

Growth and Shapes of Bacteria

Growth

Bacteria reproduce by **binary fission**, a process by which one parent cell divides to form two progeny cells. Because one cell gives rise to two progeny cell, bacteria are said to undergo exponential growth can be illustrated by the following relationship .:

Number of cells :	1	2	4	8	16
Exponential	: 2^0	2^1	2^2	2^3	2^4

Thus one bacterium will produce 16 bacteria after 4 generation. The generation time ranges from as little as 20 minutes for *Escherichia coli* to more than 24 hours for *Mycobacterium tuberculosis* .

The factors effect on bacterial growth including :

- 1- Bacteria species or strain.
- 2- Temperature.
- 3- pH value.
- 4- Nutrients.
- 5- Other environmental factors.

Growth Cycle

The growth cycle of bacteria has four major phase :

- 1- **Lag phase** : Metabolic activity occurs but cells do not divide. This can last for a few minutes to many hours.

- 2- **The log phase** is when rapid cell division occurs.
- 3- **Stationary phase** occurs when nutrient depletion or toxic products cause growth to slow until the number of new cells produced balances the number of cells that die.
- 4- **The death phase** which is marked by a decline in the number of viable bacteria.



Aerobic and Anaerobic growth

The bacteria cells classified into three groups according to response to oxygen:

- 1- **Obligate aerobes :** They require oxygen to grow because their **ATP-generating system** is dependent on oxygen as the hydrogen acceptor. For example : ***M. tuberculosis***.
- 2- **Facultative anaerobes :** They utilize oxygen if it is present, to generate energy by respiration, but they can use the fermentation pathway to synthesize ATP in the absence of sufficient oxygen. For example ***E. coli***.

- 3- **Obligate anaerobes bacteria** : The bacteria cannot grow in the presence of oxygen because they lack superoxide dismutase or catalase , or both. Obligate anaerobes vary in their response to oxygen exposure some can survive but are not able to grow, whereas others are killed rapidly.

Fermentation of Sugars

The term (**Fermentation**) refers to the breakdown of a sugar (such as **glucose** or **maltose**) to pyruvic acid and then to lactic acid. Fermentation is the process by which facultative bacteria generate ATP in the absent of oxygen.

If oxygen is present , the pyruvate produced by fermentation enters the **Krebs cycle** and is metabolized to two final products , CO₂ and H₂O . the Krebs cycle generates much more ATP than the fermentation occur in absent oxygen (**glycolytic cycle**).

Shapes and forms of bacteria

Bacterial cells differ in their shapes but usually three conventional shapes have been recognized. Initially the classification of bacteria was based on their shapes but now it is not used. The various shapes are as follows:

(1) Spherical / Cocci

The term cocci has originated from a Greek word; kokkos = grain or kernel. It is the simplest form of bacteria in which bacteria appears like a minute sphere (0.5μ - 1.25μ in diameter) they lack flagella. On the basis of arrangements cocci are further classified as follows:

i. Micrococci: When a bacterium appears singly e.g. *Micrococcus agitis*, *M. aureus*.

ii. Diplococcus: When they appear in a pairs of cells e.g. *Diplococcus pneumoniae*.

iii. Streptococci: When they appear in rows of cells or in chains e.g. *Streptococcus lactis*.

iv. Staphylococci: When they arrange in irregular clusters like bunches of grapes e.g. *Staphylococcus aureus*.

v. Tetracoccus: When they arrange in a sequence of four e.g. *Neisseria* and *Micrococcus tetragenus*.

vi. Sarcinae: When they arrange in cuboidal or in a different geometrical or packet arrangements e.g. *Sarcinae lutea*.

(2) Rod Shaped Bacteria or Bacillus

The word bacillus originated from Greek word, bacilli means rod or stick. Their ends are rounded flat or pointed. Their size ranges from 0.5-1.2 μ in diameter and 3-7 μ in length. They may be flagellated or non-flagellated. Most of the bacteria causing disease in plants belongs to bacilli category. They may be of following types:

(i) Monobacillus: When they arrange singly.

(ii) Diplobacillus: When they are present in a group of two e.g. *Diplobacillus pneumoniae*.

