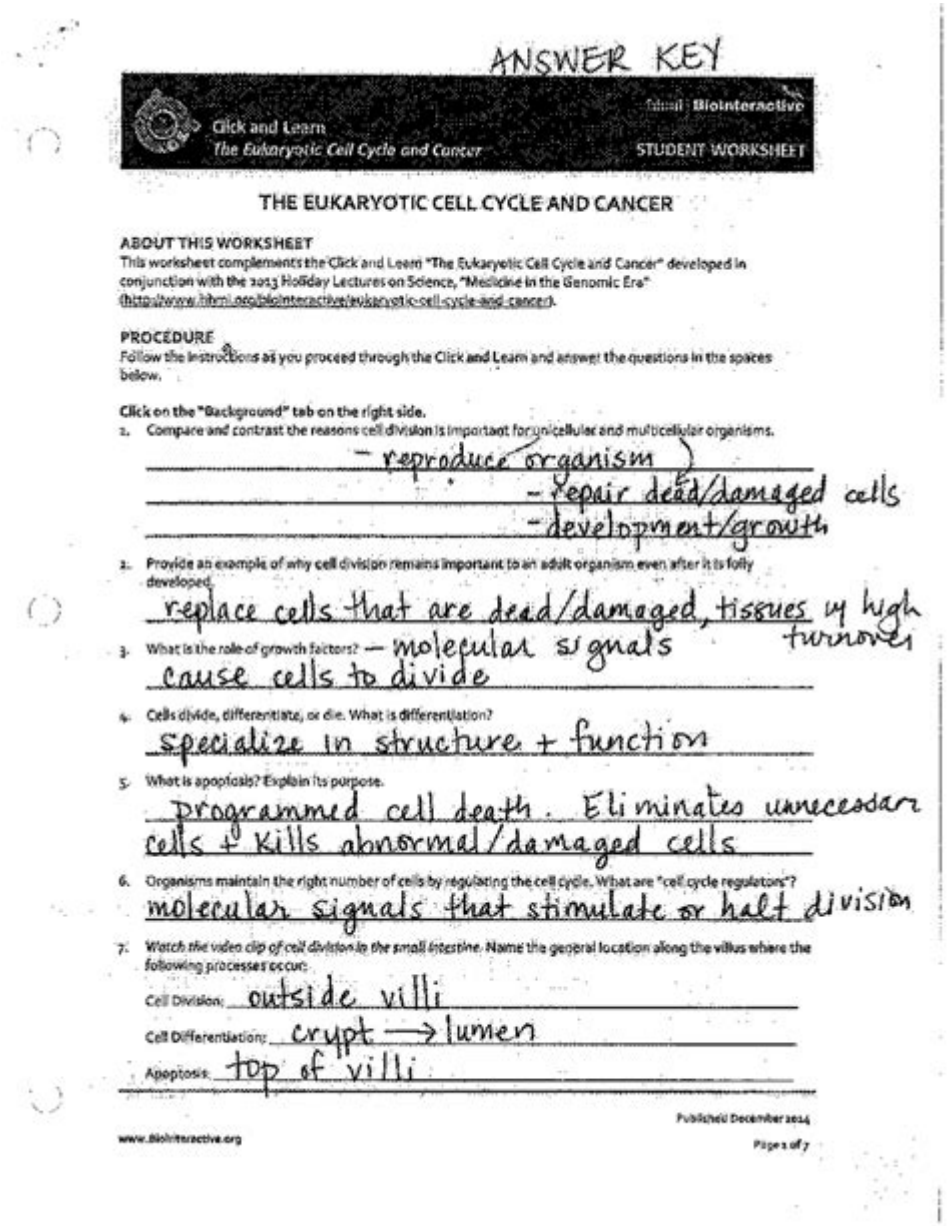
The Eukaryotic Cell Cycle And Cancer Answer Key



ANSWER KEY

Click and Learn
The Eukaryotic Cell Cycle and Cancer

HHMI | BioInteractive

STUDENT WORKSHEET

THE EUKARYOTIC CELL CYCLE AND CANCER

ABOUT THIS WORKSHEET

This worksheet complements the Click and Learn "The Eukaryotic Cell Cycle and Cancer" developed in conjunction with the 2013 Holiday Lectures on Science, "Medicine in the Genomic Era" (http://www.hhmi.org/biointeractive/eukaryotic-cell-cycle-and-cancer).

