Bacteria

Bacteria knowledge

Biology

Bacteria or prokaryotes are the most common living beings on Earth: one spoonful of soil can contain, for instance, up to 10,000 billion bacteria. They are unicellular organisms, i.e. they consist of one cell only. They are very small in size, since a large part of bacterial cells have a diameter of 1 to 10 microns (one micron equals one thousandth of a millimeter), so an orderly row of one thousand bacteria would be just one millimeter long. Bacterial cells, unlike the cells of superior organisms (eukaryotes), do not have organelles enwrapped in membranes (nucleus, Golgi apparatus…) or chromosomes. Chromosomes are structures made of DNA wrapped around proteins, called histones, and their purpose is to make the long DNA molecules contained in the nucleus more compact and orderly.
Chromosomes are essential since they arrange the large amount of genetic material contained in eukaryote cells: if, for instance, the DNA contained in just one human somatic cell were unwrapped, the resulting molecule would be approximately two metres long! In bacteria, instead, the DNA is not contained in a nucleus and is round in shape.
Another specific feature of bacteria is their protective structure (the wall) that enwraps and encloses the whole cell. The cellular wall is composed of proteins and sugars and, as well as protecting the micro-organism, it puts the cell in contact with the external environment and the other bacterial cells.

Many shapes for bacteria

Bacteria are classed by shape, feeding method, metabolism and wall features. Different forms of cells can be observed under the microscope. **Cocci** (from the Greek berries) are round in shape; when clustered together, they are called staphylococci, while when gathered into chains they are called streptococci. Rod-like prokaryotes are called **bacilli**. Bacilli can usually be found as separate cells, but sometimes they can be found in pairs (*diplobacilli*) or chains (*streptobacilli*). Other bacteria are bent in shape or look like a squat spiral. The former are called vibriones, while the latter are called **spirilla**. Finally, bacteria that look like a long and flexible spiral are called **spirochetes**. Spirochetes include some “giant” bacteria that can be up to 0.5 mm long, i.e. 500 times bigger than an ordinary prokaryote cell. .

Autotrophic or eterotrophic bacteria

Depending on the way they take the two essential resources for their survival, energy and carbon (which they need for synthesising organic substances), bacteria can be classed as autotrophic or heterotrophic. **Autotrophic** prokaryotes can synthesise organic molecules from inorganic molecules, such as carbon dioxide. The energy needed for the synthesis can be supplied by light or other chemicals. The bacteria that, like plants, use solar energy are called **photoautotrophic**, while those that take energy from chemical reactions are called chemoautotrophic. Bacteria that need to feed on already synthesised organic molecules, as all animals do, are called **heterotrophic**. These bacteria can feed on virtually anything.

Some need oxygen, other do not

The word **metabolism** refers to those biochemical reactions that are vital for life and continuously occur inside the cells of each living being. Some of these reactions can only occur if there is oxygen. Some others, instead, do not need it. **Aerobic** bacteria are those bacteria that, like animals, “breathe oxygen”. **Anaerobic** bacteria are those bacteria that can live in an environment without this gas.
Bacterial reproduction is asexual: it occurs by fission and not through the exchange of genetic material between two individuals of a different sex. Each bacterial cell divides itself to originate two identical cells that, in their turn, divide

themselves into two other identical cells, and so on. A single cell is able to generate, in a short time, colonies of bacteria that are be made up of millions of cells.

Nitrogen fixers

Nitrogen is important for all organisms since it is one of the components of proteins and nucleic acids (DNA).
Most living species cannot directly absorb nitrogen from the atmosphere, of which this gas is the largest component (78%). Only some bacteria can transform gaseous nitrogen into compounds that can be absorbed by the other living beings (especially vegetal organisms) through a series of metabolic reactions that are jointly called “nitrogen fixation”. Nitrogen, included in more complex molecules, such as ammonia and nitrates, is part of the food chain. The most important nitrogen-fixing organisms are *cyanobacteria*, also known as blue algae, which live in water. On the mainland, this function is mainly served by the *Azotobacte*r that live son earth and by the *Rhizobium* that lives in symbiosis in the roots of the plants of the genus *Leguminosae* (bean, lentil and clover).

