Bacterial binary fission

Bacterial binary fission is the process that bacteria use to carry out cell division. Learn the steps of binary fission, including copying the bacterial chromosome and forming a new cell wall.

Introduction

You may be familiar with mitosis, which is the process that eukaryotes (such as you, me, your dog, and your favourite houseplant) use to divide their nuclear DNA during cell division. However, mitosis is a complex process, a chromosomal "dance" with some fancy choreography.

So, you might be wondering: How do simpler organisms, like bacteria, undergo cell division? The answer: binary fission!

What is binary fission?

Bacterial **binary fission** is the process that bacteria use to carry out cell division. Binary fission is similar in concept to the mitosis that happens in eukaryotic organisms (such as plants and animals), but its purpose is different.

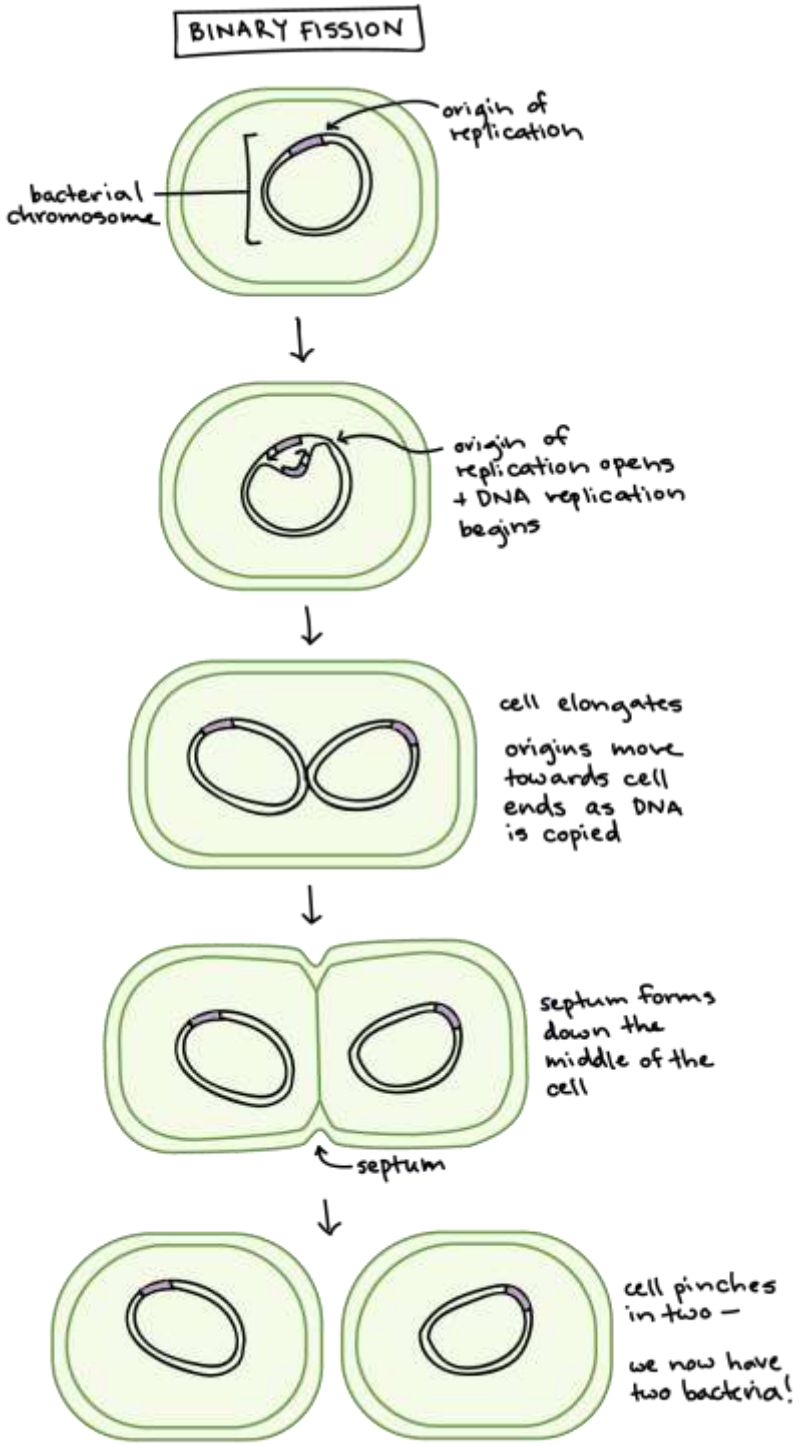
When cells divide by mitosis in the body of a multicellular organism, they cause the organism to grow larger or replace old, worn-out cells with new ones. In the case of a bacterium, however, cell division isn't just a means of making more cells for the body. Instead, it's actually how bacteria reproduce, or add more bacteria to the population.

Binary fission has features in common with mitosis, but also differs from mitosis in some important ways. Let's take a look at how it works.

Steps of binary fission

Like a human cell, a dividing bacterium needs to copy its DNA. Unlike human cells, which have multiple linear (rod-like) chromosomes enclosed in a membrane-bound nucleus, bacterial cells usually have a single, circular chromosome and always lack a nucleus. However, the bacterial chromosome is found in a specialized region of the cell called the **nucleoid**.

Copying of DNA by replication enzymes begins at a spot on the chromosome called the **origin of replication**. The origin is the first part of the DNA to be copied. As replication continues, the two origins move towards opposite ends of the cell, pulling the rest of the chromosome along with them. The cell also gets longer, adding to the separation of the newly forming chromosomes.



Stages of binary fission.

1. We see the intact bacterial chromosome (which is circular). It has two regions called the origin of replication and the terminus of replication, which are located diametrically opposite to one another on the chromosome.
2. The chromosome opens at the origin of replication, and the two DNA strands are copies, with replication proceeding in opposite directions on the two strands.

3. Copying continues, and the cell elongates. The new origins of replication move apart, towards opposite ends of the cell.
4. A septum (wall) forms down the middle of the cell, partitioning it into two new cells, each with one of the two (now-complete) bacterial chromosome copies.
5. The cell pinches in two. We now have two new bacteria!

Replication continues until the entire chromosome is copied and the replication enzymes meet at the far side. Once the new chromosomes have moved to opposite cell ends and cleared the centre of the cell, division of the cytoplasm can take place.

In this process, the membrane pinches inward and a **septum**, or new dividing wall, forms down the middle of the cell. (Bacteria have a cell wall, so they must regenerate this wall when they undergo cell division.)

Finally, the septum itself splits down the middle, and the two cells are released to continue their lives as individual bacteria.

Comparing binary fission and mitosis

Bacterial binary fission is similar in some ways to the mitosis that happens in eukaryotes and other humans. In both cases, chromosomes are copied and separated, and the cell divides its cytoplasm to form two new cells.

However, the mechanics and sequence of the two processes are fairly different. For one thing, no mitotic spindle forms in bacteria. Perhaps more importantly, DNA replication actually happens at the same time as DNA separation during binary fission (unlike in mitosis, where DNA is copied during S phase, long before its separation in M phase).