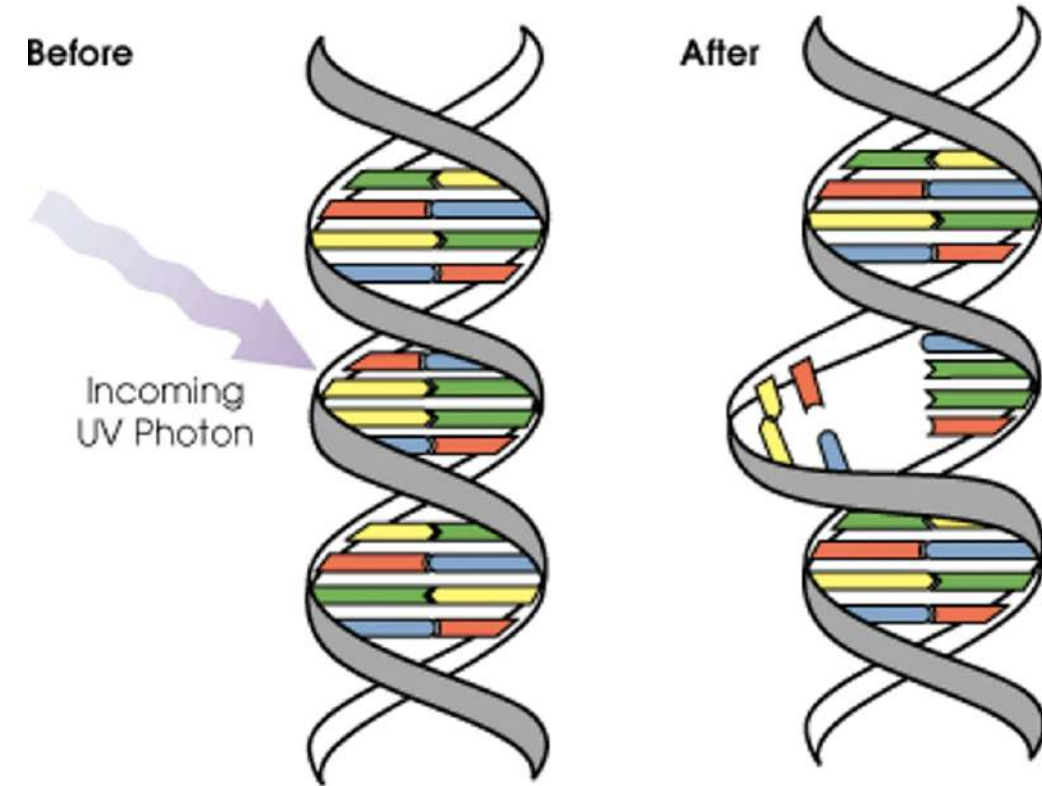


Lesson 9 - Mutations and Cancer



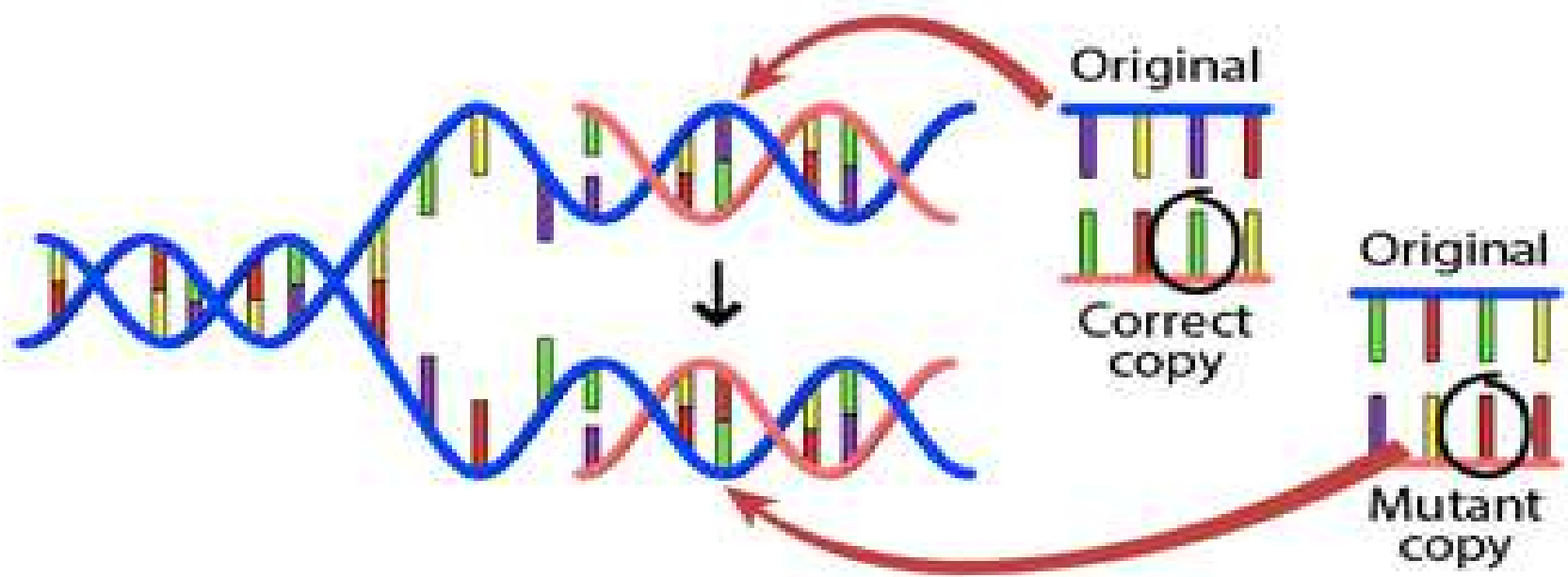
Learning Objectives:

