BACTERIA

Bacteria all are prokaryotes (prokaryote = "before nucleus") smallest, simplest, oldest cells on earth simple structure; not much internal structure no organelles.

The major characteristics of Bacteria are based on their size, shape and arrangements.

Size

The unit of measurement used in bacteriology is the micron (micrometer).

1 micron (μ) or micrometer (μm) – one thousandth of a millimeter.
1 millimicron (mμ) or nanometer (nm) – one thousandth of a micron or one millionth of a millimeter
1 Angstrom unit (Å) – one tenth of a nanometer

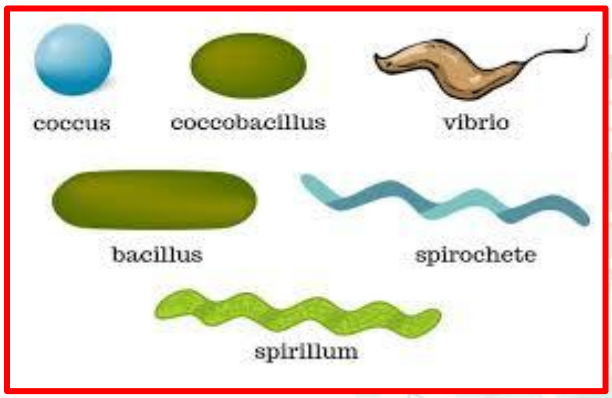
The limit of resolution with the unaided eye is about 200 microns. Bacteria are smaller which can be visualized only under magnification. Bacteria of medical importance generally measure 0.2 – 1.5 μm in diameter and about 3-5 μm in length.

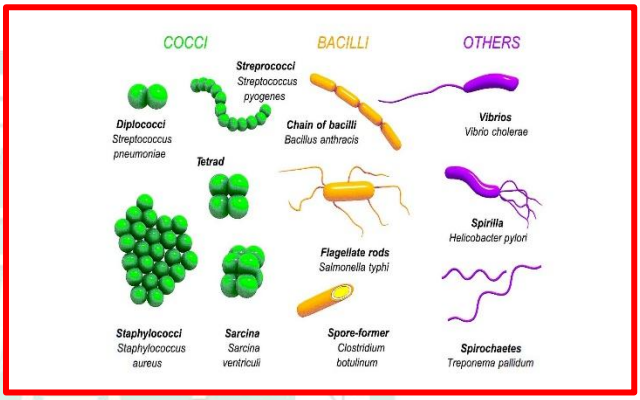
SHAPE OF THE BACTERIA

Depending on their shape, bacteria are classified into several varieties

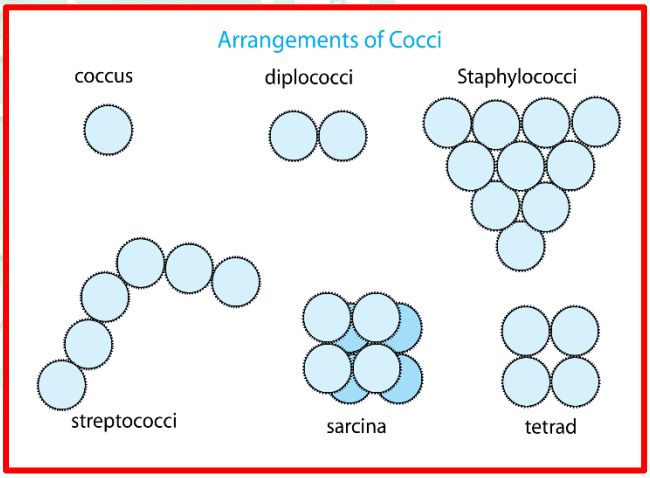
1. Cocci (from kokkos meaning berry) are spherical or oval cells.
2. Bacilli (from baculus meaning rod) are rod shaped cells
3. Vibrios are comma shaped curved rods and derive their name from their characteristics vibratory motility.
4. Spirilla are rigid spiral forms.
5. Spirochetes (from speira meaning coil and chaite meaning hair) are flexuous spiral forms
6. Actinomycetes are branching filamentous bacteria, so called because of a fancied resemblance to the radiating rays of the sun when seen in tissue lesions (from actis meaning ray and mykes meaning fungus)

7. Mycoplasmas are bacteria that are cell wall deficient and hence do not possess a stable morphology. They occur as round or oval bodies and as interlacing filaments.





Bacteria sometime show characteristic cellular arrangement or grouping. According to the plane of cellular division, cocci may be arranged in pairs (diplococci), chains (streptococci), groups of four (tetrads) or eight (sarcina), or grape like clusters (staphylococci).



