The Cell Cycle

Why it's important

Your growth, like that of many organisms, depends on cell division.

Figure 1
All organisms use cell division.

Many celled organisms like the octopus (A) , grow by increasing the number of their cells.

One celled organisms like the amoeba (B), reaches a certain size then divides to make more amoeba.

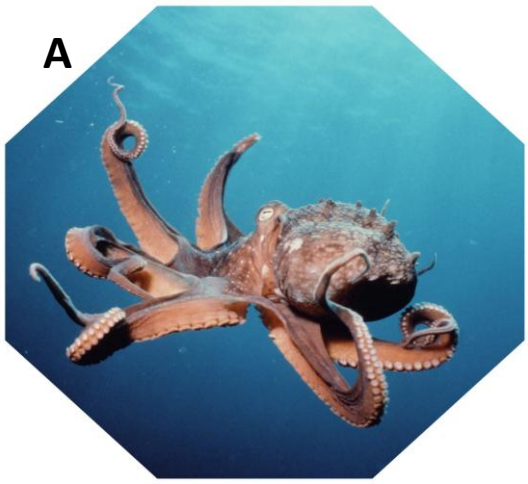
Why is Cell Division Important?

What do you, an octopus and an oak tree have in common? You share many characteristics, but an important one is that you are all made of cells – trillions of cells. Where did all of those cells come from? As amazing as it might seem, many organisms start as just one cell. That cell divides and becomes two, two becomes four, four becomes eight and so on. Many celled organisms including you, grow because cell division increases the total number of cells in an organism. Even after growth stops, cell division still takes place. Every day, billions of red blood cells in your body wear out and are replaced. During the few seconds it takes you to read this sentence, your bone marrow produced about six million red blood cells. Your body also goes through cell division to heal wounds. Cell division is important to unicellular organisms because they use cell division to reproduce (figure 1B). Cell division, or mitosis, is not as simple as just cutting the cell in half, so how do cells divide?

The Cell Cycle

A living organism has a life cycle. A life cycle begins with the organism's formation, is followed by growth and development, and finally ends in death. Right now, you are in a stage of your life cycle called adolescence, which is a period of active growth and development. Individual cells also have life cycles.

A



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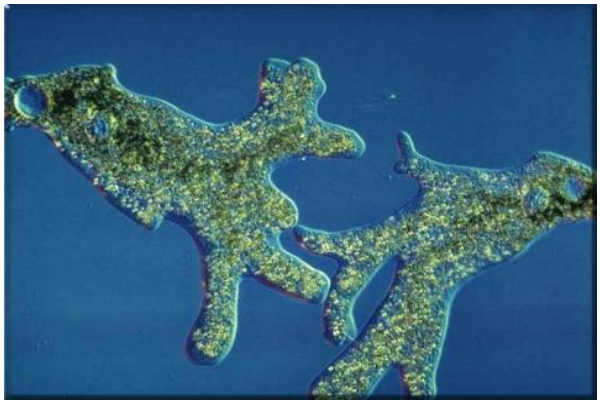


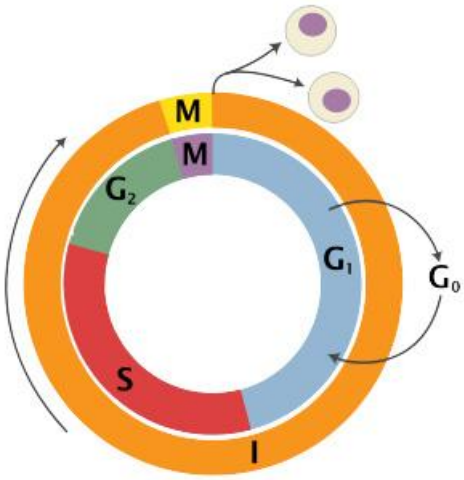


Figure 2
The Cell Cycle
Cells spend most of their time in interphase (I). The small portion labeled "M" on the outside ring show mitosis. The inside ring shows the steps that occur during interphase.

Length of Cycle

The cell cycle as shown in figure 2, is a series of events that takes place in a cell's life. This cycle details what a cell does from one cell division to the next. The time it takes to complete a cell cycle is not the same for all cells. For example, the cycle for cells in some bean plants takes about 19 hours to complete. Cells in animal embryos divide rapidly and can complete their cycles in less than 20 minutes. In some human cells, the cell cycle takes about 16 hours. Cells in humans that are needed for repair, growth, or replacement, like skin and bone cells, constantly repeat the cycle.