PROCEDURE

Follow the instructions as you proceed through the Click and Learn and answer the questions in the spaces below.

Click on the "Background" tab on the right side.

1. Compare and contrast the reasons cell division is important for unicellular and multicellular organisms.
   - reproduce organism
   - repair dead/damaged cells
   - development/growth
2. Provide an example of why cell division remains important to an adult organism even after it is fully developed.
   replace cells that are dead/damaged, tissues w high turnover
3. What is the role of growth factors? – molecular signals
   cause cells to divide
4. Cells divide, differentiate, or die. What is differentiation?
   specialize in structure + function
5. What is apoptosis? Explain its purpose.
   programmed cell death. Eliminates unnecessary cells + kills abnormal/damaged cells
6. Organisms maintain the right number of cells by regulating the cell cycle. What are "cell cycle regulators"?
   molecular signals that stimulate or halt division
7. *Watch the video clip of cell division in the small intestine.* Name the general location along the villus where the following processes occur:
   - Cell Division: outside villi
   - Cell Differentiation: crypt → lumen
   - Apoptosis: top of villi

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The eukaryotic cell cycle and cancer answer key is a critical topic in cell biology, essential for understanding how cells grow, replicate, and ultimately behave in relation to diseases such as cancer. The eukaryotic cell cycle consists of a series of phases that a cell goes through to divide and reproduce. This cycle is tightly regulated, and any disruptions in this regulation can lead to uncontrolled cell growth, a hallmark of cancer. In this article, we will explore the various phases of the eukaryotic cell cycle, the mechanisms that regulate it, and the implications of these processes in the context of cancer.

The Eukaryotic Cell Cycle: An Overview

The eukaryotic cell cycle is typically divided into four main phases: G1 (Gap 1), S (Synthesis), G2 (Gap 2), and M (Mitosis). Each phase plays a crucial role in preparing the cell for division and ensuring that genetic material is accurately replicated and distributed.

1. Phases of the Cell Cycle

- **G1 Phase:** This is the first phase of the cell cycle, where the cell grows and synthesizes proteins necessary for DNA replication. During G1, the cell also checks for DNA damage and prepares for the next phase.
- **S Phase:** In this phase, DNA replication occurs. Each chromosome is duplicated, resulting in two sister chromatids for each chromosome, ensuring that each daughter cell will receive an identical set of chromosomes.
- **G2 Phase:** The cell continues to grow and produces the proteins and organelles required for cell division. Additionally, the cell checks for any errors in DNA replication and repairs them if necessary.
- **M Phase:** This phase includes mitosis and cytokinesis. Mitosis is the process where the sister chromatids are separated and distributed into two daughter cells, while cytokinesis is the final step that divides the cytoplasm, resulting in two distinct cells.

Regulation of the Cell Cycle

The eukaryotic cell cycle is regulated by a series of checkpoints that ensure the integrity of the cell's DNA and the proper timing of cell division. These checkpoints are critical for preventing the propagation of damaged or incomplete DNA, which can lead to cancer.

1. Key Checkpoints

- **G1 Checkpoint:** Also known as the restriction point, this checkpoint assesses whether the cell has adequate nutrients, growth factors, and is free from DNA damage before proceeding to the S phase.
- **G2 Checkpoint:** This checkpoint verifies that DNA has been replicated correctly and that there is no damage before the cell enters mitosis.
- **M Checkpoint:** Occurring during metaphase of mitosis, this checkpoint ensures that all

chromosomes are properly attached to the spindle apparatus before the cell proceeds with division.