(iii) Streptobacillus : When they appear in chains e.g. *Bacillus tuberculosis*.

(iv) Palisade: Very rarely the bacillus arrange in a palisade arrangement.

(3) Spiral or Helical

The origin of word is from Greek word; spira means coiled. They appear like a cork screw. A single spirillum has more than one turn of helix. Generally they are found as free living, unicellular entity. Their size ranges from 10-50 μ in length and 0.5 - 3 μ in diameter. They are flagellated e.g. *Spirillum minus*, *S. volutans*.

(4) Vibrio or Coma

The bacteria of this group are like 'coma or small curved rod. They bear flagella at their end. Their size ranges from 1.5-1.7 μ in diameter and up to 10 μ in length e.g. *Vibrio cholerae*.

(5) Spirochaeta

These bacteria appears like a cork screw and atrichous. Their length is more as compared to their diameter. Their body is more flexible.

(6) Filamentous

These type of bacteria are generally found in sewage water and the water coming out from sugar industry or effluent of sugar industry e.g. *Sphaerotilus natans*. Basically they are rod shaped bacilli which grow in an elongated chain and are covered by a tubular envelope. Ferrous containing water generally contain filamentous bacteria e.g. *Leptothrix*, *Cladothrix*, *Nocardia* and *Beggiatoa*.

(7) Stalked

These bacteria are enveloped by an extra cellular structure which encloses the entire cell. This structure is known as prosthecae which is a slightly hard appendage appendicular structure. Because of the presence of Prosthecae they are known as prosthecate bacterium. These bacteria are classified in following two groups.

(a) The bacteria in which prosthecae does not take part in reproduction e.g. *Colobacter*.

(b) The bacteria where prosthecae participate in reproduction e.g. *Hypomicrobium*.

There stalk is about 20 μ in length and are formed in nutrient media rich in phosphate. The basal end of the stalk is either knobbed structure or sticky in nature. Many colobacter cells unite with their lower basal knob and arrange like the petals of a rose.