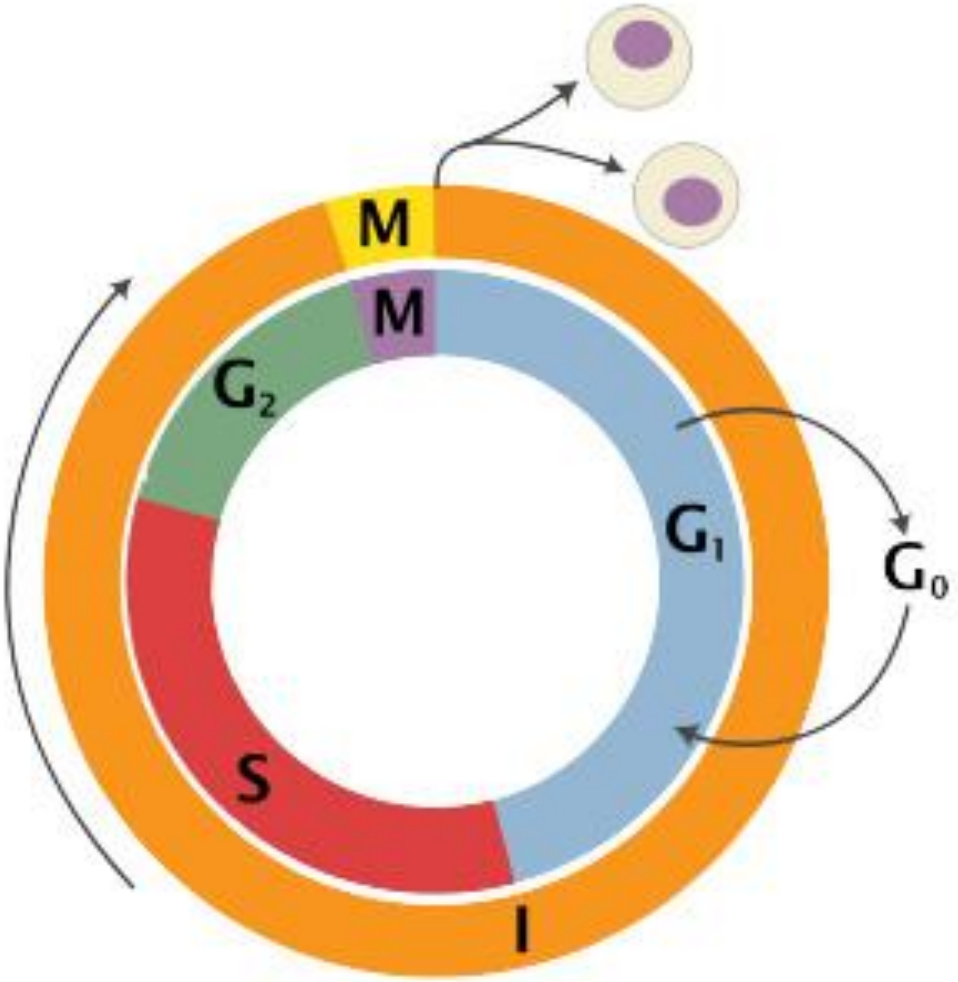
Interphase

Most of the life cycle of any eukaryotic cell (a cell with a nucleus) is spent in a period of growth and development called interphase. If you look at figure 2, the orange portion labeled "I" is interphase. Cells that divide spend about 95% of their time in interphase. Cells in your body that no longer divide, such as nerve and muscle cells, are always in interphase. An actively dividing cell, such as a skin cell, copies its genetic material and prepares for cell division during interphase.

Why is it important for a cell to copy its genetic material before dividing? Imagine that you have a part in a play and the director has one complete copy of the script. If the director gave only one page to each person in the play, no one would have the entire script. Instead the director (nucleus) makes a complete separate copy of the script for each member in the cast so that each one can learn his or her part. Before a cell divides, a copy of the genetic material must be made so that each of the two new cells will get a complete copy. Just as the actors in the play need the entire script, each cell needs a complete set of genetic material to carry out life functions.