Decomposers

Bacteria are among the main decomposing organisms, i.e. they degrade organic substances and release in the environment simple molecules that can be used by the other living beings. They play an essential role: without decomposers, the substances that make life possible would no longer be available in the environment. Some bacteria, the nitrifying ones, demolish proteins and release nitrogen-rich compounds, others release phosphor, sulphur and other useful substances.

Bacteria and digestion

The human gastrointestinal apparatus can contain on average 300-500 different species of bacteria that are jointly referred to as the “intestinal bacterial flora”. Most bacteria are located in the colon, while very few are in the stomach and in the first part of the intestine, because they contain corrosive substances (acids, bile and pancreatic secretions) which make these habitats inhospitable for micro-organisms. The colonisation of the intestine starts at birth and takes a few days. The bacterial flora is composed of anaerobic and aerobic bacteria. The first group includes such bacteria as bifidobacteria, eubacteria, clostridia and peptococci. Anaerobic bacteria include, among others, escherichia, enterobacteria, enterococci, klebsiella, lactobacilli and proteus.
The intestinal bacterial flora serves different important functions:
- it protects the organisms from the attack of harmful micro-organisms,
- it breaks food into microscopic particles to supply the organism with vitamins, mineral salts and all the micro-nutrients it needs,
- it produces vitamin K, which is important for blood coagulation, the liver and bone calcification
- it produces vitamin B12, which is important for cell reproduction and the synthesis of haemoglobin
- it makes hard-to-digest foods, such as vegetables, digestible.

The bacterial flora of the intestine is weakened by some drugs, such as antibiotics. This is why antibiotic treatments are often associated with milk enzymes (which are among the main components of the bacterial flora), which restore the correct balance of these small and precious allies.

The bacteria of the rumen

Herbivores cannot directly absorb the vegetables they feed on, but they can through the action of the bacteria that colonise their digestive apparatus. Cattle chew vegetables for a long time and accumulate them in large amounts in the rumen, which is the first part of their stomach. In this hot, very humid place, bacteria quickly develop and attack the vegetal fibres. In so doing, the bacteria release the nutrients contained in these vegetables, which are then absorbed by the intestine. Horses do not have a rumen, but they host these precious bacteria in their long intestine.

Anywhere in the world

Bacteria live anywhere, even in the most extreme environments where no other form of life could survive. They can be found in the ocean depths, in the desert, in the hot waters of volcanic springs, inside rocks, in the frosty soil of the permafrost and even in environments so acidic they could destroy any other form of life. Many bacterial species live inside or on other organisms as symbionts or parasites. Symbiosis is an association between two or more species, which benefits each component; conversely, in parasitism only one of the members benefits from the association (the parasite), while the other (the host) is damaged by it.
Our body too is inhabited by very many species of bacteria. Every square centimetre of our skin is populated by thousands of bacterial cells that reproduce endlessly. Our gastrointestinal apparatus contains up to 500 different bacterial species, mostly living in the colon.

The first organisms

Bacteria have been the very first organisms to live on Earth. They made their appearance 3 billion years ago in the waters of the first oceans. At first, there were only anaerobic heterotrophic bacteria (the primordial atmosphere was virtually oxygen-free). The first autotrophic bacteria, very similar to the current cyanobacteria, appeared approximately 2 billion years ago. Photosynthesis occurred in these organisms and this is how the atmosphere was enriched with precious oxygen. Cyanobacteria or blue algae made the primitive atmosphere breathable and allowed life to colonise the lands above sea level.
Man has just recently become aware of the existence of bacteria because they were too small to be observed or studied before the microscope was invented.