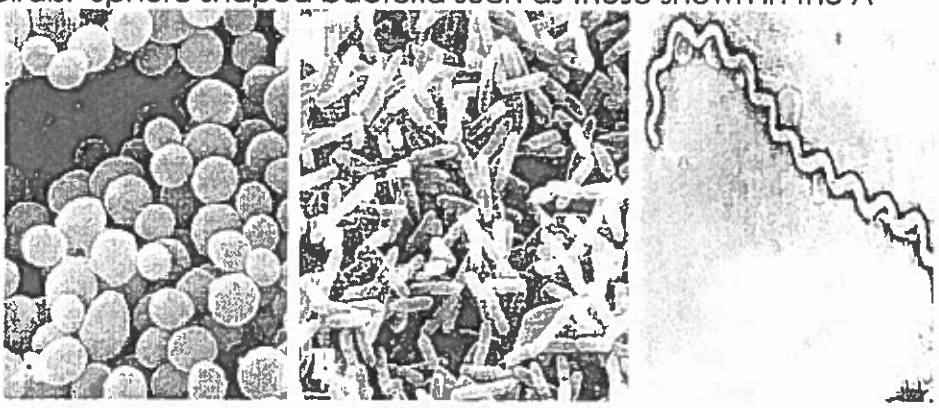
Classification of Bacteria

Eubacteria can be classified several different ways. Bacteria can be grouped by shape, by energy source, and by membrane structure.

1. By Shape

The first way we will classify them is by shape. The three most common shapes are spheres, rods and spirals. Sphere shaped bacteria such as those shown in the A section of the photo to the right are called **coccus** (pl. is cocci) bacteria. They usually have coccus in their name like streptococcus. Another group in the shape classification system is the **bacillus** (bacilli =plural). These bacteria are rod shaped. These bacteria are pictured above in B. The third group is the **spirillum** (spirilla plural). These are the corkscrew shaped bacteria. These bacteria are pictured above in C.



Because scientist wished to give as much information as they can when naming bacteria, scientist use their shape as well as if they are found in pairs, chains, or clusters.

If they are found in pairs, adding the prefix **diplo-** to their shape forms the name. An example is diplococci (a sphere shaped bacteria that is found in pairs).

If the bacteria are found in chains, the prefix **strepto-** is added to their shape (ex. streptococci = long chains of sphere shaped bacteria).

Bacteria that are found in grapelike clusters have the prefix **staphylo-** added to their shape (ex. staphylobacilli = grapelike clusters of rod shaped bacteria).

2. By cell walls makeup

The second way to classify bacteria is by the structure of their cell walls. Bacteria cell walls come in three varieties, **gram +, gram -**, and **mycoplasmas**. It would seem not all cell walls are created equally. The differences in what makes up the cell wall can be shown by a procedure called gram staining.

The steps in the gram staining procedure are:

1. Bacteria are stuck to a slide
2. They are stained with a purple dye solution called **crystal violet**.
3. The purple dye is washed off with water
4. A solution of iodine is added to the slide.
5. The bacteria are rinsed with alcohol and then restained with a pink dye called **safranin**.

Bacteria with a thick outer layer with protein in it in their cell walls will stain purple and are called **gram positive**. **Gram-negative bacteria** have cell walls that are made a

weird lipid outer layer. The lipoprotein layer does not hang onto the purple stain so it gets washed away. This layer, however, does hand onto the pink safranin so gram-negative bacteria appear pink after gram staining.

The third type of bacteria does not have cell walls at all and are called **mycoplasmas**. Instead of cell walls, these bacteria have a triple layered membrane made of lipids. These organisms are considered the simplest of the simplest organisms. Scientist think the first organisms on earth were very much like. These bacteria cause certain types of pneumonia in humans and cattle. The problem with mycoplasmas is penicillin doesn't work on them. Penicillin kill bacteria by stopping the growth of the cell wall. That doesn't work with these little charmers since they do not have a cell wall. If you get a type of pneumonia that is caused by a mycoplasma, you will just have to get over it.

3. By how they get their energy

The third way bacteria are classified is by how they get their energy. Some of these terms should sound familiar since we had some of them when we were studying ecology. They are broken up into three groups.

1. The first group is the **heterotrophs**. These bacteria get their energy by decomposing other organisms. These bacteria have a huge roll in recycling materials in an ecosystem.

2. The second group is the **photosynthetic autotrophs**. Before you have a large word freak out, this group is not as scary as its name. These bacteria are able to change sunlight into food (that's the photosynthetic part) all by themselves (that's the autotroph part). These bacteria are important because they are the producers in almost all aquatic ecosystems. They capture the sunlight and change it into energy the consumers in the ecosystem can use.