Interesting fact

Adult human nerve cells do not undergo mitosis. This is why paralysis can happen after a bad injury and why people say alcohol and drugs kill brain cells. They do not have the ability to divide to replace themselves. Once they are damaged, they are gone.



A Closer Look At the Cell Cycle

Even though the cell is at rest during interphase, there are still many things going on to prepare the cell for its next division. The inner ring shows the different phases of interphase. The chart below gives a description of each phase of the cell cycle.

State	Phase	Abbreviation	description
quiescent	Gap 0	**G_0**	a resting phase
interphase	Gap 1	**G_1**	cell increases in size
	Synthesis	**S**	DNA replication occurs (genetic material is copied)
	Gap 2	**G_2**	cell continues to increase in size
cell division	Mitosis	**M**	cell separates the two copies of DNA and completes the division process to form two compete cells.

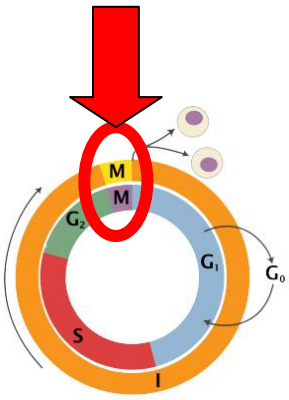


Figure 3
The arrow is pointing to the part of the cell cycle known as mitosis.

Mitosis

Now we are going to focus on the cell division or mitosis portion of the cell cycle (figure 3). **Mitosis** is the process in which the nucleus divides to form two identical nuclei. Each new nucleus is identical to the one it came from. Mitosis is describes as a series of phases or steps. The steps of mitosis, in the order the occur, is: prophase, metaphase, anaphase, and telophase.

Steps of Mitosis

When any nucleus divides, the chromosomes play the important part, A **chromosome** is a structure in the nucleus that that contains the genetic material for the cell. During interphase, each chromosome duplicates (creates a copy). When the cell is ready to divide, each duplicated chromosome coils tightly into thickened, identical strands called chromatids, as shown in figure 4.

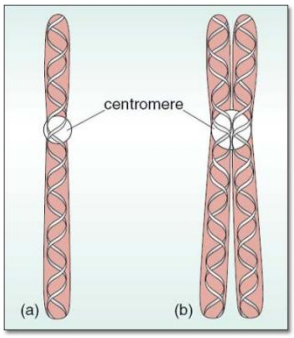
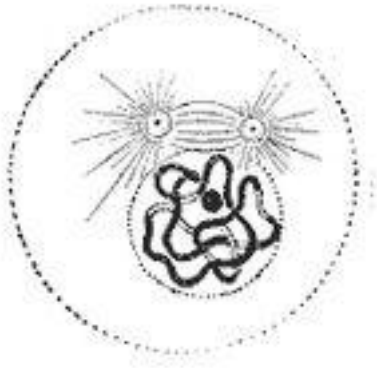


Figure 4
DNA is copied during interphase. (a) is an unduplicated chromosome and has one strand of DNA. (b) is a duplicated chromosome and has two identical DNA strands that are held together by a

First Step: Prophase

During prophase, the pairs of chromatids are fully visible when viewed under a microscope. The nucleolus and nuclear membrane disappear. Two small structures called **centrioles** move to opposite ends of the cell. Between the centrioles, threadlike spindle fibers begin to stretch across the cell. Plant cells also from spindle fibers during mitosis but do not have centrioles.



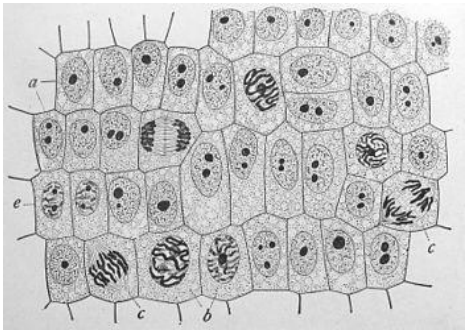
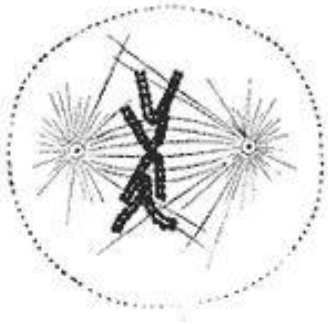


Figure 5
Allium cells in different phases of the cell cycle.

