Cell Cycle

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CHAPTER 1 Cell Cycle

- Define the cell cycle.
- List, in order, the phases of the cell cycle.
- Summarize the phases of the eukaryotic cell cycle.
- Explain control of the cell cycle.
- Define cancer.

What is a cell's life like?

The eukaryotic cell spends most of its "life" in interphase of the cell cycle, which can be subdivided into the three phases, G1, S and G2. During interphase, the cell does what it is supposed to do. Though cells have many common functions, such as DNA replication, they also have certain specific functions. That is, during the life of a heart cell, the cell would obviously perform certain different activities than a kidney cell or a liver cell.

The Cell Cycle

Cell division is just one of several stages that a cell goes through during its lifetime. The **cell cycle** is a repeating series of events that include growth, DNA synthesis, and cell division. The cell cycle in prokaryotes is quite simple: the cell grows, its DNA replicates, and the cell divides. In eukaryotes, the cell cycle is more complicated.

The Eukaryotic Cell Cycle

The diagram in **Figure** 1.1 represents the cell cycle of a eukaryotic cell. As you can see, the eukaryotic cell cycle has several phases. The **mitotic phase** (M) actually includes both mitosis and cytokinesis. This is when the nucleus and then the cytoplasm divide. The other three phases (G1, S, and G2) are generally grouped together as **interphase**.

During interphase, the cell grows, performs routine life processes, and prepares to divide. These phases are discussed below.

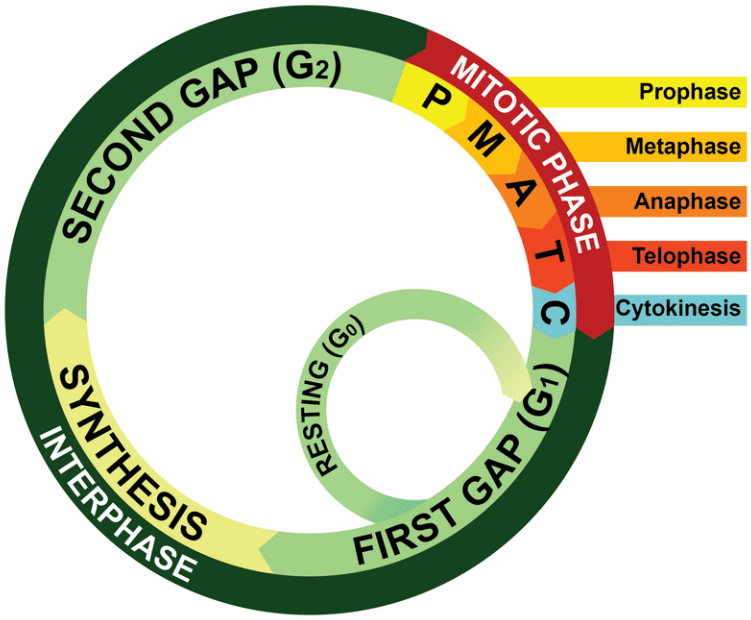


FIGURE 1.1

Eukaryotic Cell Cycle. This diagram represents the cell cycle in eukaryotes. The First Gap, Synthesis, and Second Gap phases make up interphase (I). The M (mitotic) phase includes mitosis and cytokinesis. After the M phase, two cells result.

Interphase

Interphase of the eukaryotic cell cycle can be subdivided into the following three phases, which are represented in **Figure** 1.1:

- **Growth Phase 1 (G1):** during this phase, the cell grows rapidly, while performing routine metabolic processes. It also makes proteins needed for DNA replication and copies some of its organelles in preparation for cell division. A cell typically spends most of its life in this phase. This phase is sometimes referred to as Gap 1.
- **Synthesis Phase (S):** during this phase, the cell's DNA is copied in the process of **DNA replication**.
- **Growth Phase 2 (G2):** during this phase, the cell makes final preparations to divide. For example, it makes additional proteins and organelles. This phase is sometimes referred to as Gap 2.

