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Bacteria: An Overview

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ABSTRACT

Background: Bacteria are very small, primitive, microscopic, mostly unicellular prokaryotes without chlorophyll-A. A Dutch man, Anton van Leeuwenhoek was the first to discover the bacteria on June 10, 1675, but he treated them as the animalcules (microscopic animals). The detail work of Louis Pasteur (1864) and Robert Koch (1876) highlighted the importance of bacteria. The bacteria are pathogenic in nature in case of plants, animals and human beings.



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Occurrence

The bacteria cause many diseases of plants, animals and human beings while many of them are highly beneficial. They are cosmopolitan in distribution. They are found to be occurring under all conditions and anywhere. They occur in air which we breathe, in water which we drink, in food which we eat, and any objects which we touch. They also occur in our mouth and intestines and found on all organic bodies living or dead. Most of them grow well in hot springs and in snow.

Systematic Position: They belong to the kingdom Monera which includes Archaeobacteria, Eubacteria, Cyanobacteria and Actinomycetes.

Forms of Bacteria

Spherical bacteria: The spherical bacteria are called as the cocci (singular coccus) bacteria. They are non-motile. The name Coccus is derived from a Greek word 'Kokkas' which means 'grains'. On the basis of arrangement and number of cells in a cluster, the cocci are of six groups such as:

1. Micrococci (Single): A single spherical bacteria.
2. Diplococcic: Spherical bacteria always occurring in pairs.
3. Streptococci: Spherical bacteria occurring in chain in a single row.
4. Tetrads: Spherical bacteria occurring in a group of four i.e. in a tetrad.
5. Staphylococci: A group of spherical bacteria forming irregular shapes.
6. Sarcina: The spherical bacteria arranged in cubes of eight.

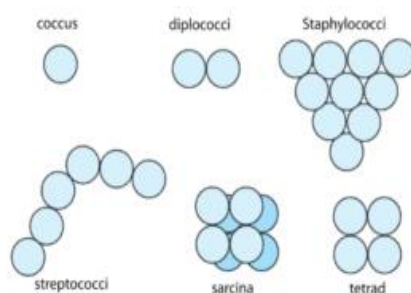


FIGURE NO. 1: SPHERICAL BACTERIA¹

Rod shaped bacteria: The rod shaped bacteria are called as the bacilli (singular bacillus). The name bacillus is derived from a Latin word 'Bacillum' which means 'stick' or rod. The bacilli bacteria are motile or non-motile. Flagella may or may not be present. On the basis of arrangement and number of cells in the cluster, the bacilli are of three types such as:

1. Monobacillus: A single rod shaped bacterium with or without flagellum.
2. Diplobacillus: Rod shaped bacteria always arranged in pairs.
3. Streptobacillus: Rod shaped bacteria occurring in chain in a single row.

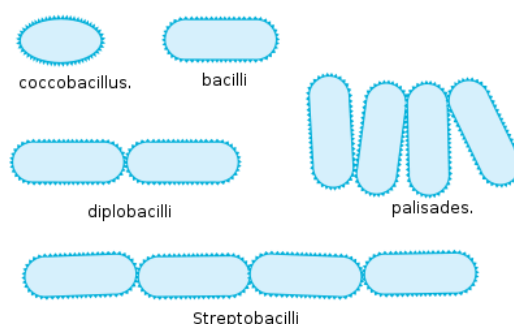


FIGURE NO. 2: ROD SHAPED BACTERIA²

Spiral or Helical or Spirillum Bacteria: The bacteria which are spiral or coiled in shape are called as Spirilli (singular spirillum). They are spirally coiled. They are with or without flagella.

Comma shaped or Vibrio bacteria: The small, comma shaped bacteria are called as the Vibrio. The vibrio bacteria are generally with a single flagellum.

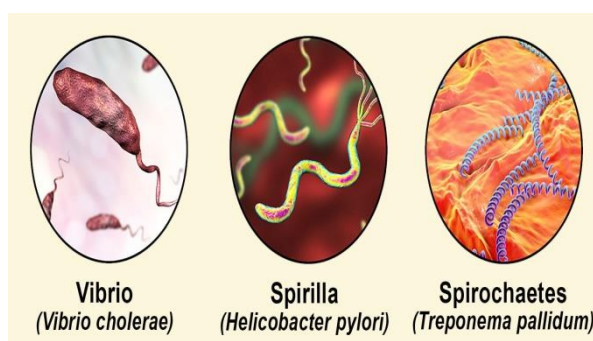


FIGURE NO. 3: SPIRAL AND COMMA SHAPED BACTERIA³

Flagellation in Bacteria

The flagella are fine hair like locomotory organs. They may be one to many. Each flagellum is single stranded made up of protein fibrils. Most of the bacteria, especially bacilli bacteria possess one of many whip like flagella on their surface. All the cocci and some bacilli are devoid of flagella. On the basis of number and distribution of flagella, the bacteria are of six types such as:

1. Atrichous bacteria: Flagella absent.
2. Monotrichous bacteria: Single flagellum on one side of the cell.
3. Amphitrichous bacteria: Single flagellum on either ends of the cell.
4. Cephalotrichous bacteria: A pair of flagella on one or both sides of the cell.
5. Lophotrichous bacteria: A tuft of flagella on one or both sides of the cell.
6. Peritrichous bacteria: Flagella distributed all over the cell surface.

