

Overview of the Cell Cycle

Living systems go through cycles of stable conditions and changing conditions. For example, when conditions in your outside environment change, homeostatic mechanisms in your body help restore internal stability. Cells also cycle between phases of stability and change. Some cells stay in a relatively steady state, without dividing, for long periods of time. Other cells are constantly dividing.

Stages of the Cell Cycle

The life cycle of organisms involves birth, growth and development, reproduction, and eventually death. A cell also has a life cycle, and cell division is only one part of that cycle. The **cell cycle** is the regular pattern of growth, DNA duplication, and cell division that occurs in eukaryotic cells, or cells with nuclei. This pattern can be divided into stages that get their names from the earliest studies of cell division, when scientists' observations were limited by the microscopes of the time.

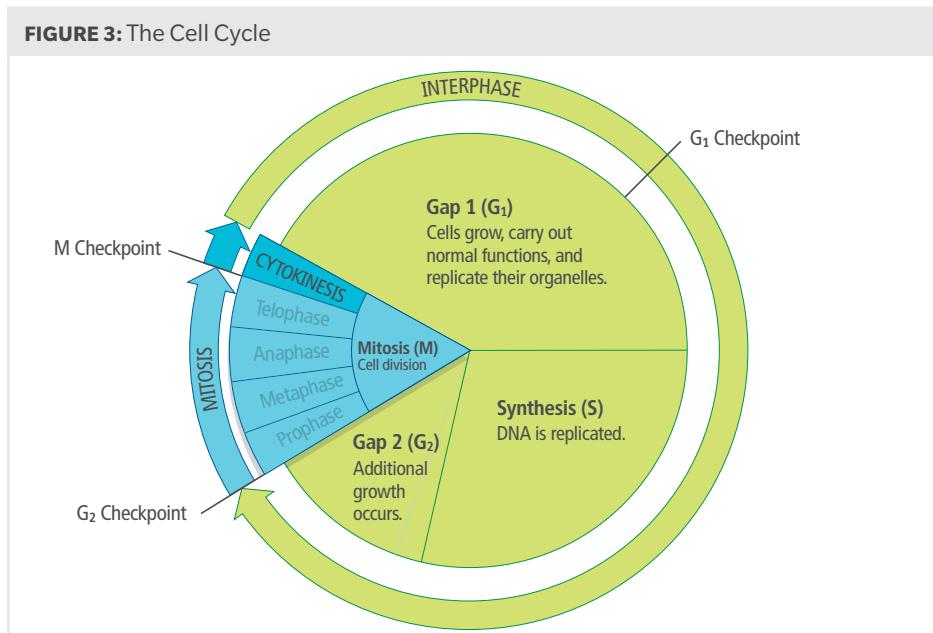
Because these scientists were unable to observe activity in cells that were not actively dividing, they separated the cycle into two parts: a resting phase and a dividing phase. The resting stage was named interphase, and the division phase was named mitosis. Mitosis includes a final step for complete cell division called cytokinesis.

FIGURE 2: A dividing cell



Predict Describe a specific situation in which an organism's cells would need to divide.

FIGURE 3: The Cell Cycle



Over time, scientists developed techniques and tools that allowed them to detect the copying of DNA (DNA synthesis). As a result, the description of the cell cycle was revised to include the DNA synthesis stage. At the time, they were still unable to observe activity between the stages of synthesis and mitosis, so the periods between these two stages were labeled gap 1 (G_1) and gap 2 (G_2). Eventually scientists learned that cells in interphase undergo critical growth and preparation for cell division while they carry out normal cellular functions.



Analyze Why is it important that DNA is copied before the cell divides?

Checkpoints in the cell cycle keep cells from moving to the next stage before certain conditions are met. During G₁, the cell must pass a critical checkpoint before it can proceed to the synthesis stage. This ensures that DNA is relatively undamaged and can be properly replicated. This checkpoint also allows other cells to signal the cell when more cell division is needed. G₂ has its own critical checkpoint. Everything must be in order—adequate cell size, DNA correctly replicated—before the cell goes through mitosis and division.



Collaborate If a cell has damaged DNA, what do you think happens during the G₂ checkpoint?

Rates of Cell Division

FIGURE 4: Different cells divide at different rates.

Cell Type	Approximate Life Span
Skin cell	2–3 weeks
Red blood cell	4 months
Liver cell	10–18 months
Intestine—internal lining	4–5 days
Intestine—muscle and other tissues	16 years

Source: Spalding et al., *Cell* 122:1

All cells in your body undergo cell division, but the rate at which they divide is linked to your body's need for that type of cell. In human cells, the S, G₂, and M stages together usually take about 12 hours. The length of the G₁ stage differs the most from cell type to cell type. The rate of cell division is greater in embryos and children than it is in adults. Children have a shorter cell cycle, and many of their organs are still developing. But the rate of cell division also varies within different tissues of the adult body. For example, the internal lining of the digestive tract receives a lot of wear and tear. The cells of the lining also encounter toxins that enter the body through the digestive tract. As a result, cells that line the stomach and intestine are replaced every few days. In contrast, cells that make up the rest of the intestine (mainly smooth muscle) and many of the internal organs, such as lungs, kidneys, and liver, divide only occasionally, in response to cell injury or death.



Analyze Why does a skin cell need to divide more frequently than a liver cell?

G Zero (G₀) Stage

Not all cells need to divide regularly. Cells that divide rarely are thought to enter a gap phase called G₀. These cells continue to carry out everyday functions, but they do not undergo any of the processes necessary to prepare for division. Some cells, such as neurons, may remain in G₀ permanently. Other cells enter this stage temporarily until there is a need for them to divide. One such cell is a lymphocyte, which is a type of white blood cell that helps fight infections. Lymphocytes can remain dormant for years until they recognize an invading organism. Once the invading organism binds to a lymphocyte receptor, the lymphocyte goes through a series of rapid cell divisions to help fight infection.



Explain Make a claim for how the cell cycle relates to the growth and maintenance of organisms. Discuss the stages of the cell cycle, mechanisms that regulate it, and how this cycle is related to the growth and maintenance of organisms.