Cell Cycle Regulators

The cell cycle is controlled by various proteins, including cyclins and cyclin-dependent kinases (CDKs), which work together to push the cell through the different phases of the cycle.

1. Cyclins and CDKs

- **Cyclins:** These proteins are synthesized and degraded in a cyclical manner, corresponding to the phases of the cell cycle. Each cyclin binds to a specific CDK to activate it.
- **CDKs:** Cyclin-dependent kinases are enzymes that, when activated by cyclins, phosphorylate target proteins to drive the cell cycle forward. The activity of CDKs is tightly regulated by the presence of their cyclin partners.

Cancer and the Cell Cycle

Cancer arises when the regulatory mechanisms of the cell cycle fail, leading to uncontrolled cell division. Mutations in genes that code for cyclins, CDKs, or checkpoint proteins can disrupt the normal regulatory processes.

1. Mechanisms of Cancer Development

- **Oncogenes:** These are mutated forms of proto-oncogenes, which normally promote cell division. When mutated, they can lead to excessive cell proliferation.
- **Tumor Suppressor Genes:** These genes, such as p53 and Rb, normally inhibit cell division or promote apoptosis (programmed cell death). Mutations that inactivate these genes can lead to unregulated cell growth.
- **DNA Repair Genes:** Deficiencies in genes responsible for DNA repair can lead to the accumulation of mutations, further increasing the risk of cancer.

Importance of Understanding the Eukaryotic Cell Cycle in Cancer Treatment

Understanding the eukaryotic cell cycle and its regulation is crucial for developing effective cancer treatments. Many cancer therapies are designed to target specific phases of the cell cycle or exploit the differences between cancerous and normal cells.

1. Targeting the Cell Cycle in Cancer Therapy

- **Chemotherapy:** Many chemotherapeutic agents target rapidly dividing cells by interfering with DNA replication or mitosis, making them effective against cancer cells that proliferate uncontrollably.
- **Targeted Therapies:** These therapies aim at specific molecules involved in the cell cycle, such as inhibitors of CDKs, to halt the progression of cancer.
- **Immunotherapy:** By enhancing the body's immune response against cancer cells, immunotherapy can help target cells that have escaped normal cell cycle regulation.

Conclusion

The eukaryotic cell cycle and cancer answer key provides invaluable insights into the fundamental processes of cell division and the mechanisms that, when disrupted, can lead to cancer. By understanding the phases of the cell cycle, the regulatory checkpoints, and the molecular players involved, researchers and clinicians can develop targeted strategies to prevent and treat cancer effectively. Ongoing research in this field continues to unveil new opportunities for innovative cancer therapies that promise to improve patient outcomes and quality of life.

Frequently Asked Questions

What are the main phases of the eukaryotic cell cycle?

The main phases of the eukaryotic cell cycle are G1 (Gap 1), S (Synthesis), G2 (Gap 2), and M (Mitosis).

How does the regulation of the cell cycle relate to cancer development?

Cancer development is often linked to mutations in genes that regulate the cell cycle, leading to uncontrolled cell division and tumor formation.

What role do cyclins and cyclin-dependent kinases (CDKs) play in the cell cycle?

Cyclins and cyclin-dependent kinases (CDKs) are crucial for regulating the cell cycle; they activate or deactivate target proteins to ensure proper progression through the cell cycle phases.

How can understanding the eukaryotic cell cycle contribute to cancer treatments?

Understanding the eukaryotic cell cycle can aid in developing targeted therapies that disrupt the cycle in cancer cells, thereby inhibiting their growth and proliferation.

What is the significance of checkpoints in the eukaryotic cell cycle?

Checkpoints in the eukaryotic cell cycle serve as critical control mechanisms that ensure each phase is completed accurately before progressing to the next, preventing errors that could lead to cancer.

The Eukaryotic Cell Cycle And Cancer Answer Key

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