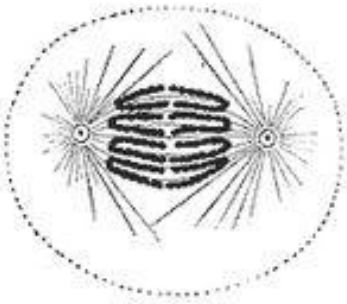
Second Step: Metaphase

In metaphase, the pairs of chromatids line up across the center of the cell. The centromere of each pair usually becomes attached to two spindle fibers – one from each side of the cell.



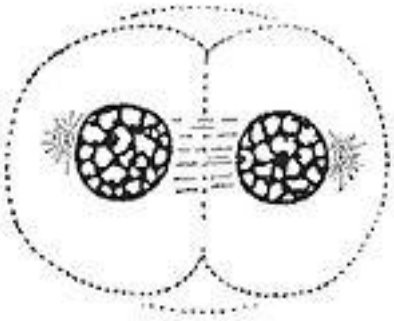
Third Step: Anaphase

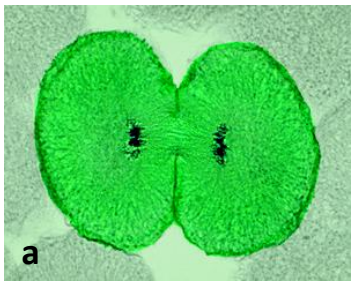
In anaphase, each centromere divides and the spindle fibers shorten. Each pair of chromatids seperates, and chromatids begin to move to opposite ends of the cell. The seprated chromatids are now called chromosomes.



Fourth Step: Telophase

In the final step, telophase, spindle fibers start to disappear, the chromosomes start to uncoil, and a new nucleus forms.





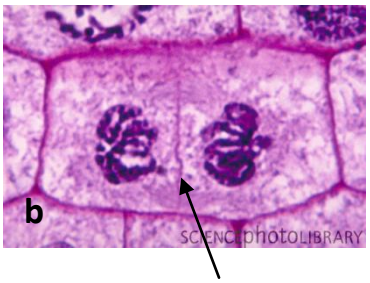


Figure 6
After mitosis occurs in any eukaryotic cell, cytokenesis takes place and the cytoplasm divides to form two complete cells. In animal cells (a), the cytoplasm splits and the cell membrane closed around each cell. In plant cells (b), a cell plate forms first and then the cytoplasm divides.

Division of the Cytoplasm

For most cells, after the nucleus has divided, the cytoplasm separates and two new cells are formed. In animals cells, the cell membrane pinches in the middle, like a balloon with a string tightened around it, and the cytoplasm divides. In plant cells, the appearance of a cell plate, as shown in figure 6, tells you the cytoplasm is being divided. New cell walls form along the cell plate, and a new cell membrane develops inside the cell walls. Following division of the cytoplasm, most new cells begin the period of growth, or interphase, again.