- Explain why mutations can be harmful
- Define cancer
- Identify risk factors that increase the chance of mutation

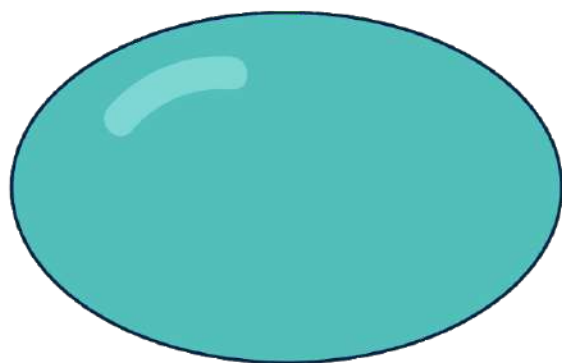
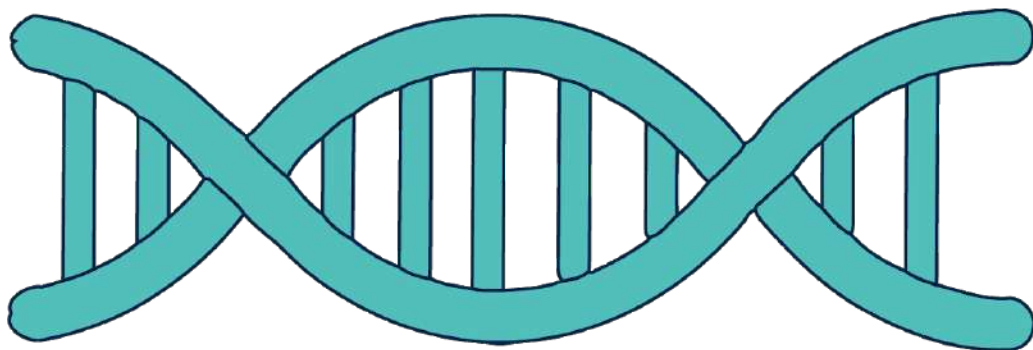
AIM: What causes mutations? Are mutations harmful?

As we learned last lesson, some **mutations** (*changes in the DNA sequence*) do *not* affect the final protein. This means that some mutations go completely unnoticed and have no effect on the organism. But, some mutations *do* affect the amino acid sequence, and thereby the shape of the protein and its function.

- In *very rare cases*, the new protein might result in a *new trait* that actually gives the organism an *advantage*! But, this is something that we will learn about during **evolution**.
- *In most cases*, any change to a necessary protein is likely to be harmful to the organism.

