Occurrence and significance of bacteria in nature

Basic characteristics of bacteria

Bacteria are classified as unicellular prokaryotic organisms. The field that deals with their study is called bacterology. Bacteria are among the most widespread microorganisms on the planet, they are ubiquitous and can survive in such extreme conditions where other organisms die. It forms an important part of the biosphere - about half of the living matter on Earth. We observe their occurrence mostly in the soil and in the aquatic environment, they inhabit the bodies of other organisms, humans, plants and animals, we find them in food, dust particles, etc. They are abundant in the air, in which they also spread. Their number varies in different areas.

Typical orders of amount of bacteria found in some environments

Environment	Amount of bacteria
Stool of a healthy person	10^9/g
Cultivated land	10^8/g
Human saliva	10^8/ml
Drinking tap water	10^2/ml
Drinking water from a well	10^3/ml
Air - surgical rooms	10^2/m³

Bacteria differ in the different demands on the environment they inhabit - an important parameter is the oxygen content, acidity, temperature, humidity, hydrostatic and osmotic pressure of the environment. Some species of bacteria are so specialized that they can adapt and survive in very extreme conditions, such as the upper atmosphere, boiling water, volcanic lakes, Antarctica and salt lakes. The environment in which these microorganisms live is the main source of nutrients that they decompose. From the decomposed substances, they use carbon and nitrogen to make proteins, nucleic acids and polysaccharides, which they use to build their cells. They are the only group of organisms in which we encounter a**ll the main types of energy production and carbonaceous nutrition** (photoautotrophic, photoheterotrophic, chemoautotrophic, chemoheterotrophic). From a complex point of view, living nature is in dynamic equilibrium and is characterized by the cycle of matter in a closed cycle. The individual parts of this system form interrelated relationships and functional ties. Thanks to this, nature develops and cooperates as a whole, and bacteria are of irreplaceable importance here not only for the cycle of substances, but also as symbiotic mutually beneficial organisms, or as a means of production in biotechnology. Then we can include bacteria causing various diseases and, last but not least, bacteria involved in the decomposition of dead organic matter (destruents). Hydrolytic bacteria are responsible for the hydrolysis of organic matter.

Soil

In nature, bacteria mostly colonize the soil. They form communities involved in metabolism and thus affect soil fertility. They can **decompose** (mineralize) the remains of plant and animal bodies and transform them into substances usable by higher plants.

Furthermore, these microorganisms are involved in **the nitrogen, carbon and sulfur circulation**. Bacteria that feed on the proteins of plant tissues and tissues are called saprophytic. During the breakdown of proteins, ammonia is released, which is oxidized in the form of ammonium salts by nitrifying bacteria to nitrite and nitrate, which the plants use as a source of nitrogen nutrition. Nitrogen-binding bacteria - *Azotobacter*, tuberous bacteria - also play a role in the nitrogen cycle in the soil.

Air

Bacteria enter the air from the soil through the **wind**, which carries dust particles containing these microorganisms. There are far more bacteria above the land (dry atmosphere) than above the sea (humid atmosphere) because the bacteria are knocked to the ground by raindrops.

Most bacteria occur above **industrial areas** due to the high concentration of dust. On the contrary, we find far fewer bacteria over villages and uninhabited areas. Bacteria are almost non-existent above snow-covered areas, except in industrial areas (e.g. air over Antarctica).

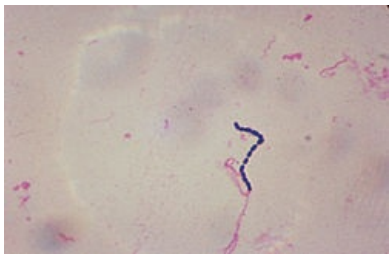
In **rooms with a large concentration of people** (cinemas, theaters, schools, railway stations) dust swirls with a lot of bacteria. Unlike outdoor air, indoor air contains more bacteria in winter than in summer. Saprophytic bacteria predominate in the rooms and we can also find pathogenic microorganisms there. In the rooms, people are a constant source of bacteria in the air, who, by talking, coughing and sneezing, permanently excrete bacteria in the droplets of saliva and mucus. Dried droplets form infectious dust, and swirling can infect anyone who inhales this dust.

Water

Due to the absence of organic matter in spring waters and mountain streams, there is a very low presence of bacteria. We consider unhealthy water to be polluted by sewage and industrial wastewater. Some infectious diseases are transmitted through this water - eg dysentery, typhus, cholera.

Seawater contains bacteria at all depths, but most are located near the coast in polluted areas. Less at greater depths and in the open ocean.

