Name: _____ Date: _____

Guided Learning: Cell Division

Learning goals
After completing this activity, you will be able to …

- Describe the stages of the cell cycle, including DNA replication and mitosis.
- Describe the importance of the cell cycle to the growth of organisms.
- Recognize that disruptions of the cell cycle lead to diseases such as cancer.
- Recognize the significance of meiosis to sexual reproduction.

Vocabulary: asexual reproduction, cancer, cell cycle, chromosome, cytokinesis, DNA, interphase, meiosis, mitosis, sexual reproduction

Warm-up questions:

1. All of the cells in your body originally came from a single cell. How do you think this is possible? _____

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2. As a human body grows, do you think its cells get bigger or its cells get more plentiful? Explain your thoughts. _____

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Activity A: Cell division and reproduction
According to the cell theory, all new cells come from existing cells. Cells are able to produce new cells through the process of cell division. Cell division allows unicellular organisms, such as bacteria, to reproduce. When a bacterium uses cell division to reproduce, its offspring are genetically identical to itself. This kind of reproduction is known as **asexual reproduction**.

Humans use a much more complex form of reproduction known as **sexual reproduction**. During sexual reproduction, two reproductive cells fuse. The genetic material from each of these cells joins together in the newly produced cell. Thus, the offspring produced by sexual reproduction can inherit genetic material from two separate individuals.

Both asexual and sexual reproduction involves certain forms of cell division. You will learn about these forms of cell division in this worksheet.

1. Compare and contrast asexual and sexual reproduction. _____

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2. What do you think might be some advantages and disadvantages to each form of reproduction? _____

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Activity B: The cell cycle

Prokaryotic cells go through a very simple form of cell division called binary fusion. The division of eukaryotic cells is much more complex. Eukaryotic cells go through a series of stages known as the **cell cycle** as they grow and divide. During the cell cycle, a cell first grows. Once it reaches its full size, it prepares for cell division and then divides to form two daughter cells. The events of the cell cycle are shown in the diagram on the next page.

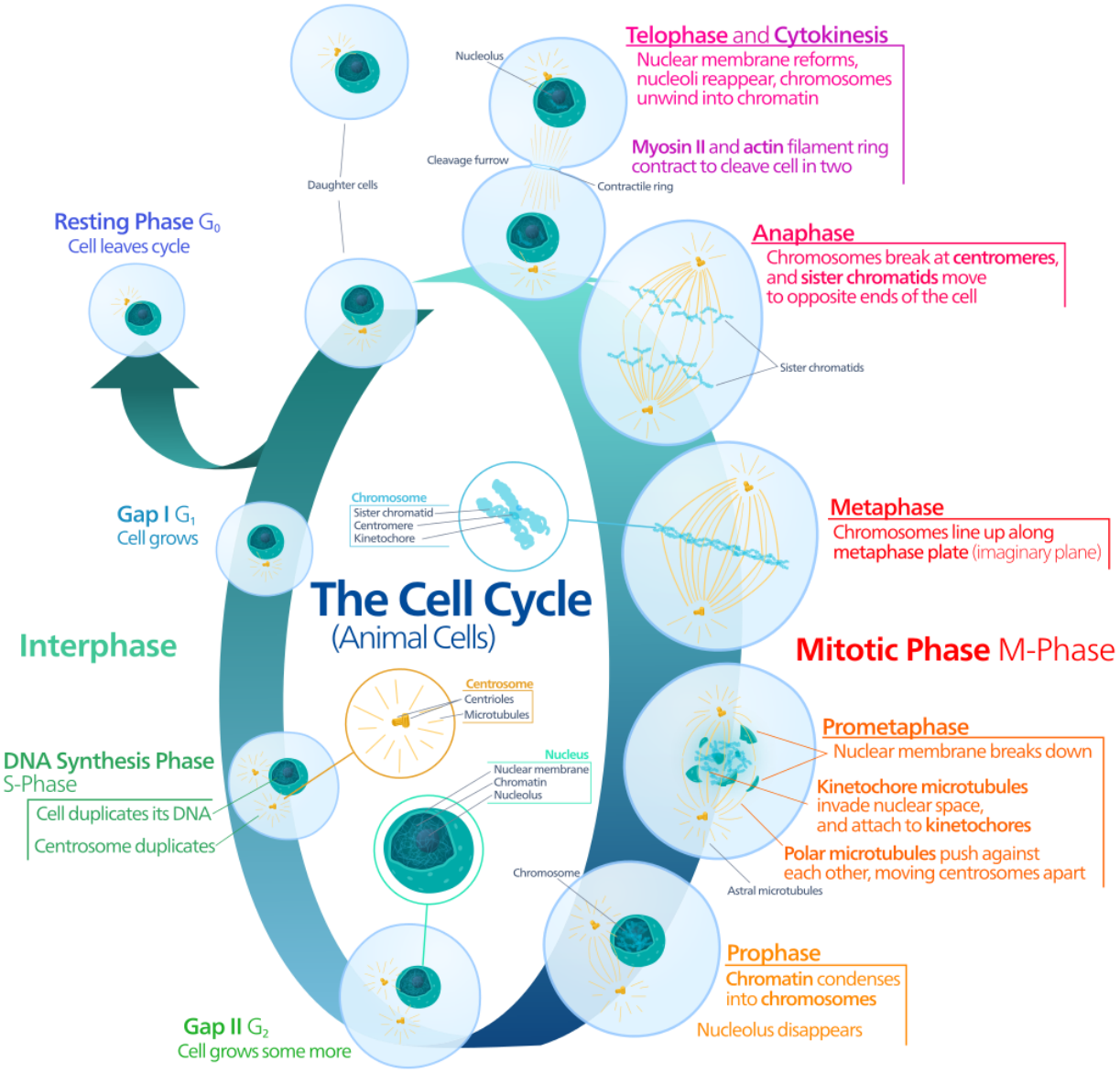
Resting Phase (G_0): A cell that has just newly divided enters a resting phase. During this phase, the cell is relatively inactive. As soon as the cell starts to grow, it enters the next phase.

