Interphase and the Mitotic phase

Once the zygote is formed, it will begin to reproduce or divide through a process called mitosis (Figure 8.5). Mitosis must occur billions of times to produce the billions of genetically identical cells that make up one multicellular human. All multicellular organisms use mitosis for growth, maintenance, and cell repair.

The cell cycle has two major phases: interphase and the mitotic phase (Figure 8.6). During **interphase**, the cell grows, and DNA is replicated. The mitotic phase consists of two subphases: mitosis and cytokinesis. In **mitosis**, the nucleus breaks down and the genetic material is equally divided. Once the DNA is divided, two new identical nuclei are formed. **Cytokinesis** then divides the cytoplasm into two new distinct cells.

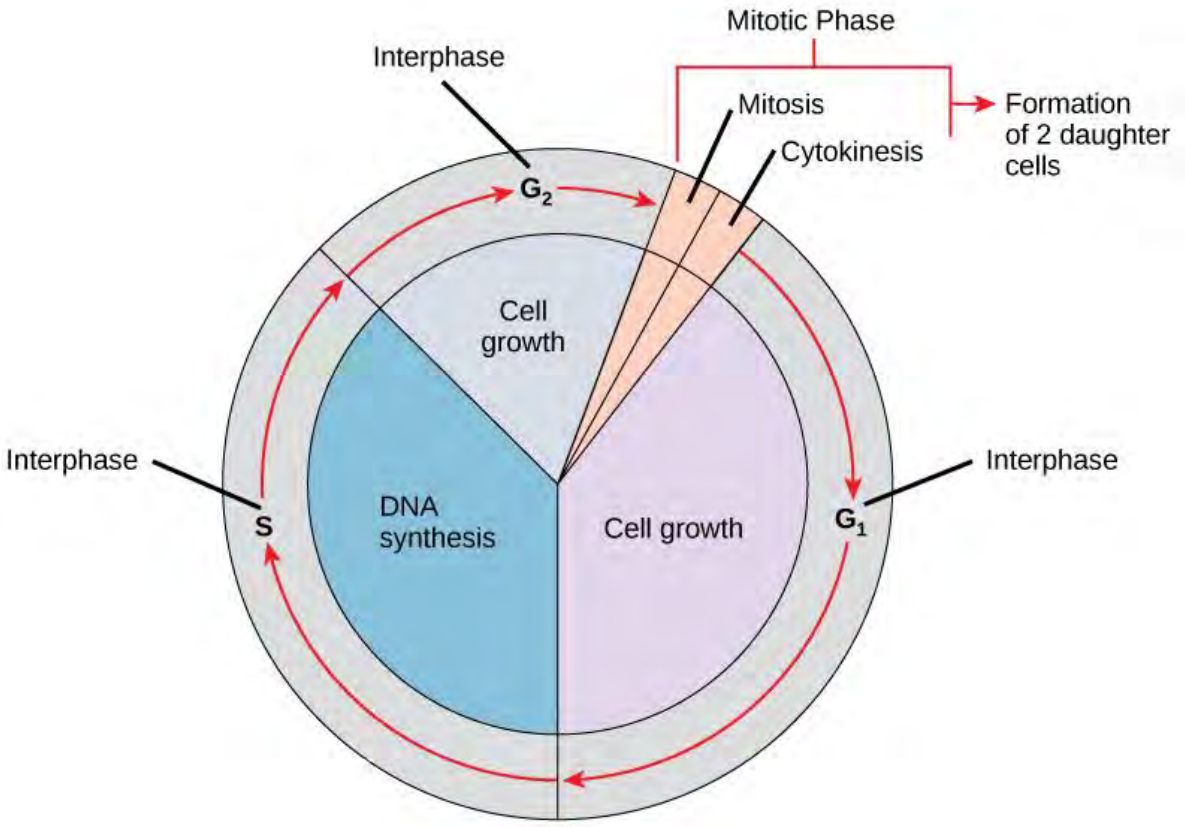

Figure 8.6 A cell moves through a series of phases called the cell cycle. (credit: Clark et al. / Biology 2E OpenStax)

Interphase

Most cells spend the majority of their time in interphase. During interphase, the cell undergoes normal processes while also preparing for cell division. The three stages of interphase are called G_1 (gap 1), S (synthesis), and G_2 (gap 2).

G_1 Phase

The first stage of interphase is called the **G_1 phase**, or gap 1. Although it may not seem like much happens in gap one, especially given its name, the cell is actually very active at the biochemical level. During the G_1 phase, the cell is accumulating the materials it will need to replicate its chromosomes. The cell must also generate enough energy to perform the processes of DNA replication and cell division. The cell also continues to carry out its normal cell function.

S Phase

Throughout interphase, chromosomes are in a semi-condensed state, meaning chromatin is visible; however, individual chromosomes are not. In the **S phase** or synthesis phase, DNA replication occurs. DNA replication involves making an identical copy of each chromosome. It is helpful to refer to chromosomes as being in either the unduplicated state or the duplicated state (Figure 8.7).

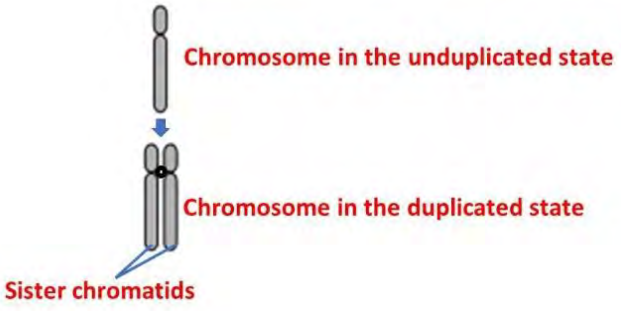

Figure 8.7 Chromosome in the unduplicated state versus a chromosome in the duplicated state. (credit: Elizabeth O'Grady)

For example, in G_1 all chromosomes exist in the unduplicated state. After S phase chromosomes exist in the duplicated state. Chromosomes in the duplicated state each consist of two identical sister chromatids. **Sister chromatids** are firmly attached to one another at a location called the centromere region (Figure 8.8).