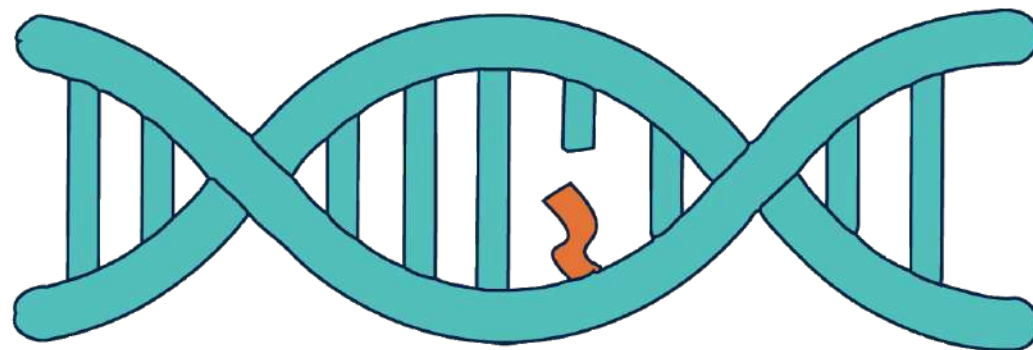


Normal Gene

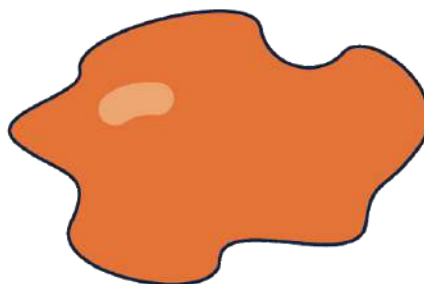


Normal Protein

Mutated Gene



or

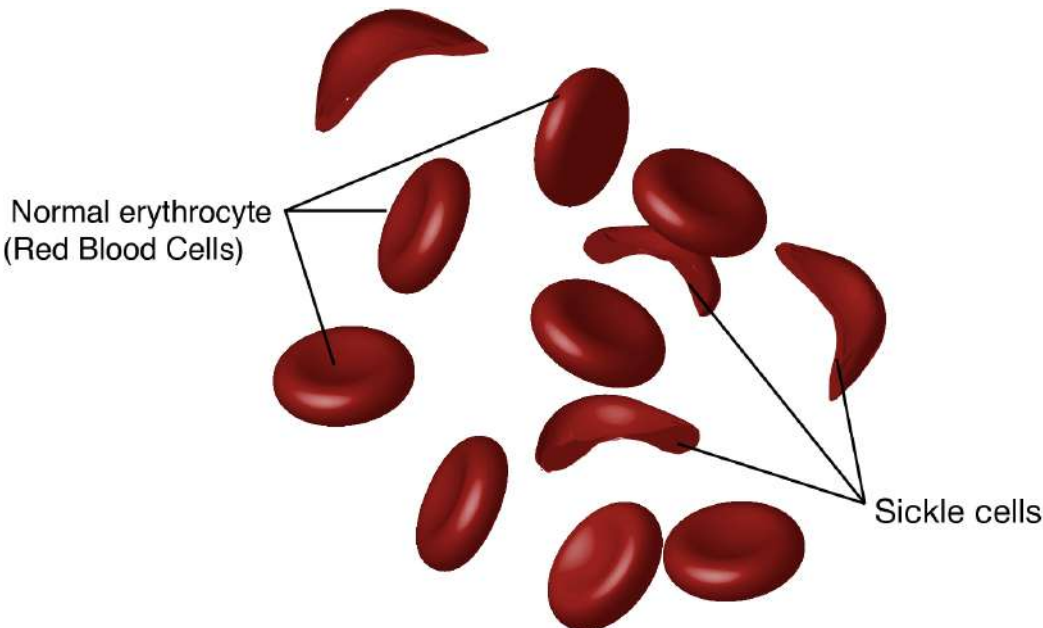
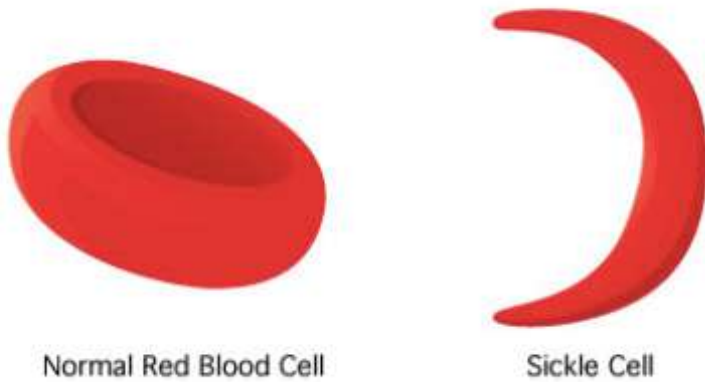