Gap I (G_1) Phase: A cell grows larger during this phase, building proteins and making new organelles.

DNA Synthesis (S) Phase: During this phase, there is a great deal of activity within the cell's nucleus. The nucleus contains **DNA**, which is a molecule that provides "instructions" for how the cell can build proteins and other structures. During S phase, DNA is duplicated. In addition, a tiny structure called a *centrosome* is duplicated. These structures will help keep materials organized when the cell starts to divide.

Gap II (G_2) Phase: During this phase, the rest of the organelles, molecules, and other structures needed for cell division are produced. The G_1, S, and G_2 phases are collectively known as **interphase**.

Mitotic (M) Phase: During this phase, the cell divides into two daughter cells. The first part of this process is called **mitosis**. During mitosis, the cell's nucleus divides. The second part of this process is called **cytokinesis**. During cytokinesis, the cell's cytoplasm divides.



Take a close look at the diagram. Mitosis is broken down into five phases:

Prophase: During this phase, loose DNA, known as *chromatin*, condenses to form **chromosomes**, which are organized bundles of DNA. The *nucleolus,* which is the small dense center of the nucleus, dissolves.

Prometaphase: Next, the nuclear envelope surrounding nucleus breaks down. A fan-like system of *microtubules* forms. These microtubules will help separate the duplicated chromosomes. Some of the microtubules attach to *kinetochores,* which are protein structures on the chromosomes.

Metaphase: During this phase, the microtubules line up the chromosome across the center of the cell. This line is called the *metaphase plate.*

Anaphase: Next, the duplicated chromosomes break at their center points, called *centromeres*. Each half of the separated chromosomes is referred to as a *sister chromatid.* The sister chromatids are pulled away from each other toward opposite ends of the cell.

Telophase: Nuclear envelopes begin to reform around the sister chromatids. The chromosomes unravel back into chromatin.

While telophase is occurring, cytokinesis begins. During cytokinesis in animal cells, the cell membrane is pulled inward, pinching the cytoplasm into two equal sections. Each section contains its own nucleus and organelles, thus forming two daughter cells. Cytokinesis is slightly different in plant cells. Remember, plant cells have cell walls that keep the cells rigid. So, rather than the cell membrane pinching inward, a cell plate forms between the two newly formed nuclei to create two new cells.

Now that you've learned about the cell cycle, think back to the **Warm-up** questions you answered on the first page of this worksheet:

- How do you think it is possible for all of the cells in your body to originate from a single cell?
- As a human body grows, do you think its cells get bigger or its cells get more plentiful?

You know probably have a pretty good idea of what the answers to these questions are. You started as a single fertilized egg cell. Through the process of mitosis, that cell divided again and again. The daughter cells that were formed also divided. Eventually, you grew into an organism made up of trillions of cells. Each of these cells grew to a normal size before dividing again. Therefore, the growth of your body is caused by a combination of cell division and cell growth. However, the majority of this growth was due to cell division rather than cells increasing in size.

