g., Spirillum).
- Vibrios: Comma-shaped, curved rod bacteria (e.g., Vibrio cholerae).

B**y Gram Stain:**

- Gram-positive: Bacteria with thick peptidoglycan walls that retain crystal violet stain (appear purple).
- Gram-negative: Bacteria with thin peptidoglycan walls and outer membrane that do not retain crystal violet (appear pink/red).

By Oxygen Requirement:

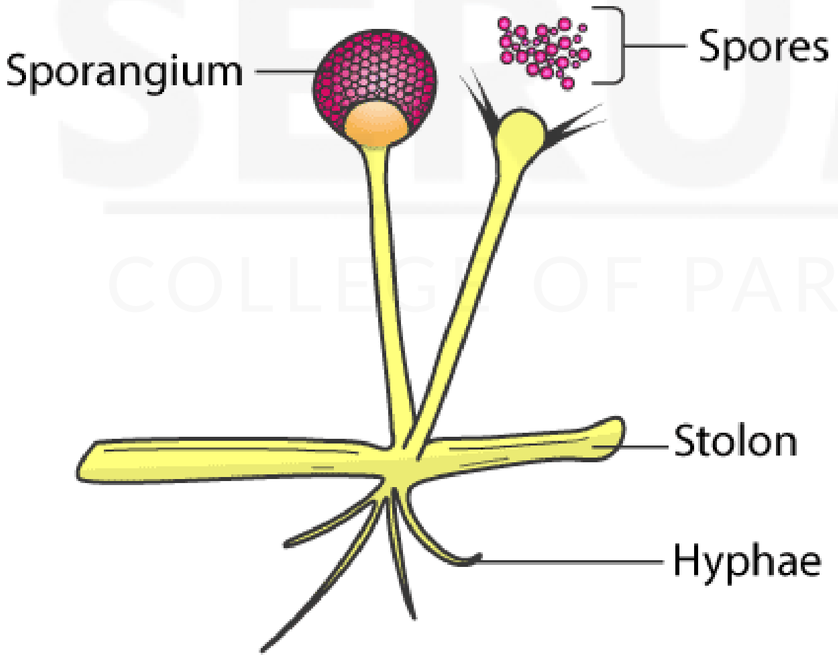
- Aerobic: Require oxygen for growth (e.g., Mycobacterium tuberculosis).
- Anaerobic: Grow in the absence of oxygen (e.g., Clostridium species).
- Facultative anaerobes: Can grow with or without oxygen (e.g., E. coli).
- Microaerophilic: Require low levels of oxygen (e.g., Helicobacter pylori).

By Temperature Range:

- Psychrophiles: Grow at cold temperatures (0–15°C).
- Mesophiles: Grow at moderate temperatures (20–45°C); most human pathogens.
- Thermophiles: Grow at high temperatures (above 45°C).

General characteristics and classification of Fungai

- Fungi are eukaryotic, heterotrophic organisms with cell walls made of chitin, and they exhibit both unicellular and multicellular forms.
- They are classified based on their morphology, spore formation, and fruiting bodies. Major fungal classifications include Chytridiomycota, Zygomycota, Ascomycota, and Basidiomycota.



General Characteristics of Fungi

Eukaryotic: They have a true nucleus and membrane-bound organelles.
Cell Wall: Made of chitin.a polysaccharide that provides structural support.
Heterotrophic: Absorb nutrients from decaying organic matter (saprophytic).
Structure:

- Unicellular: e.g., Yeast
- Multicellular: e.g., Molds with hyphae

Reproduction: Asexual (spores, budding) and sexual methods.
Growth Conditions: Prefer warm, moist, slightly acidic environments.
Non-motile: Unlike bacteria, most fungi do not move.
Absorptive Nutrition: Fungi digest their food externally by releasing enzymes into the surrounding environment and then absorbing the digested nutrients.
Spore Production: Fungi reproduce through spores, which are dispersed by wind, water, or animals.
Hyphae and Mycelium: Multicellular fungi are composed of hyphae, which form a network called a mycelium.
Saprophytes and Parasites: Many fungi are saprophytes, feeding on dead organic matter, while some are parasites, living on or in living hosts.

