

## The Prokaryotic Cell Cycle

**Slide 2** The prokaryotic cell cycle is a relatively straightforward process. Essentially, unicellular prokaryotic organisms grow until reaching a critical size, using the 12 key intermediates to synthesize more cytoplasm, cell membrane, ribosomes, cell wall, and other cell constituents. They then replicate their DNA, segregate copies of the chromosome, and divide by a process called binary fission to produce two new genetically identical daughter cells.

**Slide 3** Most research suggests that the rate of fission in prokaryotic organisms is largely controlled by environmental conditions. For example, most prokaryotic organisms have an optimum temperature range for cell growth. When environmental temperatures are above or below the optimum, cell division tends to decrease. The rate of fission is also dependent on sufficient nutrients in the environment.

Under ideal environmental conditions, many prokaryotic species undergo binary fission at a fairly rapid rate with generation times of one to several hours. This can lead to an astonishing growth in population size over a relatively short period of time. In some instances, populations of prokaryotes may increase by a million or even a billion fold in a matter of days.

**Slide 4** Replication of the cell's DNA prior to cell division is essential for the process of binary fission, as each new cell must have an accurate and complete copy of the DNA in order to function properly. Although prokaryotic DNA often appears as a tangled mass, it is in fact organized as a single, supercoiled circular chromosome. Replication of the circular bacterial chromosome starts at a specific location on the chromosome – the origin of replication, called “ori,” for short. As replication proceeds, the DNA is threaded through an assemblage of proteins called a replication complex that makes a second copy of the cell's DNA. As the chromosome is replicated, the two ori regions – one from each copy of the DNA - are attached to the plasma membrane. The two ori regions then move apart as more of the chromosome is replicated and new plasma membrane is synthesized and added between the points of attachment. When DNA replication is complete, there are two identical copies of the cell's DNA that have segregated to each end of the cell.

**Slide 5** The final step of fission is called cytokinesis. Cytokinesis is the physical division of one cell into two cells. This process generally begins shortly after the replication of DNA. Cytokinesis begins with a pinching in of the cell membrane. As the membrane pinches inward to divide the cytoplasm, new cell wall materials are synthesized and deposited in the plane of cell division. Ultimately, two genetically identical cells with complete cell membranes and cell walls are produced, and the process of growth and fission may begin again.

**Slide 6** It may be surprising to learn that certain organelles in eukaryotic cells also go through the process of binary fission, just as prokaryotic organisms do. For example, chloroplasts and mitochondria both contain DNA - single, circular chromosomes – just like prokaryotic cells. These organelles also replicate their chromosomes and undergo binary fission within the cytoplasm of eukaryotic cells. Based on this and other similarities between these organelles and prokaryotic organisms, it is generally thought that chloroplasts and mitochondria were once free-living prokaryotic organisms that were engulfed by larger cells at some time in the past. The theory describing this phenomenon is called the “Endosymbiosis Theory.”