

Topic: Bacteria & Human health  
B.Sc. Botany (Hons.) I  
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Bacteria are found all around us; in the air we breathe, in the soil and water, even inside and on our bodies. They are tiny single-celled organisms, only a few micrometers in size, and the individual cells can only be seen under a microscope.

On some surfaces, for example when grown on agar plates in the laboratory, bacteria can form colonies that can be made up of several hundred thousands of cells and thus are visible to the eye.

### **Bacteria in relation to human**

Bacteria multiply fast and can quickly reach large populations. Some fast growing species like *Clostridium perfringens* and *Escherichia coli* can double every 15 to 20 minutes in favorable environments. Here is a theoretical example to demonstrate how fast bacteria grow in relation to man.

Bacteria	Man
100 generations $\approx$ 24 hours	100 generations $\approx$ 2,000 years
1000 generation $\approx$ 10 days	1000 generations $\approx$ 20,000 years

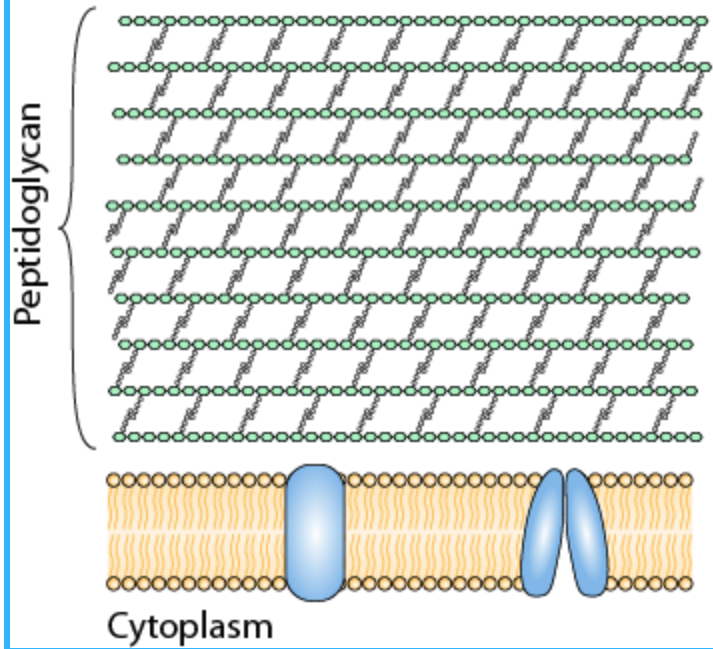
## Gram-positive and Gram-negative bacteria

Bacteria can be broadly categorized into two groups: Gram-positive and Gram-negative bacteria, based on the structure and composition of the cell wall and membranes surrounding the bacterial cell.

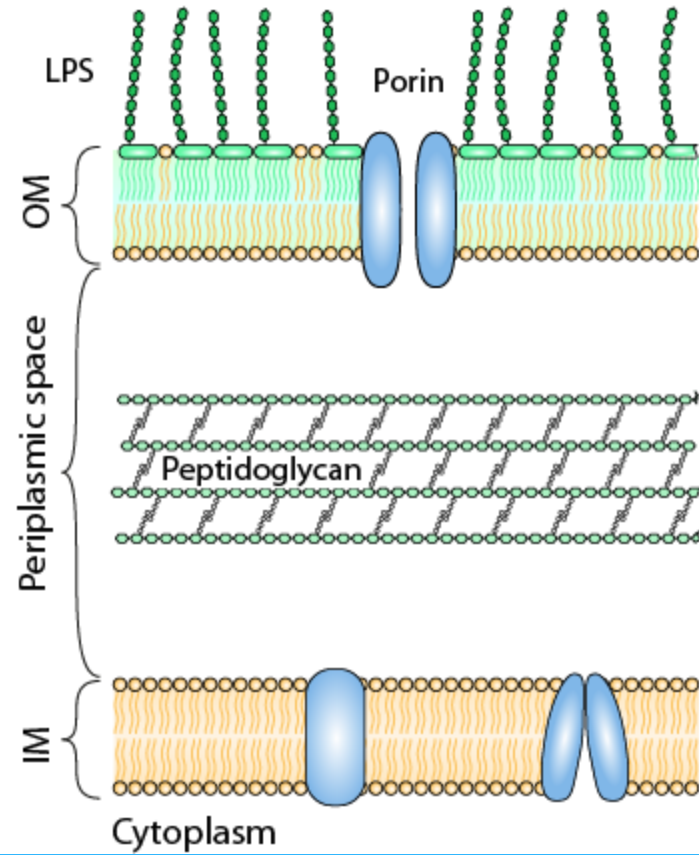
This classification is named after the Danish scientist Hans Christian Gram who developed a staining method for bacteria. Depending on how different colored stains enter and remain in the bacterial cell wall after treatment, bacteria are stained purple (Gram-positive bacteria) or pink/red (Gram-negative bacteria), which can be seen under the microscope.