Human body and organisms



Streptococcus

Bacteria inhabiting organisms are distinguished according to their relationship to their host into **symbiotic** (mutually beneficial), **pathogenic** (causing diseases) and those that l**ive with the organism and do not affect it in any way**.

Skin and mucous membrane

In the human body we find a rich microflora on human skin and mucous membranes, which are in **direct contact with the external environment.**

The skin is not a suitable environment for the development of bacteria due to drying out. Every cavity and every part of the body surface has its own characteristic microflora, which is inherent in a person throughout life. Due to their moisture, there are only certain places on the human body that can multiply bacteria, namely: **hair, face, ears, armpits, urinary tract, rectum and toes**.

Skin gland secretions contain significant amounts of nutrients for bacteria, such as urea, amino acids, salts, lactic acid, and lipids, which they break down to form foul-smelling products. The skin reaction is always acidic - it ranges from pH 4-6. Mainly staphylococci, micrococci and bacteria, which decompose fatty acids, break down fats, cause unpleasant odors.

The skin of the human fetus in the uterus is sterile and bacteria begin to colonize it only at birth - the main source of microflora is the mother, air and objects with which the fetus comes into contact. The newborn's skin is more prone to infections caused by staphylococci and other pathogens, because it does not have a far-developed normal microflora that would compete with these pathogens.

Mouth

The mouth creates a **warm and humid environment** conducive to bacterial colonization. The source of nutrients here are saliva containing proteins and other substances. The microflora in the mouth depends on the condition of the teeth - a toothless mouth differs in its microflora from a mouth with teeth.

In infants up to one year of age, we mainly observe streptococci and lactobacilli. As teeth grow, the microflora varies from aerobic to anaerobic bacteria. Bacteria capable of surviving on the surface of the teeth and in the folds of the mucosa develop mainly. **A thin film** forms on the surface of the teeth, so tightly settled that it cannot be removed even by cleaning with a toothbrush. This film contains mainly **gram-negative filamentous anaerobic bacteria fermenting sugars to lactic acid**. Streptococci, micrococci and others live in the community with these bacteria.

Lactic bacteria (**lactobacilli**) play a negative role in the oral cavity because they form lactic acid from sugars, which causes **decalcification of tooth enamel**, and this leads to the formation of **tooth decay**. All organisms living in the oral cavity are normally harmless, but when the mucosa is damaged, they penetrate the tissue and cause disease.

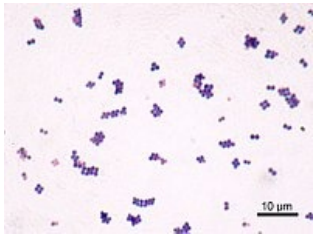
The microflora in the oral cavity is significantly affected by smoking - direct and indirect. A study looking at the effect of smoking exposure on the state of the microflora in the mouth found that smokers have fewer aerobic and anaerobic organisms in the oral cavity with the ability to positively affect the environment, but have more potential pathogens compared to non-smokers. A high number of pathogens are found in the nasopharynx of smokers - this condition will return to normal after smoking is completely stopped. The flora in healthy children of smokers' parents contains a high number of potential pathogens similar to those of their parents. A high level of agreement was observed between the pathogens of smokers' parents and their children. Parents and smokers hide more potential pathogenic microorganisms, which can further serve as a source of infection - they can colonize or infect children. These studies demonstrate the detrimental effect of direct or indirect smoking on colonization of the mouth by potential pathogens.

Respiratory tract

With each inhalation, a large amount of dust particles containing settled bacteria enter the airways and these settle in the airways - in the **nasopharynx** and **bronchi**.

In healthy people, the bacteria are not present in the lungs, because most of them stick to the mucus secreted by the mucous membranes of the airways, which prevents them from penetrating further into the lungs.

On the contrary, the **oral cavity and nasopharynx are abundantly populated by bacteria**, both non-pathogenic and pathogenic - staphylococci, streptococci, micrococci. These similar bacteria are also found on **tonsils** (in infectious diseases, tonsils are usually enlarged and painful).



Staphylococcus aureus – Gram stain

Gastrointestinal tract

The gastrointestinal tract is the primary site of digestion, which begins in the mouth and continues into the stomach and intestines.

Due to its high acidity, the **stomach** acts as **the first line of defense** against the penetration of unwanted microflora into the intestines. Despite the low pH, bacteria occur in the stomach (mainly acid-tolerant lactobacilli and streptococci). These appear in the stomach of the newborn the first week after birth.