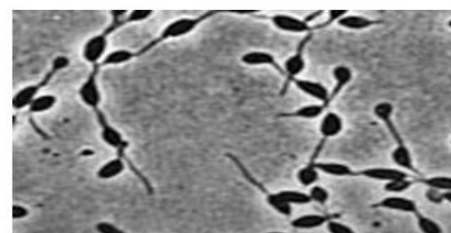
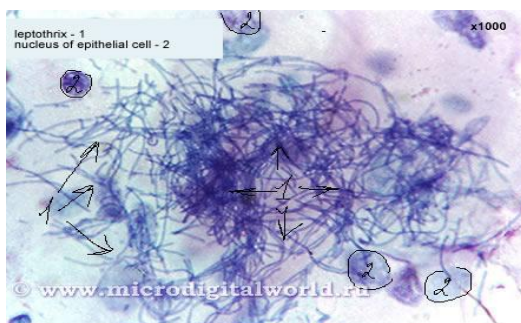
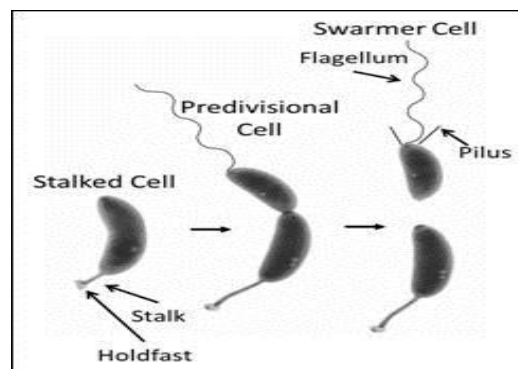
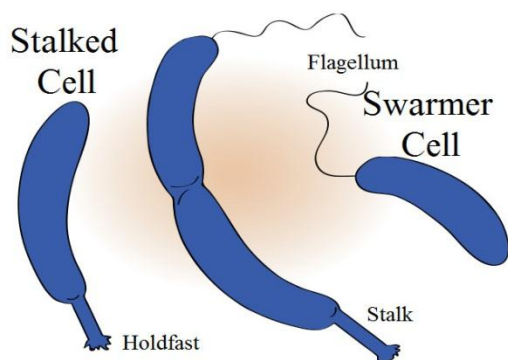
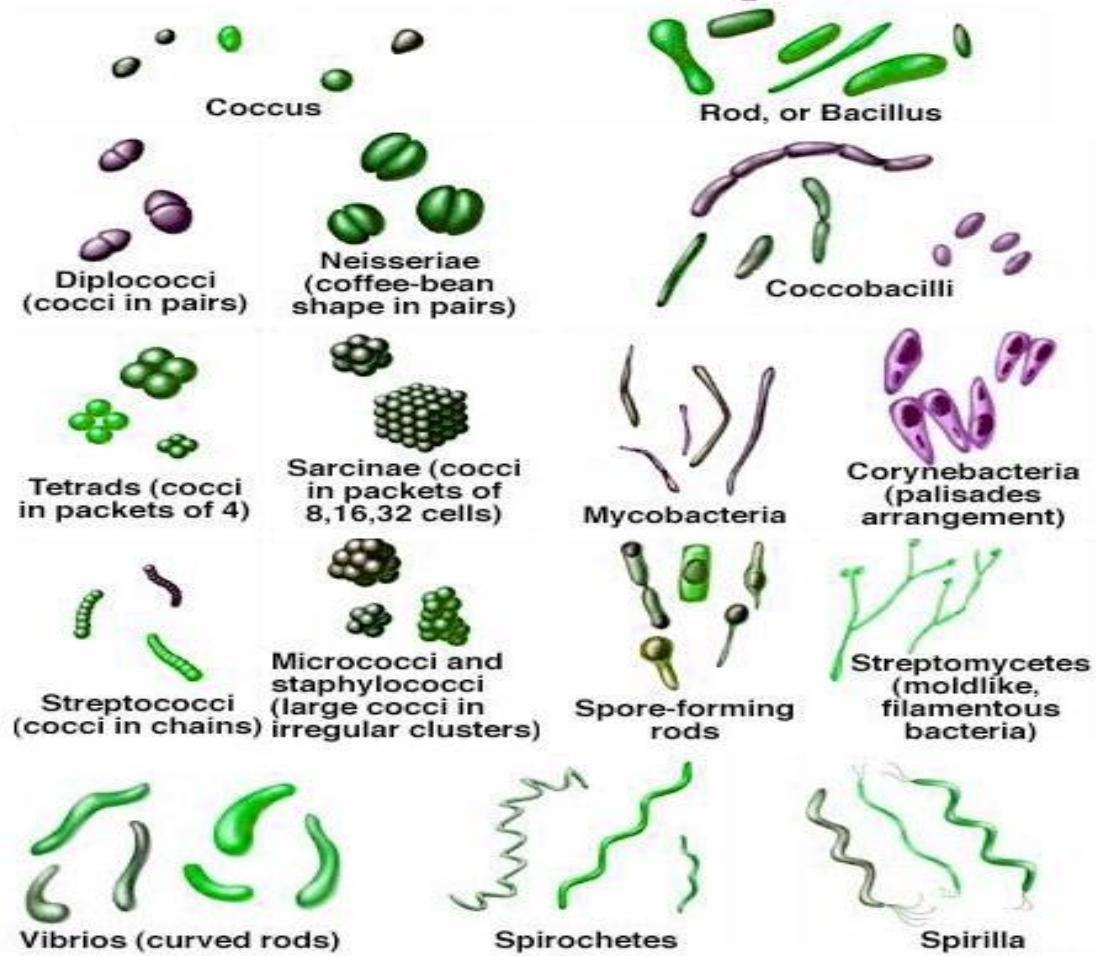
(8) Pleomorphic

Many bacteria change their shape and structure with the change in environmental conditions. These bacteria which are found in various forms are known as pleomorphic bacteria e.g. *Acetobacter*.

(9) Budding Bacteria

These are of football shaped structure with a swollen part and a thin tube. This tube gradually increases in size and its terminal end swells up to form new cell which is globular and ultimately a network of cell is formed e.g. *Rhodomicrobium*.

Bacteria Shapes



Pedunculada
(*Rhodomicrobium*)