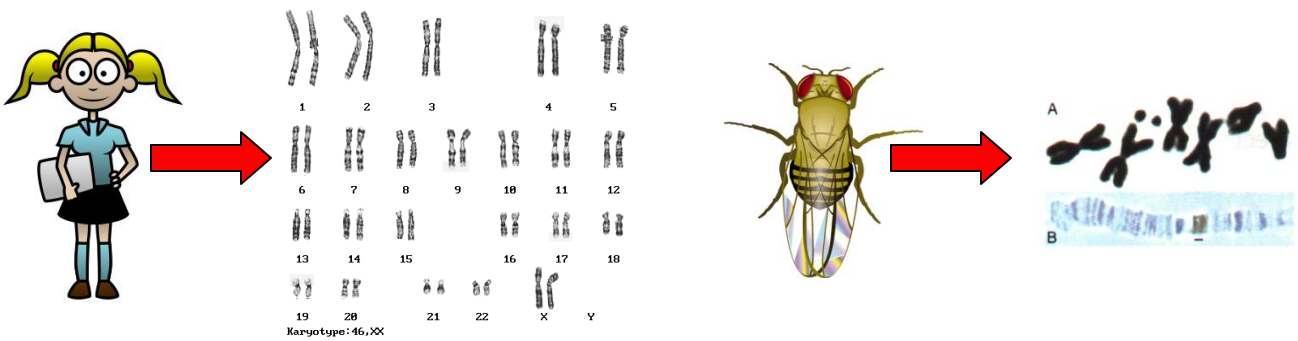
Results of Mitosis

You should remember two important things about mitosis. First, it is the division of a nucleus. Second, it produces to nuclei that are identical to each other. Both of the resulting nuclei, has the same number and type of chromosomes. Every cell in your body, except sex cells, has a nucleus with 46 chromosomes. This is because you began as one cell with 46 chromosomes in its nucleus. Skin cells, produced to replace or repair your skin, have the same 46 chromosomes as the one original cell you developed from. Each cell in a fruit fly has eight chromosomes, so each new cell produced by mitosis has a copy of those eight chromosomes. Figure 7 shows the chromosomes found in most human cells and those found in most fruit fly cells.

Each of the trillions of cells in your body, except sex cells, has a copy of the same genetic material. Even though all actors in a play have copies of the same script, they do not learn the same lines. Likewise, all of your cells use different parts of the same genetic material to become different types of cells.

Cell division allows growth and replaces worn out or damaged cells. You are much larger and have more cells than you has as a baby because of cell division. If you cut yourself or break a bone, the wound heals because cell division is producing more cells to take the place of the ones that were damaged.

Figure 7
Humans have 46 chromosomes (23 pairs) while fruit flies have 8 chromosomes (4 pairs).



Mistakes During Mitosis

Mistakes can occur during mitosis. In most cases, the cell containing the mistake dies. However, in some cases, the mistake during mitosis creates a cancerous cell. When a cell that has become cancerous goes through mitosis, it creates more cancer cells. Mistakes during mitosis can also create mutations as in figure 8.

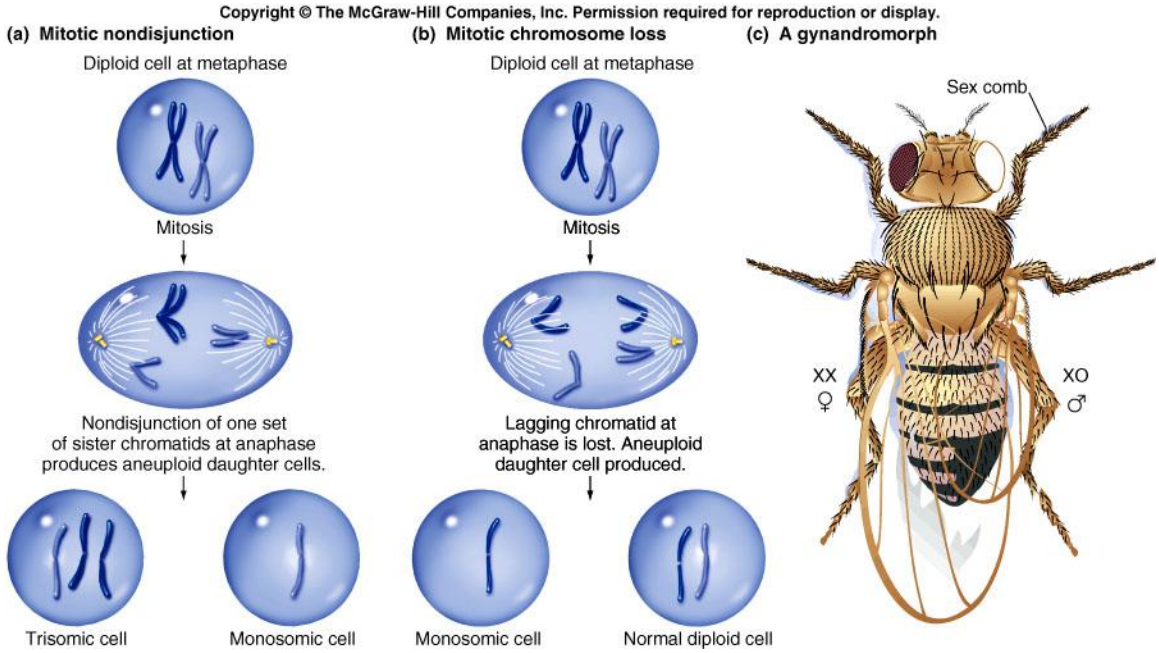


Figure 8

Mistakes can occur during mitosis. In (a), one cell ended up with three chromatids and the other only has one. In (b) one cell only has one chromatid and the other cell is a normal cell with two chromatids.