Bacterial Nutrition

Bacteria can be divided into two groups according to the source of energy and carbon needed for nutrition and build their organic matter:

First: Autotrophic Bacteria:

These bacteria obtain carbon from various inorganic materials such as carbon dioxide gas CO_2 and energy through the oxidation of inorganic matter or from light. They are also divided into two groups according to the source from which they obtain the energy needed to build their organic matter:

1- **Photosynthetic bacteria**:

These bacteria carry out photosynthesis, as they take the carbon they need from CO_2 or from organic materials in the medium such as acetate and alcohols, and derive energy from sunlight, while they derive the hydrogen needed to reduce carbon from inorganic compounds such as hydrogen, hydrogen sulfide and ammonia. However, these bacteria are distinguished from green higher plants in that they are anaerobic, and the photosynthesis process taking place in their cells is not accompanied by the release of oxygen. These bacteria possess different photosynthetic pigments (such as Bacteriochlorophyll) that enable them to absorb light energy and carry out photosynthesis in structures extending along the cell called pigment carriers. Such as Purple Sulfur Bacteria, which includes both the genera *Chromatium* and *Thiospirillum.* These bacteria derive the electrons needed to reduce CO_2 from hydrogen sulfide H_2S or thiosulfate $Na_2S_2O_3$ as in the equation:

$$6\,CO_2 + 12\,H_2S \longrightarrow C_6H_{12}O_6 + 12\,S\downarrow + 6\,H_2O$$

The sulfur released as a result of this reaction accumulates in the cell in the form of distinctive spots. The purple color of these bacteria is attributed to the abundance of the pigment **Spirilloxanthin**, which overpowers the green color of bacterial chlorophyll.

2- **Chemosynthetic Bacteria:**

These bacteria live in aerobic conditions, and produce their organic matter from the oxidation of various inorganic materials in the medium, deriving energy from them through the process of chemical synthesis, and taking carbon from CO_2 mainly.

According to the inorganic material that provides energy and hydrogen (electrons), these bacteria are divided into:

- **Nitrifying bacteria**: They live in aerobic conditions in the soil and work to oxidize nitrogenous compounds. This oxidation process takes place in close cooperation between two groups of bacteria, namely Nitrite Bacteria, which convert ammonium to nitrite, such as the genus *Nitrosomonas*, and Nitrate Bacteria, which convert nitrite to nitrate, such as the genus *Nitrobacter*.

$2\ NH_3 + 3\ O_2 \longrightarrow 2\ HNO_2 + 2\ H_2O$ + Energy (158 Kcal/ mol)

$2\ HNO_2 + O_2 \longrightarrow 2\ HNO_3$ + Energy (43 Kcal / mol)

These bacteria play a fundamental role in enriching the soil with nitrates, which are the most important source of nitrogen for higher plants. These bacteria are usually found in the soil alongside bacteria that decompose organic matter containing nitrogen, which releases ammonium from it.

- **Sulfur-oxidizing bacteria**: found in hot springs and factory purification tanks, and the most famous of its genera is *Thiobacillus*. These bacteria play an important role in oxidizing sulfur compounds, converting them into sulfuric acid.

$2H_2S + O_2 \longrightarrow 2\ H_2O + 2\ S$ + Energy (50 Kcal /mol)

$2\ S + 2\ H_2O + 3\ O_2 \longrightarrow 2\ H_2\ SO_4$ + Energy (119 Kcal /mol)

- **Iron-oxidizing bacteria**: These bacteria obtain the energy needed to reduce carbon dioxide and manufacture organic matter by oxidizing iron (II) compounds and converting them into iron (III), such as *Leptothrix* bacteria.

$4\ Fe^{+2} + 4\ H^{+} + O_2 \longrightarrow 4\ Fe^{+3} + 2\ H_2O$ + Energy (16 Kcal / mol)

Second: Heterotrophic Bacteria:

The vast majority of bacteria are heterotrophic, as they obtain the carbon and energy necessary for their nutrition and growth from various organic sources, and based on that they are divided into three main groups:

1- **Symbiotic Bacteria**:

These bacteria live in the cells and tissues of various living organisms that rely on the principle of symbiosis and mutual benefit. Such as *Rhizobium* bacteria that live inside nodules on the roots of legume plants. They work to fix atmospheric nitrogen gas and convert it into organic nitrogen that is beneficial to the plant, while obtaining shelter and food from the roots of these plants.

2- **Parasitic Bacteria**:

Also called pathogens, they live in the cells and tissues of different living organisms, deriving from them the organic matter necessary for their nutrition and growth, and at the same time causing many diseases for these organisms by secreting various toxins in the body of the host organism.

3- **Saprophytic Bacteria**:

These bacteria live outside the bodies of living organisms and obtain the organic matter necessary for them from non-living organic materials such as the remains of organisms and food materials. These bacteria are responsible for the decomposition of the bodies of dead organisms and the spoilage of food.