Escherichia coli is one of the best known colonic bacteria. It ferments a variety of sugars to form lactic acid. It also participates in the production of B vitamins and substances with antibiotic effect. This also affects the other bacterial flora of the intestine. We find not only this bacterium in the intestine, but also others. Their quantity and species representation depends on the age of the person, the composition of the food, its condition and health. However, the bacterial flora of the intestine is most affected by nutrition. In healthy individuals, there is a natural balance in the gut between different types of bacteria. This is disrupted by the administration of antibiotics or a radical change in nutrition. Inadequate nutrition allows the development of unwanted bacteria, which leads to significant damage to the digestive process and intestinal problems (they last until the natural bacterial microflora is restored). Bacteria make up about a third of the weight of feces.

Urogenital track

Of the urinary tract, only the anterior part of the urethra is normally populated, which must be borne in mind when examining urine, as these bacteria cause normal contamination of the samples taken.

There are similar settlements on the female external genitalia as on the skin, mainly gram-positive cocci (Staphylococcus epidermidis, Enterococcus faecalis, Sarcina) and Candida. The colonization of the vagina changes during life, which is related to the action of hormones. In newborns, the vagina is inhabited by lactobacilli, in childhood the flora is similar to the external genitalia. From puberty, lactobacilli begin to predominate, fermenting glycogen and lowering the pH, which greatly limits colonization by other bacterial species. If the pH increases due to hormonal changes, there is a possibility of colonization by other types of bacteria. In some cases, the vagina can be colonized by Streptococcus agalactiae, which has no health consequences for the woman herself, but can give birth to a newborn at birth.

The presence of pathogenic bacteria in organisms can cause the development of bacterial infections, which are caused by the entry and multiplication of bacteria in the host organism. The result of this process is a disease that can manifest itself or occurs without obvious symptoms.

Use of bacteria in industry

Bacteria are not only pathogenic microorganisms for humans, but can be beneficial to them in many ways - for example in the **food industry**, the **pharmaceutical industry**, **genetics**, etc.

We use **lactic acid** bacteria in industrial production to produce lactic acid due to their ability to **ferment** some carbohydrates into lactic acid. **Butter bacteria** ferment sugars into butyric and acetic acid. Butyric acid is then fermented to butanol and acetone, which we use in the industry to prepare these substances. We use bacterial cultures in the production of **cheese** (maturing) and also for **fermenting milk** (this creates kefir). Some bacteria are able to synthesize **vitamins** and **amino acids**. In industry, we cultivate these bacteria in tanks, where we maintain a suitable environment for the production of these substances. Contaminated water is the nutrition (carbon or energy source) for bacteria, which we use to treat wastewater. Some bacteria, in turn, have the ability to produce antibiotics. To produce acetic acid, we then use acetic bacteria, which produce it from ethanol.

Bacteria can help us in **genetic engineering** due to the fact that they contain a small amount of DNA - **plasmids**. We isolate plasmids from the bacteria, attach parts of the DNA from the chromosomes of animals and plants to them, and use them to produce proteins that the bacteria themselves are unable to produce. In this way, for example, insulin and other important substances can be synthesized with the help of bacteria. Abroad, they produce **insulin** and **growth hormone** in this way.

Summary

There are hundreds of thousands of bacteria, of which only 5,500 species are described in detail. However, from a medical point of view, only a fraction of this number is important, especially those that can colonize the human body, whether physiologically or species that are involved in the development of various diseases. At present, bacteria are also widely used in industry, namely in agriculture, food, pharmaceutical or chemical. They have also found application in genetic engineering.

Links

Related articles

- Bacteria
- Escherichia coli
- Staphylococcus species
- Streptococcus species

Bibliography

- ROSYPAL, Stanislav. *Bakteriologie a virologie.* 1. v ČR edition. Praha. 1994. ISBN 80-85827-16-6.
- BETINA, Vladimír – NEMEC, Pavel. *Všeobecná mikrobiológia.* 1. edition. Bratislava : Alfa, vydavatelstvo technickej a ekonomickej literatury, 1977. ISBN 80-227-0576-4.
- KAPRÁLEK, František. *Fyziologie baktérií.* 1. edition. Praha : Státní pedagogické nakladatelství, 1986. ISBN 80-7184-811-5.
- BEDNÁŘ, Marek – SOUČEK, Andrej – FRAŇKOVÁ, Věra. *Lékařská mikrobiologie : Bakteriologie, virologie, parazitologie.* 1. edition. Praha : Marvil, 1996. 558 pp. ISBN 80-238-0297-6.