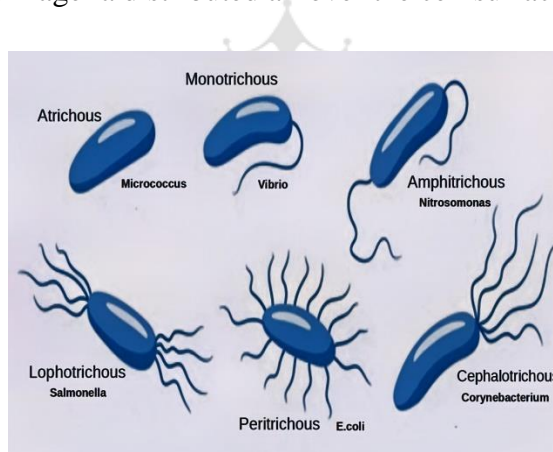


FIGURE NO. 4: FLAGELLA IN BACTERIA⁴

Mode of nutrition in bacteria

On the basis of mode of nutrition, there are two groups of bacteria such as Autotrophic bacteria and Heterotrophic bacteria.

Genetic material: The nuclear material or chromatin material or genetic material in the form of granules represents the nucleus. Recent studies reveal the existence of nucleotides in the centre of the cell in the cytoplasm. The nucleotides are made up of DNA which occurs in super coiled state. They are associated with RNA and Protein. DNA of *E. coli* is circular and

highly folded and occurs in the form of one or two stranded molecule. It is about 1000 μ long.

Reproduction in bacteria

Bacteria reproduce asexually and sexually.

Asexual reproduction: Asexual reproduction takes place by the binary fission and by the formation of endospores.

By binary fission: Fission or cell division is the most common method of asexual reproduction in bacteria. The fission takes place during the period of favourable conditions. The process of splitting of a bacterial cell into two new equal daughter cells is called as the binary fission. The binary fission is a common rule in bacteria.

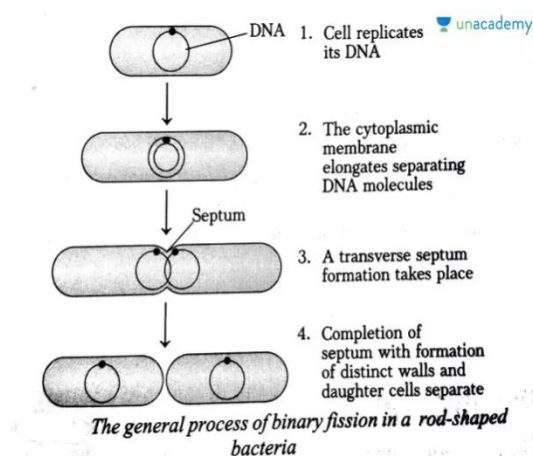


FIGURE NO. 5: ASEXUAL REPRODUCTION⁵

Sexual reproduction: The true sexual reproduction is absent in bacteria. It is because of the absence of the important steps of sexual reproduction the karyogamy and meiosis. However, the exchange of genetic material, the essence of sexual reproduction is reported through other methods. The exchange of genetic material or the genetic recombination in bacteria takes place by three different methods in different species of bacteria such as Transformation in *Streptococcus pneumoniae*, Transduction in *Salmonella typhimurium*, Conjugation in *E. coli*.

Transformation: Transformation may be artificial or natural. The artificial transformation is a process of uptake of a naked DNA molecule or fragment from the medium and the incorporation of it into recipient (F-) chromosome in a heritable form. In the natural

transformation, the DNA comes from a donor bacterium. The process of transformation was first reported by Frederick Griffith (1928) in *Streptococcus pneumoniae*.

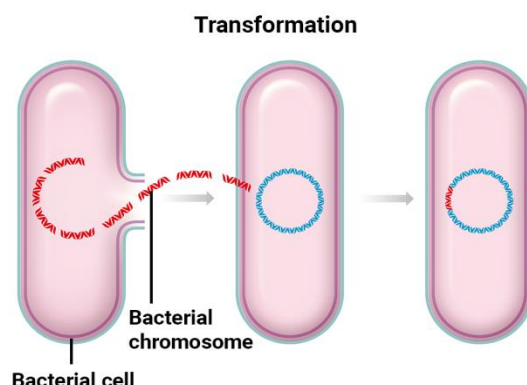


FIGURE NO. 6: TRANSFORMATION IN BACTERIA⁶

Transduction: It is the process of transfer of bacterial genetic material by the viruses. It was first discovered in 1952 by Lederberg and Zinder. During the process of transduction, a bacteriophage (virus) infects a bacterial cell and multiplies. During multiplication, the virus takes in a small piece of bacterial DNA. The virus with the bacterial DNA when infects another bacterial cell of the same species with opposite strain. The bacterial DNA from the virus gets transferred to it. This process of virus through transfer of genetic material from one bacterial cell to another is called transduction.