BACTERIAL STRUCTURE

The outer layer or cell envelope consists of two components, a rigid cell wall and beneath it a cytoplasmic or plasma membrane. The cell envelope encloses the protoplasm, comprising the cytoplasm, cytoplasmic inclusions such as ribosomes and mesosomes, granules, vacuoles and the nuclear body.

Cell wall

Cell wall It is very rigid & gives shape to the cell. Its main function is to prevent the cell from expanding & eventually bursting due to water uptake. Cell Wall constitutes a significant portion of the dry weight of the cell and it is essential for bacterial growth & division. The cell wall cannot be seen by direct light microscopy and does not stain with simple stains. It may be demonstrated by microdissection, reaction with specific antibodies, mechanical rupture of the cell, differential staining procedures or by electron microscopy.

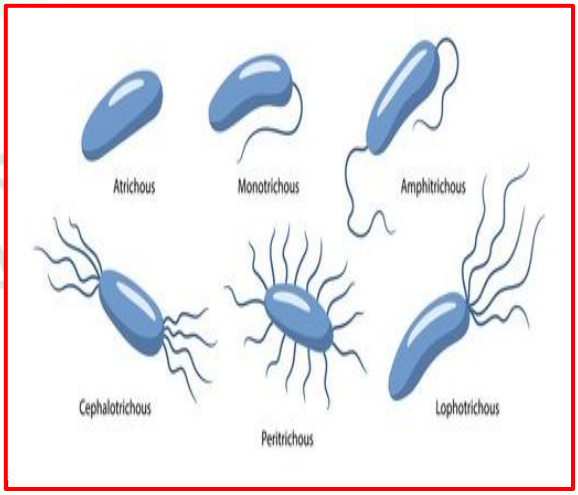
Bacterial Cell Structures:

- **Flagella**
- **Pili**
- **Capsule**
- **Plasma Membrane**
- **Cytoplasm**
- **Cell Wall**
- **Lipopolysaccharides**
- **Teichoic Acids**
- **Inclusions**
- **Spores**

Flagella:

Motility - movement
Classified according arrangement basis

- **Monotrichous: 1 flagella**
- **Lophotrichous: tuft at one end**
- **Amphitrichous: both ends**
- **Peritrichous: all around bacteria**



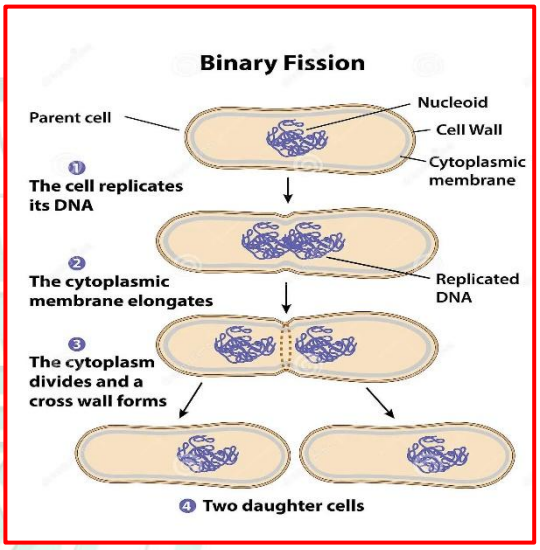
Bacterial Growth:

Culture: Increase in the population of cells

Generation time: The time cell takes to divide (double) is called

Reproduction: Binary Fission

- Division exactly in half
- Most common means of bacterial reproduction.
- Forming two equal size progeny
- Genetically identical offspring
- Cells divide in a geometric progression doubling cell number



Factors Influencing Bacterial Growth

Nutrition, Temperature, Oxygen, Salinity, pH, Pressure, Radiation

Nutrition:

Source of Energy:

• Bacteria are found in almost every environment because they can use widely different energy sources.

• Based on their energy source bacteria can be grouped into 4 major types

– Photosynthetic Bacteria: (1) Photoautotrophs and (2) Photoheterotrophs

An autotroph is an organism able to make its own food. Photoautotrophs are organisms that carry out photosynthesis. Using energy from sunlight, carbon dioxide and water are converted into organic materials to be used in cellular functions such as biosynthesis and respiration.

A heterotroph is an organism that depends on organic matter already produced by other organisms for its nourishment. Photoheterotrophs obtain their energy from sunlight and carbon from organic material and not carbon dioxide.

– Chemosynthetic Bacteria: (3) Chemoautotrophs and (4) Chemoheterotrophs

Chemoautotrophs are able to synthesize their own organic molecules from the fixation of carbon dioxide. These organisms are able to produce their own source of food, or energy. The energy required for this process comes from the oxidation of inorganic molecules such as iron, sulfur or magnesium.