Control of the Cell Cycle

If the cell cycle occurred without regulation, cells might go from one phase to the next before they were ready. What controls the cell cycle? How does the cell know when to grow, synthesize DNA, and divide? The cell cycle is controlled mainly by regulatory proteins. These proteins control the cycle by signaling the cell to either start or delay the next phase of the cycle. They ensure that the cell completes the previous phase before moving on. Regulatory proteins control the cell cycle at key checkpoints, which are shown in **Figure** 1.2. There are a number of main checkpoints.

- The G1 checkpoint, just before entry into S phase, makes the key decision of whether the cell should divide.
- The S checkpoint determines if the DNA has been replicated properly.
- The mitotic spindle checkpoint occurs at the point in metaphase where all the chromosomes should have aligned at the mitotic plate.

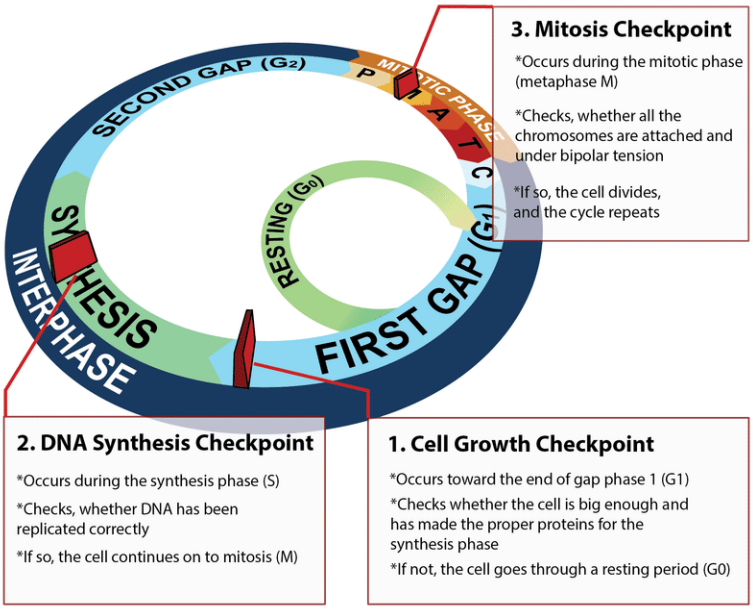


FIGURE 1.2

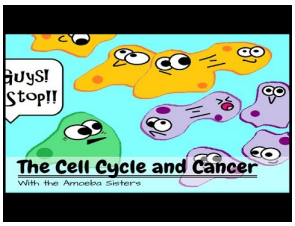
Checkpoints in the eukaryotic cell cycle ensure that the cell is ready to proceed before it moves on to the next phase of the cycle.

Cancer and the Cell Cycle

Cancer is a disease that occurs when the cell cycle is no longer regulated. This may happen because a cell's DNA becomes damaged. Damage can occur due to exposure to hazards such as radiation or toxic chemicals. Cancerous cells generally divide much faster than normal cells. They may form a mass of abnormal cells called a **tumor** (see **Figure** 1.3). The rapidly dividing cells take up nutrients and space that normal cells need. This can damage tissues and organs and eventually lead to death.

FIGURE 1.3

These cells are cancer cells, growing out of control and forming a tumor.



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Summary

- The cell cycle is a repeating series of events that cells go through. It includes growth, DNA synthesis, and cell division. In eukaryotic cells, there are two growth phases, and cell division includes mitosis.
- The cell cycle is controlled by regulatory proteins at three key checkpoints in the cycle. The proteins signal the cell to either start or delay the next phase of the cycle.
- Cancer is a disease that occurs when the cell cycle is no longer regulated. Cancer cells grow rapidly and may form a mass of abnormal cells called a tumor.

Review

1. Identify the phases of the eukaryotic cell cycle.
2. What happens during interphase?
3. Define cancer.
4. Cells go through a series of events that include growth, DNA synthesis, and cell division. Why are these events best represented by a cycle diagram?
5. Explain how the cell cycle is regulated.
6. Why is DNA replication essential to the cell cycle?

References

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2. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. Checkpoints control the cell cycle . CC BY-NC 3.0
3. Ed Uthman. Cancer cell tumor . Public Domain