Classification of Fungi

A. Based on Reproduction

Zygomycota: -

- Sexual Reproduction: Formation of zygospores
- Example: Rhizopus (bread mold)
- Key Characteristics: Non-septate hyphae, fast-growing molds

Ascomycota:

- Sexual Reproduction: Formation of ascospores in asci
- Example: Saccharomyces (yeast)
- Key Characteristics: Largest group; includes yeasts, molds, and more

Basidiomycota:

- Sexual Reproduction: Formation of basidiospores -
- Example: Mushrooms, puffballs
- Key Characteristics: Produce large fruiting bodies (basidiocarps)

Deuteromycota:

- Sexual Reproduction: No known sexual reproduction
- Example: Candida, Aspergillus (some species)
- Key Characteristics: Called 'imperfect fungi' due to unknown sexual stage

B. Based on Morphology

Yeasts:

- Structure: Unicellular
- Example: Saccharomyces cerevisiae
- Key Characteristics: Reproduce by budding or fission

Molds:

- Structure: Multicellular, filamentous (hyphae)
- Example: Rhizopus, Penicillium
- Key Characteristics: Form visible mycelium, reproduce via spores

Dimorphic Fungi:

- Structure: Yeast at 37°C, mold at 25°C
- Example: Histoplasma, Blastomyces
- Key Characteristics: Pathogenic fungi; form depends on environment

Requirements for Growth:
Nutrients: Carbon, nitrogen, sulfur, phosphorus
Temperature: Varies for psychrophiles, mesophiles, thermophiles
pH: Most bacteria grow at pH 6.5–7.5; fungi prefer slightly acidic pH
Oxygen:
Obligate aerobes (require O_2)
Obligate anaerobes (cannot tolerate O_2)
Facultative anaerobes (can grow with or without O_2)
Moisture: Essential for microbial growth
Growth Curve (in batch culture):
Lag phase – adaptation
Log (exponential) phase – active multiplication
Stationary phase – growth rate = death rate
Decline phase – death exceeds growth

Growth of Microbes

Requirements for Microbial Growth

1) Nutrients: Microorganisms need nutrients for energy production and building cellular components.

Carbon (C):

- Main structural element of organic molecules (proteins, lipids, carbohydrates, nucleic acids).
- Sources: CO_2 (autotrophs), organic compounds (heterotrophs).

Nitrogen (N):

- Essential for amino acids, proteins, nucleic acids (DNA/RNA).
- Sources: Ammonia (NH_3), nitrate (NO_3^-), nitrogen gas (N_2) by nitrogen-fixing bacteria.

Sulfur (S):

- Required for synthesis of sulfur-containing amino acids (cysteine, methionine) and some vitamins (thiamine, biotin).

Phosphorus (P):

- Component of ATP, nucleic acids, and phospholipids in membranes.
- Source: Phosphate ions (PO_4^{3-}).

2. Temperature

Temperature affects enzyme activity and membrane fluidity. Based on temperature preference, microbes are classified as:

- Psychrophiles (cold-loving): Grow best at 0–15°C (e.g., in Arctic regions, deep oceans).
- Mesophiles (moderate temperature): Optimum growth at 25–40°C. Most human pathogens fall in this group.
- Thermophiles (heat-loving): Thrive at 45–70°C. Found in hot springs and compost piles.
- Extreme thermophiles (hyperthermophiles): Grow at 80°C or above. Found in volcanic and deep-sea vents.

3. pH

pH influences enzyme activity and nutrient transport across the membrane.

- Most bacteria: Prefer near-neutral pH (6.5–7.5).
- Fungi (molds and yeasts): Prefer slightly acidic pH (5.0–6.0).
- Acidophiles: Grow in acidic environments (e.g., pH < 5.0).
- Alkaliphiles:Thrive in basic environments (e.g., pH > 8.0).

4. Oxygen Requirement

Obligate aerobes:

- Require oxygen for cellular respiration.
- Have enzymes (like catalase, superoxide dismutase) to detoxify harmful oxygen forms.

Obligate anaerobes:

- Cannot survive in presence of oxygen.
- Lack detoxifying enzymes.

Facultative anaerobes:

- Can use oxygen when available but can grow without it using fermentation or anaerobic respiration.
- Example: Escherichia coli

Microaerophiles:

- Require low oxygen concentration.

Aerotolerant anaerobes:

- Do not use oxygen but can tolerate its presence.

5. Moisture

- Essential for all microbial life.
- Microbial cells are about 80–90% water.
- Water is needed for enzyme activity, transport, and cell metabolism.
- Dry conditions inhibit growth but may not kill the microorganism (e.g., spores survive dryness).

Microbial Growth Curve (in Batch Culture)

Growth of microorganisms in a closed system (like a broth culture in a test tube) shows distinct phases:

1. Lag Phase
   - Period of adaptation to new environment.
   - Cells increase in size but do not divide.
   - Enzyme synthesis and metabolic adjustments occur.

2. Log (Exponential) Phase
   - Rapid cell division; population doubles at a constant rate.
   - Cells are most metabolically active and uniform.
   - Best phase to study antibiotics and enzyme production.

3. Stationary Phase
   - Growth rate = death rate.
   - Nutrients become limited; waste products accumulate.
   - Some cells form endospores or show stress responses.

4. Decline (Death) Phase
   - Death rate exceeds growth.
   - Nutrients are exhausted; toxic wastes reach high concentration.
   - Population declines, though some cells may persist in dormant forms.