Chemoheterotrophs, unlike chemoautotrophs, are unable to synthesize their own organic molecules. Instead, these organisms must ingest preformed carbon molecules, such as carbohydrates and lipids, synthesized by other organisms. They do, however, still obtain energy from the oxidation of inorganic molecules like the chemoautotrophs.

Bacterial requirements

Water: Used to dissolve materials to be transported across the cytoplasmic membrane

Carbon: required for the construction of all organic molecules

- Autotrophs use inorganic carbon (CO_2) as their carbon source
- Heterotrophs: use organic carbon

Nitrogen: Obtained from:

- Inorganic source: e.g. Nitrogen gas (N_2), Nitrate (NO_3), Nitrite(NO_2), and Ammonia (NH_3)
- Organic source: e.g. Proteins, broken down to amino acids
- Many organisms use nitrogen gas by nitrogen fixation to produce ammonia

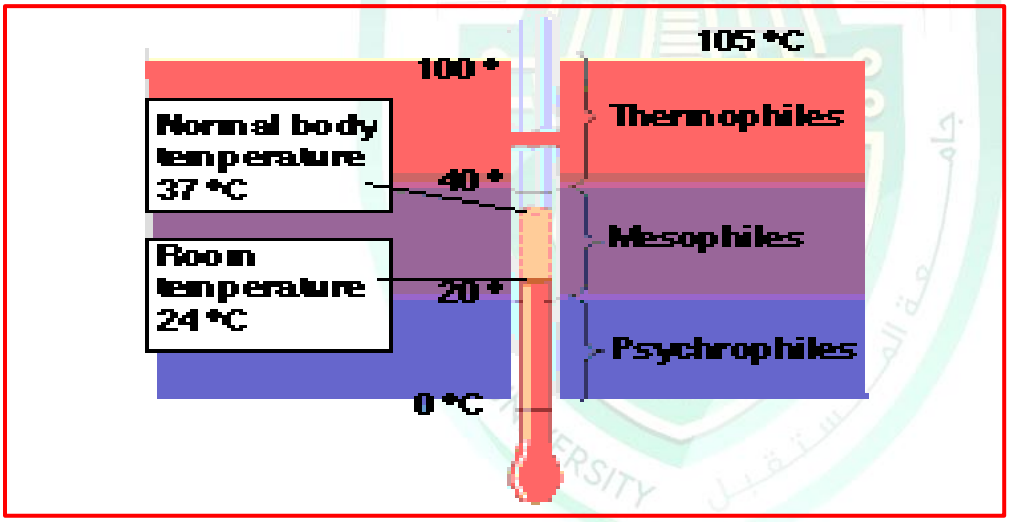
Other nutrients: Required in small amounts such as Iron, Sulfur, and Phosphorus

Temperature Requirements

Psychrophiles: Are defined as cold-loving bacteria. Specifically, their cardinal temperatures are 20 °C for maximal growth, 15 °C or lower for optimal growth, and 0 °C or lower for minimum growth

Mesophiles: Are microorganisms which grow at moderate temperatures between 20 °C and 45 °C and with an optimum growth temperature in the range of 30–39 °C

Thermophiles: Thermophiles are micro-organisms that grow optimally at between 55 and 65 °C but can grow between 40 and 90 °C. Thermophilic bacteria are spore formers.



Oxygen Requirements

• Required for aerobic respiration and energy production

• Organisms are classified according to their gaseous requirements

1. Obligate aerobes : is an organism that requires oxygen to grow. ex. *Pseudomonas.*

2. Facultative anaerobes: any organism that is able to grow either with or without free oxygen. Ex. *Escherichia coli*

3. Obligate anaerobes: Are microorganisms that can only survive in oxygen-free environments as free oxygen molecules are toxic to them. ex. *Clostridium*

Salinity Requirements

Halophiles: are the class of microorganisms that grow optimally at high NaCl concentrations

Moderates Halophiles: grows at salt concentration of 3-15% (w/v) and can tolerate

0-25% (w/v)

Extreme Halophiles: Grow well at NaCl concentrations of greater than 15% .

Bacterial pH Requirements

Microbes have different optimum pH requirements:

Acidophiles: are organisms that grow at an optimum pH below 3–4.

Neutrophiles: They grow optimally at a pH within one or two pH units of the neutral pH of 7, between 5 and 8

Alkalinophiles: are a class of extremophilic microbes capable of survival in alkaline (pH roughly 8.5–11) environments, growing optimally around a pH of 10