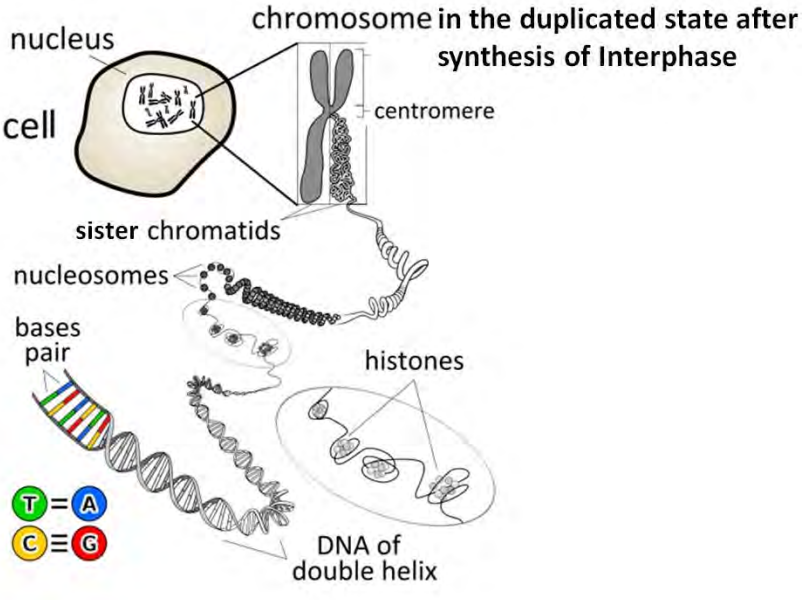

Figure 8.8 shows a chromosome in the duplicated state consisting of two identical sister chromatids. (credit: Modified by Elizabeth O'Grady original work of KES47 Wikimedia commons)

Centrosomes are also duplicated during the S phase. Recall from chapter 4 that **centrosomes** are mostly microtubule-organizing centers (Figure 8.9). The two centrosomes give rise to the **mitotic spindle,** a microtubule network used to physically move the chromosomes during mitosis. The centrosomes consist of a pair of rod-like centrioles at right angles to each other (Figure 8.9). Centrioles help organize cell division in human cells and different types of animal cells. Neurons found in the brain and spinal cord lack centrioles and are therefore amitotic, meaning they do not divide. Plants and most fungi also do not use centrioles for cell division.

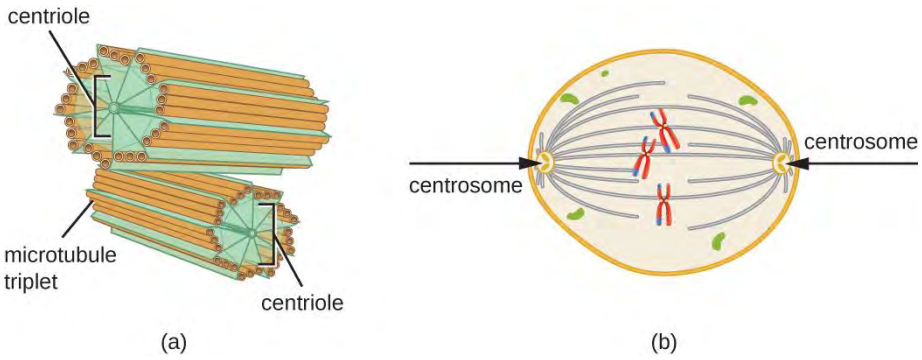

Figure 8.9 (a) A centrosome is composed of two centrioles positioned at right angles to each other. (b) In animal cells, the centrosomes (arrows) serve as microtubule-organizing centers of the mitotic spindle during mitosis. (credit: Parker et al. / Microbiology OpenStax)

G_2 Phase

In the **G_2 phase**, or gap 2, the cell replenishes its stored energy and synthesizes the proteins necessary for separating the chromosomes. Some cell organelles are duplicated, and the cytoskeleton is dismantled to provide resources for the mitotic spindle. There may be additional cell growth during G_2. The final preparations for the mitotic phase must be completed before the cell can enter the first stage of mitosis.

G_0 Phase

Some cells can also enter a resting phase called the G_0 phase (Figure 8.10). Cells, such as muscle cells and hair follicle cells, can temporarily stop dividing and will not enter the S phase. At that time, these cells are said to be in the **G_0 phase**. When cued, the cells can enter back into gap one of interphase. Some cells, such as nerve cells or mature cardiac muscle, have permanently stopped dividing and are also said to be in the G_0 phase.

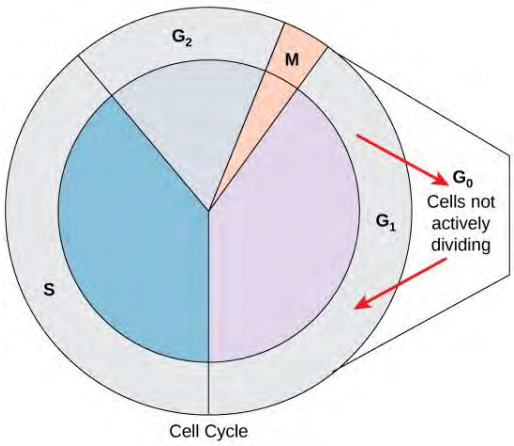

Figure 8.10 Cells that are not actively preparing to divide enter an alternate phase called G0. (credit: Fowler et al. / Concepts of Biology OpenStax)