Abnormal Protein

No Protein

Example of a harmful gene mutation: Sickle Cell Disease

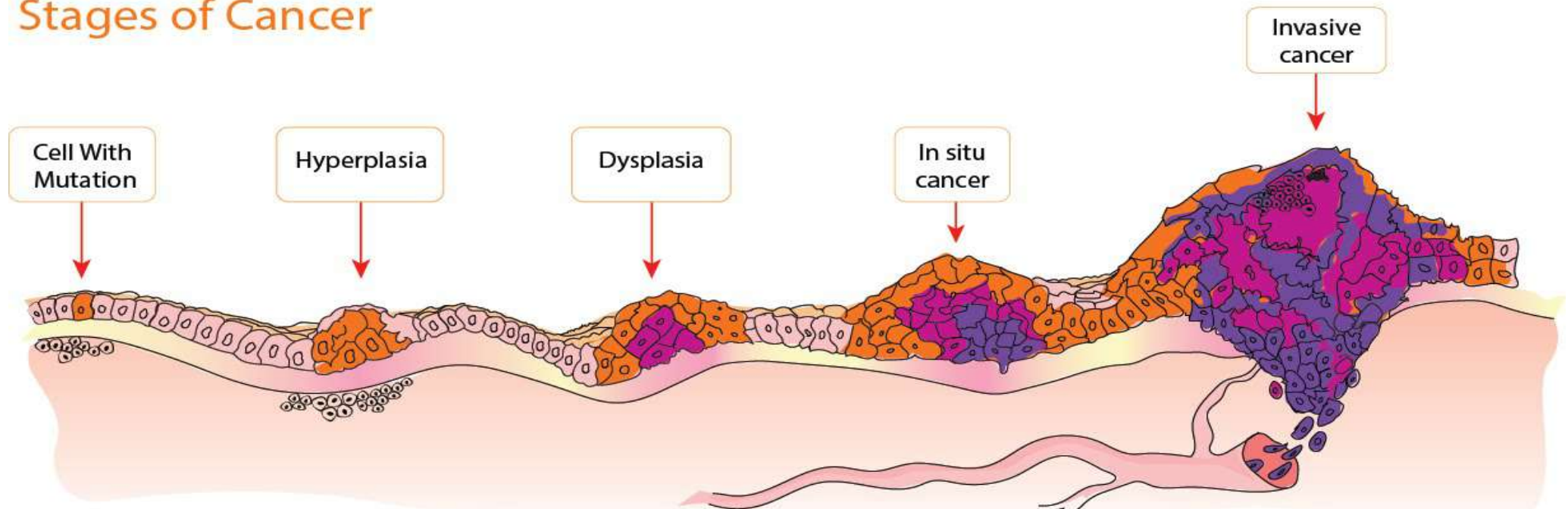
- Sickle Cell Disease is a **genetic disorder** than can be *inherited*. People with sickle cell disease have a **mutation** in the **gene** that codes for hemoglobin. **Hemoglobin** is a protein found in red blood cells that helps to transport oxygen. Did you know that this mutation results from just a SINGLE base change in the gene, but that this change affects *the entire shape of the protein??* The change in the hemoglobin actually affects the entire shape of the red blood cell, as you can see in the picture. The “sickle cells” are not able to transport oxygen very well, and this affects the health of the individual.



Example of a harmful gene mutation: Cancer

- Gene mutations in a cell can result in uncontrolled cell division, called **cancer**. This can occur at any random point in any person's life. A random mutation can occur in any cell performing cell division (mitosis). If the mutation occurs in a gene that *regulates cell division*, the cell may start to **divide uncontrollably**. The genes that control cell division are genes that produce "GO" and "STOP" signals, telling cells right time to divide (i.e., growth & repair). If these STOP and GO signals are mutated, a cell may start to divide uncontrollably. Each time the cell divides, *it passes on the mutation and creates more cancerous cells*. Cancer cells serve no purpose and steal oxygen and nutrients from healthy cells.
- You can see from the diagram below that cancer starts with *a single mutation in a cell*. The mutated cells are often described as "abnormal cells."

