CONCEPTUAL LIFE SCIENCE

Cellular Reproduction

CELL DIVISION

In the process of cell division, the nucleus divides first. This nuclear division is known as mitosis. After the nucleus divides, the cytoplasm divides. This process is known as cytokinesis. The cellular reproduction process is part of a general cycle known as the cell cycle.

Mitosis

Mitosis is the division of the cell nucleus. In humans, there are 23 pairs of chromosomes in the nucleus of the cell. The chromosome complement, or genome, of the human consists of 22 pairs of regular chromosomes known as autosomes. There is a 23rd pair of chromosomes called the sex chromosomes. There are two kinds of sex chromosomes designated as X and y. Females have two X chromosomes while males have one X chromosome and one y chromosome.

During mitosis, each chromosome has to be separated. The total number of chromosomes in humans is 46 and is designated by the quantity 2n. The number of pairs of chromosomes is 23 and is designated by the quantity n. The 2n number is called the diploid number, while the n number is known as the haploid number.

![Chromatid and Centromere](image)

Figure 5-1. A chromosome. At the beginning of mitosis, the chromosome consists of two long chromatids, each containing DNA, connected by a centromere. At the end of mitosis, each chromosome will consist of a single chromatid.

As the cell enters mitosis, each chromosome consists of two equal parts known as chromatids. A chromatid is one full-length chromosome. At the beginning of mitosis, each chromosome unit contains its two chromatids connected by a central body known as a centromere. This chromosomal structure is shown in Figure 5-1. The purpose of mitosis is to separate the chromatids of each of the 46 chromosomes of the mother cell to give two separate sets of chromosomes that are the same, that is, the daughter cells each have 46 chromosomes at the end of the process. Each chromosome in each daughter cell will consist of one chromatid.
Phases of mitosis.

The process of mitosis occurs in a series of steps or phases. The purpose of mitosis is to assure that each daughter cell gets its correct complement of 46 chromosomes. When the cell is not actually dividing, it is said to be in interphase. The process of mitosis was observed microscopically and described by biologists long before it was learned what goes on during interphase. Originally, it was thought that interphase was a rest period between division phases. We now know that the cell is busy all the time, including interphase.

Interphase. During interphase, new DNA is synthesized and each chromosome develops two chromatids. At this time, the chromosomes are very long and thin and cannot be seen easily with the microscope. The nucleolus of the cell is visible during interphase. There is an interphase period before and after each nuclear division.

Prophase. This is the first of the microscopically visible stages in mitosis. The prefix pro means “before” so this phase comes before the others. During prophase, the chromosomes become short and thick. This is accomplished by contraction of the chromatin material of which the chromosomes are made. Each chromosome has two chromatids at this point. See Figure 5-1. Also the nuclear membrane and nucleolus disappear during prophase.

Metaphase. During metaphase (meta implies “middle”), the chromosomes line up in the middle of the cell. A spindle of microtubules forms. In animal cells, formation of the spindle is assisted by the centrioles. Plant cells can form a spindle without assistance of microtubules.

Anaphase. During anaphase (ana implies “apart”), the centrioles divide and each chromatid is pulled apart from its partner. At this time, they have graduated to become full-fledged chromosomes, although with one chromatid each. These newly formed chromosomes are pulled to the opposite ends of the spindle which are known as poles. When the chromosomes arrive at the poles, anaphase is over.

Telophase. Telophase is the final phase of mitosis. It is the reverse of prophase in that the chromosomes become long and thin again, the nuclear membrane becomes reconstituted, and the nucleolus is restructured. At the same time, the cytoplasm begins to divide.

Cytokinesis

At the end of mitosis, the cytoplasm divides to form two new daughter cells. Cytokinesis occurs during and just after telophase. The process of cytokinesis is different in plant and animal cells.
In plant cells, a middle lamella forms between the two daughter cells. Lamella means layer, so this is a layer in the middle of the space between the two daughter cells. Once the middle lamella membrane is completed, each daughter cell builds a thin primary wall on its side of the membrane. This completes the process of cytokinesis for them.

In animal cells, there is no cell wall to be concerned about. The cells merely pinch apart and the two daughter cells result.

**THE CELL CYCLE**

The cell cycle has four phases or sections. The first three are known as G₁, S, and G₂. These three phases occur as part of the overall time period of interphase. After interphase, mitosis occurs, followed by the next interphase with its three cell cycle phases once again.

**G₁.** The G₁ phase begins just after the completion of cytokinesis. The size of the cell doubles and the contents of the cell double during the G₁ phase.

**S.** In the S phase, the new DNA is synthesized. At the end of mitosis, each chromatid had only one chromatid. During S phase, each chromosome develops a second chromatid to resemble the two-chromatid structure shown in Figure 5-1.

**G₂.** The G₂ phase occurs after the end of DNA synthesis but before mitosis. Protein synthesis and other preparations take place for cell division during the G₂ phase.

**Mitosis.** After the G₂ phase, the division of the cell concludes the cell cycle. Both the original cell and the daughter cells contain the same number of chromosomes. Then the next round of the cell cycle will begin.