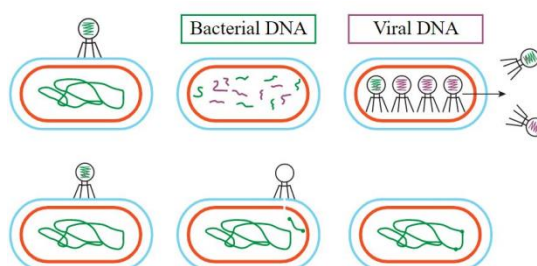


FIGURE NO. 7: TRANSDUCTION IN BACTERIA⁷

Conjugation: The exchange of genetic material through cell to cell contact is known as conjugation. The process of conjugation is first described by Lederberg and Tatum in 1946 in *E. coli*.

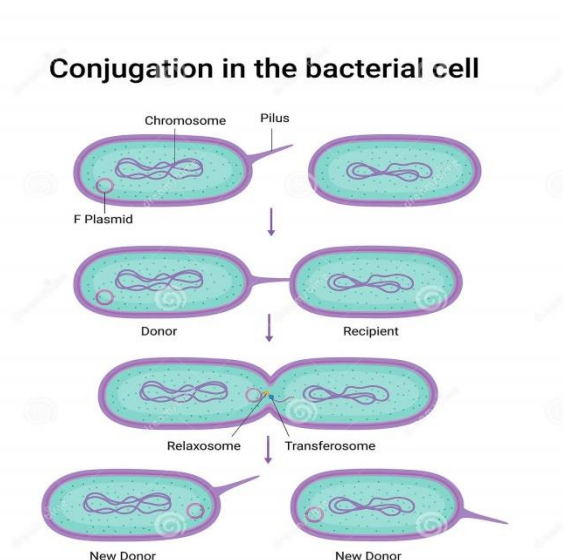


FIGURE NO. 8: CONJUGATION IN BACTERIA⁸

Economic importance of bacteria

The ammonifying, nitrifying and nitrogen fixing bacteria maintain nitrogen cycle in nature, fix the free nitrogen in soil and increase soil fertility by adding nitrogenous compounds. The bacteria like *Nitrosomonas*, *Nitrobacter*, *Rhizobium*, *Azotobacter*, *Azospirillum*, *Colsteridium*, *Rhodospirillum*, *Rhodomicrobium* and *Chlorobacterium* fix the atmospheric gaseous nitrogen into the soil and increase soil fertility. The Cyanobacteria like *Nostoc*, *Anabaena*, and *Oscillatoria* etc. are also capable of gaseous nitrogen fixation and help in increasing the soil fertility. The Cyanobacteria like *Nostoc*, *Anabaena* etc. commonly occur growing in paddy fields and increase soil fertility of the field.

Role of bacteria in industries

The bacteria play very important role in many industries. There are many industries which are based on the use of bacteria such as dairy industries, solvent industries, vinegar (acetic acid) industries, tobacco and tea curing industries and dextrin industries.

Dairy industries: Manufacture of milk products like butter, cheese, butter milk, involves the use of bacteria like lactic acid bacteria, *Lactobacilli* and *Streptococci*. These bacteria convert the lactose sugar of milk into lactic acid.

Solvent industries: Many species of *Clostridium* are used in the production of solvents like acetone, butanol and ethanol. The bacterium ferment sugars into butyric acid first, and then

the buteric acid is converted into butanol and acetic acid, the acetic acid converted into ethanol and acetone by the action.

Vinegar (acetic acid) industries: The bacteria like *Acetobacter* and *Clostridium* play very important role in acetic acid of vinegar industries. The bacteria convert alcohol into acetic acid or vinegar. For example if wine and beer exposed to air they get contaminated with these bacteria and turn sour due to the conversion of alcohol into acetic acid.

Tobacco and Tea curing industries: Curing of tobacco and tea leaves is generally done under the controlled activity of many bacteria.

Dextrin industries: Some species of lactic acid bacteria are used in the production of dextrin (polysaccharide of higher molecular weight).

Role of bacteria in medicines

The bacteria are the source of many medicines like antibiotics, serums and vaccines. The antibiotics are the chemical substances secreted by certain bacteria. The antibiotics inhibit the growth and development of other microbes. Many antibiotics are isolated from the bacteria like *Streptomyces* and *Bacilli*. Bacitracins, Polymixin-G & E, Trotrycin are some important antibiotics.

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