The structure of the cell wall is one of the factors that influences bacterial susceptibility to different antibiotics. *Staphylococcus aureus* and *Streptococcus pneumoniae* are examples of Gram-positive bacteria, while *E. coli* and *Salmonella typhimurium* are examples of Gram-negative bacteria.

## Gram-positive bacteria



## Gram-negative bacteria



The first thing to learn about bacteria is that most are beneficial and do not cause disease. They play essential roles in many environments, including the human body.

### **The microbiota**

An adult human is colonized with many hundreds of bacterial species, and the total microbial biomass in an average adult is approximately 0.2 kg<sup>1</sup>. Bacteria and other microorganisms in the body make up the human microbiota or normal flora. The majority is located in the gastrointestinal tract, but all surfaces in contact with the environment are colonized, that is, the skin, upper respiratory tract and genital tract.

### **Most bacteria are good for us**

The bacteria in our bodies help degrade the food we eat, help make nutrients available to us and neutralize toxins, to name a few examples<sup>1</sup>. Also, the microbiota play an essential role in the defense against infections by protecting the colonized surfaces from invading pathogens.

Recent years have seen an increase in the studies of microbes in the body and their genomes (DNA). It is becoming more and more evident that these microbes are important for human health, but also disease. Inflammatory bowel disease, gastric ulcers, colonic cancer and obesity are examples of conditions for which the composition of the microbiota has been indicated to play a role

Apart from the human microbiome, microbiomes are also found in for example animals, different habitats on Earth and even the Earth as a whole. Animals, like humans, have microbiomes that are essential for their lives and functions. The most influential bacteria for life on Earth are found in the soil, sediments and seas. Well known functions of these are to provide nutrients like nitrogen and phosphorus to plants as well as producing growth hormones. By decomposing dead organic matter, they contribute to soil structure and the cycles of nature.

## **Bacterial infections have played a central role in the lives and deaths of humans-**

Bacteria cause many common infections such as pneumonia, wound infections, bloodstream infections (sepsis) and sexually transmitted diseases like gonorrhea, and have also been responsible for several major disease epidemics. One example is the plague, also known as the “Black death”, that spread across Asia and Europe along the trading routes, killing millions of people. The disease is now known to be caused by the bacterium *Yersinia pestis* and is treatable by antibiotics.

Bacteria can be strictly pathogenic, which means that they will cause disease if they manage to overwhelm the human immune system. Other bacteria only cause disease given the right circumstances, these are so-called opportunistic pathogens. Opportunistic pathogens normally do not cause infections in healthy humans but when the immune system is compromised or suppressed by for example cancer chemotherapy, other diseases (like HIV/AIDS) or malnutrition, the risk of infection increases. These infections often originate from the individual’s own bacterial flora such as that on the skin or in the

gut. Many bacterial pathogens can spread and infect via water and food, including *Salmonella*, *Campylobacter* and *E. coli*. Sometimes bacteria are transmitted directly or indirectly from animals to humans and cause disease. Such infections are called zoonotic infections. Other bacteria like *Neisseria gonorrhoea* and *Chlamydia trachomatis* spread via sexual contacts.

### **Bacterial infections**

The introduction of antibiotics to treat bacterial infections in combination with improved hygiene and sanitation, use of preventive vaccinations as well as increased knowledge about bacteria have greatly reduced deaths from bacterial diseases. However, antibiotic resistance among bacteria is now threatening to again leave us without effective treatments for many common bacterial infections. Resistant bacteria are now widespread in most parts of the world and more and more people die from bacterial infections because the antibiotics have stopped working.



## Identifying the disease

Diagnostics are used to determine what disease a patient is affected by, and in the case of infectious diseases what is causing the disease. This information is then used to determine what the appropriate therapy is: for example a specific antibiotic, other medicines or bed rest. In the absence of a proper diagnosis many patients may not get the correct antibiotic treatment when they need it, but another common problem is that patients who do not need antibiotics are given one just in case it is a bacterial infection.