3. The third group is the **chemosynthetic autotrophs**. This group can make their own energy but instead of using sunlight to do it they use chemicals around them. These bacteria are important in changing the nitrogen in the atmosphere that we can't use into a form that we can use to make proteins.

Miscellaneous Bacteria Info

Some of the oldest known fossils are of bacteria. These organisms lived on Earth when it had a climate and atmosphere very different from those of today. Some of these fossils contain substance similar to chlorophyll and were among the first producers. As Earth's atmosphere got more oxygen, these bacteria evolved adaptations that allowed them to survive in the changing environment.

Some bacteria, when faced with bad environmental conditions produce structures called **endospores**. Endospores have a hard outer covering and are resistant to drying out, boiling, and many chemicals. While in the endospore form, the bacterium is in a state of hibernation, and it does not reproduce. When condition are again right, the endospore germinates and starts to grow and reproduce. Some endospores have been found to germinate after thousands of years.

Endospores are a great help for bacteria. Because endospores can survive boiling, canned foods and medical instruments must be sterilized under high pressure. This can be done either in a pressure cooker or in an autoclave. When water is boiled under high pressure, it is hotter than the normal boiling point of water. This great heat and high pressure kill endospores.

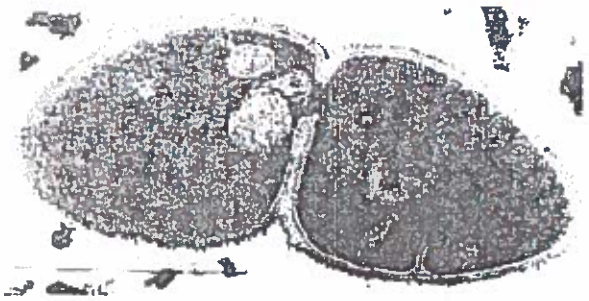
The clostridia are a group of bacteria are anaerobic (must live in an environment that is free of oxygen). One member of this group, *Clostridium botulinum*, produces an extremely powerful poison. Instead of dying when exposed to oxygen, *Clostridium botulinum* forms endospores. These endospores can find their way into canned food. If the canned food has not been properly sterilized, the endospores will germinate and the bacteria will grow and produce their deadly toxin. Although the resulting disease, botulism, is extremely rare, it is often fatal.

Another member of the clostridium group produces a nerve toxin that causes the often-fatal disease, tetanus. This bacteria *Clostridium tetani* is pictured to the left. Because endospores of *C. tetani* are found on nearly every surface, they can easily enter a wound. A puncture wound can introduce the *C. tetani* into the body. The endospores germinate in the wound, and the bacteria reproduce in great numbers. The bacteria produce a toxin, which enters the bloodstream and attacks the nerve cells in the spinal cord. Fortunately, there is an immunization for tetanus. You received this shot as a child. A booster shot is given as a precaution after a puncture wound. Deep wounds are hard to clean and provide ideal conditions for growth of the tetanus bacteria.

Reproduction

Bacteria cannot reproduce by mitosis or meiosis because they have no nucleus. Instead, they have evolved different methods of reproduction, binary fission and conjugation.

Bacteria reproduce asexually by a process known as **binary fission**. The steps in this process are:



1. The bacterium first copies its single chromosome.
2. The copies attach to the cell's plasma membrane.
3. As the cell grows in size, the two copies of the chromosome separate.
4. The cell then divides in two as a partition forms between the two new cells as shown in the picture to the right.

Each new cell receives one copy of the chromosome. Therefore, the daughter cells have the same information as each other. Bacterial reproduction can be extremely rapid. Under ideal conditions, bacteria can reproduce every 20 minutes. Such a rate of reproduction yields enormous numbers of bacteria in a short time

When you have an infection, billions of bacteria grow in your body. If you are given an antibiotic for the infection, you should take the antibiotic for the full prescribed period—even though you feel better after just one or two days. Shortly after you begin to take the antibiotic, most of the bacteria are killed. However, if you stop taking the antibiotic and even a single bacterium is left, it will start reproducing. A day later, you will have millions of bacteria in your body and you will be sick again. Completing the antibiotic as prescribed ensures that all of the bacteria will be killed so you will not get sick again.

In addition to reproducing by binary fission, some bacteria have a simple form of sexual reproduction called **conjugation**. You will remember that conjugation is not sexual reproduction in the strict sense of the word since there are no specialized sex cells involved. In conjugation, one bacterium transfers all or part of its chromosome to another cell through a bridge like structure called a pilus (pl. pili) that connects the two cells. This transfer of genetic material can be seen in the picture to the left.