Cell Division Reading Guide

Repair and Growth

Take a moment to look at the skin on your arm. You might be surprised to learn that the outermost layer of skin is actually a layer of dead cells. Underneath the surface layer are living cells busily carrying out the chemical reactions you studied in Unit 2. The living cells are also engaged in another vital activity: They are reproducing. The new cells gradually move outward toward the skin's surface, replacing dead cells that have rubbed off. This renewal of your skin goes on throughout your life. And when your skin is injured, additional cell reproduction helps heal the wound. The replacement of lost or damaged cells is just one of the important roles cell reproduction plays in your life. Another is growth—simply increasing in size from a baby to a child to an adult. All of the trillions of cells in your body result from cell reproduction, a series of cell divisions that began with a single fertilized egg cell.

Reproduction

While the production of new cells can result in growth and repair *within* organisms, cell division also has an essential role in the reproduction of *entire* organisms. Some organisms reproduce by simple cell division, in which a single cell or group of cells each duplicates its genetic material and then splits into two new genetically identical cells. This process, which is known as **asexual reproduction**, produces offspring that inherit all their genetic material from just one parent. As a result, the offspring are genetically identical to one another and to their parent. Single-celled organisms such as *Paramecium* usually reproduce this way. Many multicellular organisms can also reproduce asexually at certain times. For example, some sea stars, when divided into two pieces, can regrow into two whole new individuals through simple cell division. And if you've ever grown a geranium from a leaf cutting, you've taken advantage of the plant's ability to reproduce asexually.

Chromosomes and Cell Division

Almost all the genes of a eukaryotic cell are located in the cell nucleus. Most of the time, this genetic material exists as a mass of very long fibers that are too thin to be seen under a light microscope. These fibers consist of **chromatin**, a combination of DNA and protein molecules which can function (making DNA and RNA) but cannot be transported.. As a cell prepares to divide, its chromatin fibers condense, becoming visible as the compact structures called **chromosomes**. Chromosomes can be transported by spindle fibers without being broken. Each chromosome now consists of two identical joined copies called **sister chromatids**. The region where the two chromatids are joined tightly together is called the **centromere**. A dividing human skin cell starts with 46 pairs of duplicated chromosomes (each made up of two sister chromatids). When the cell divides, the sister chromatids separate from each other. Once separated from its sister, each chromatid is considered a full-fledged chromosome. The result of the division is two offspring nuclei, each containing 46 chromosomes.



The Cell Cycle



Interphase

The cell may spend as much as 90 percent of the cell cycle in interphase. **Interphase** is the stage during which a cell carries out its metabolic processes and performs its functions. Interphase is divided into three stages: G1, S and G2 .During G1 (*G stands for gap*), a cell increases its supply of proteins and increases the number of many of its organelles (such as mitochondria and ribosomes). Next is the **S phase** (*S* stands for DNA *synthesis*). During S, the cell duplicates its chromosomes. During G2 the cell grows

Mitotic Phase

Prophase In <u>prophase</u>, the first stage of mitosis, the **chromosome make their appearance**. In the nucleus, the chromatin fibers have condensed and are thick enough to be seen with a light microscope. With high magnification, each chromosome can be clearly seen now to consist of a pair of sister chromatids joined at the centromere. The **nucleolus disappears**, and the cell stops making ribosomes. Late in prophase, the **nuclear envelope breaks down**. Meanwhile, in the cytoplasm, a football-shaped structure called **the mitotic spindle forms**. The chromatids now attach to the microtubules that make up the spindle. The spindle starts tugging the chromosomes toward the center of the cell for the next step in the dance.

Metaphase During <u>metaphase</u>, the brief second stage, the **chromosomes all gather in a plane across the middle of the cell.** The mitotic spindle is now fully formed. All the chromosomes are attached to the spindle microtubules, with their centromeres lined up about halfway between the two ends, or poles, of the spindle. **Anaphase** <u>Anaphase</u> is the third stage of mitosis. The sister chromatids suddenly separate from their partners. Each chromatid is now considered a daughter chromosome. **Proteins at the centromeres help move the daughter chromosomes along the spindle microtubules toward the poles**. At the same time, these microtubules shorten, bringing the chromosomes closer to the poles. However, spindle microtubules that are not attached to centromeres do just the opposite—they grow longer, pushing the poles farther apart.

Telophase and Cytokinesis The final stage of mitosis, <u>telophase</u>, begins when the chromosomes reach the poles of the spindle. During this stage, the processes that occurred in prophase are reversed. The spindle disappears, **two nuclear envelopes reform** (one around each set of daughter chromosomes), the **chromosomes uncoil and lengthen**, and the **nucleoli reappear**. Mitosis, the division of one nucleus into two genetically identical daughter nuclei, is now finished.

<u>Cytokinesis</u> completes the cell division process by **dividing the cytoplasm into two daughter cells**, each with a nucleus. Usually this process occurs along with telophase.

Answer the following questions ON YOUR OWN SHEET OF PAPER!

- 1. State three reasons why cells divide?
- 2. What is chromatin? How does chromatin change as the cell prepares to divide?
- 3. What is the structure of a chromosome? Why do chromosomes form?
- 4. What are the 3 stages of interphase? What occurs in each stage?
- 5. What are the names of the five stages of mitosis?
- 6. What are 4 important events that occur during prophase?
- 7. What happens to the chromosomes during metaphase?
- 8. What happens to the chromosomes during anaphase?
- 9. How do the chromosomes move during anaphase?
- 10. What are 3 important event of telophase?
- 11. What occurs during cytokinesis?
- 12. How do the daughter cells compare to the parent cell?
- 13. How do the daughter cells compare to one another?