All of your cells eventually die, so cell division is necessary for your continued health. The rate at which cells divide is controlled by regulatory proteins. These proteins determine how long cells stay in different phases of the cell cycle. But sometimes cells cease to respond to these regulatory proteins and begin to divide uncontrollably. This causes a disorder known as **cancer**. The uncontrolled cells may form a mass known as a *tumor.* Tumors can invade and destroy healthy tissue, disrupting life processes and possibly leading to death.

1. Why is the cell cycle important to the growth of organisms? _____

2. During which step of the cell cycle is DNA duplicated? _____

3. Complete the chart by describing the stages of the cell cycle.

Phase	Main Events
Gap I (G1) Phase	
DNA Synthesis (S) Phase	
Gap II (G2) Phase	
Mitotic (M) Phase	

4. How can a disruption of the cell cycle lead to cancer? _____

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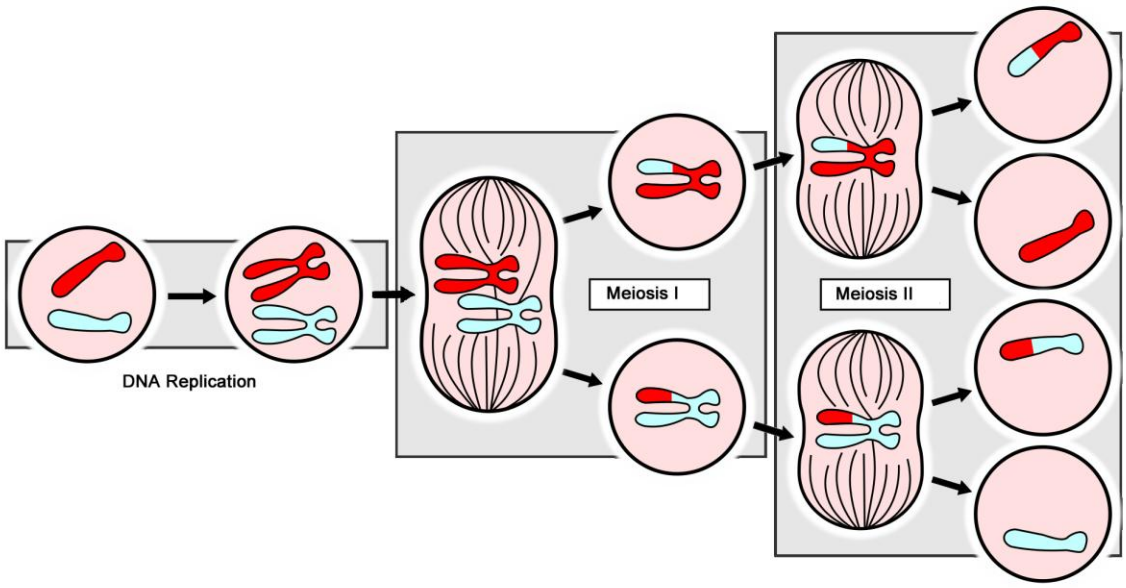
Activity C: Meiosis

As you learned in Activity A, reproductive cells are able to fuse during sexual reproduction in order to form a new cell that contains genetic material from both parent cells. Reproductive cells are formed through a special form of cellular division called **meiosis**.

Examine the diagram of meiosis below. Like mitosis, a parent cell's DNA must first be replicated before meiosis can occur. A human parent cell has 23 pairs of chromosomes (46 total). After the DNA is replicated, each chromosome consists of two identical chromatids held together with a central centromere. During the first part of meiosis, called *meiosis I*, one chromosome from each pair moves to one daughter cell, and the other chromosomes move into the other daughter cell. Each daughter cell ends up with 23 chromosomes, each with two chromatids. This process is different from mitosis, where each daughter cell ends up with 46 individual chromatids.

During the second part of meiosis, called *meiosis II,* each of the two daughter cells divides to form two reproductive cells. Each of the four reproductive cells only has 23 chromatids—half the number of the original parent cell. Thus, when two human reproductive cells fuse, the resulting cell has 46 chromosomes. In this way, offspring produced through sexual reproduction have the same number of chromosomes as each of their parents.



1. Describe what occurs during meiosis in humans. _____

2. Explain the significance of meiosis to sexual reproduction. _____