Stages of Cancer

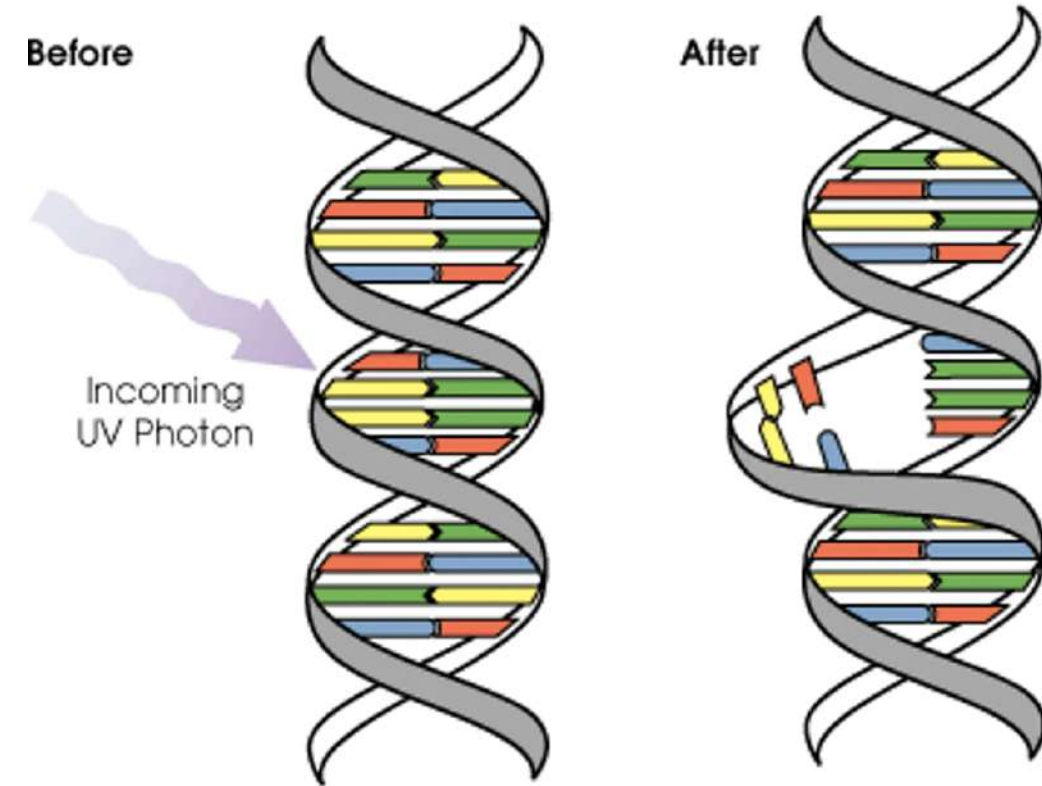


What causes mutations??

- Once again, mutations are *copying errors* that occur during DNA replication. Mutations are like “cellular typos.”
- Mutations are **COMPLETELY RANDOM EVENTS**- they can happen at any time to any cell that is dividing.
- While a mutation **CANNOT** be predicted or pre-determined, there are some factors that can *increase your chances of mutation*.
- **RISK FACTORS FOR MUTATIONS:**
 - **Exposure to harmful radiation**- this includes **UV radiation** from the sun and **X-rays**
 - **Exposure to harmful chemicals**- you often hear on the news about chemicals that have been linked to cancer. For example- harmful chemicals in tobacco products have been linked to lung cancer.
 - Exposure to risk factors does NOT “guarantee” mutation- it only *increases the likelihood*.



Lesson 9 - Mutations and Cancer



Learning Objectives:

- Explain why mutations can be harmful
- Define cancer
- Identify risk factors that increase the chance of mutation

1. Researchers have found that formaldehyde and asbestos can alter DNA base sequences. Based on this research, the use of these chemicals has been greatly reduced because they
 - (1) may act as fertilizers, increasing the growth of algae in ponds
 - (2) have been replaced by more toxic compounds
 - (3) are capable of causing mutations in humans
 - (4) interfere with the production of antibiotics by white blood cells

2. Genetic researchers have discovered a number of different gene mutations that have led to the development of cancer. These mutations affect how frequently a cell reproduces. Which process would be directly influenced by these mutations?

- | | |
|---|---------------------------|
| (1) differentiation of cells in an embryo | (2) meiotic cell division |
| (3) division of sperm and egg cells | (4) mitotic cell division |

3. It is recommended that people avoid excessive use of tanning beds. Exposure to the radiation emitted by tanning beds can cause skin cancer. This cancer is the direct result of a

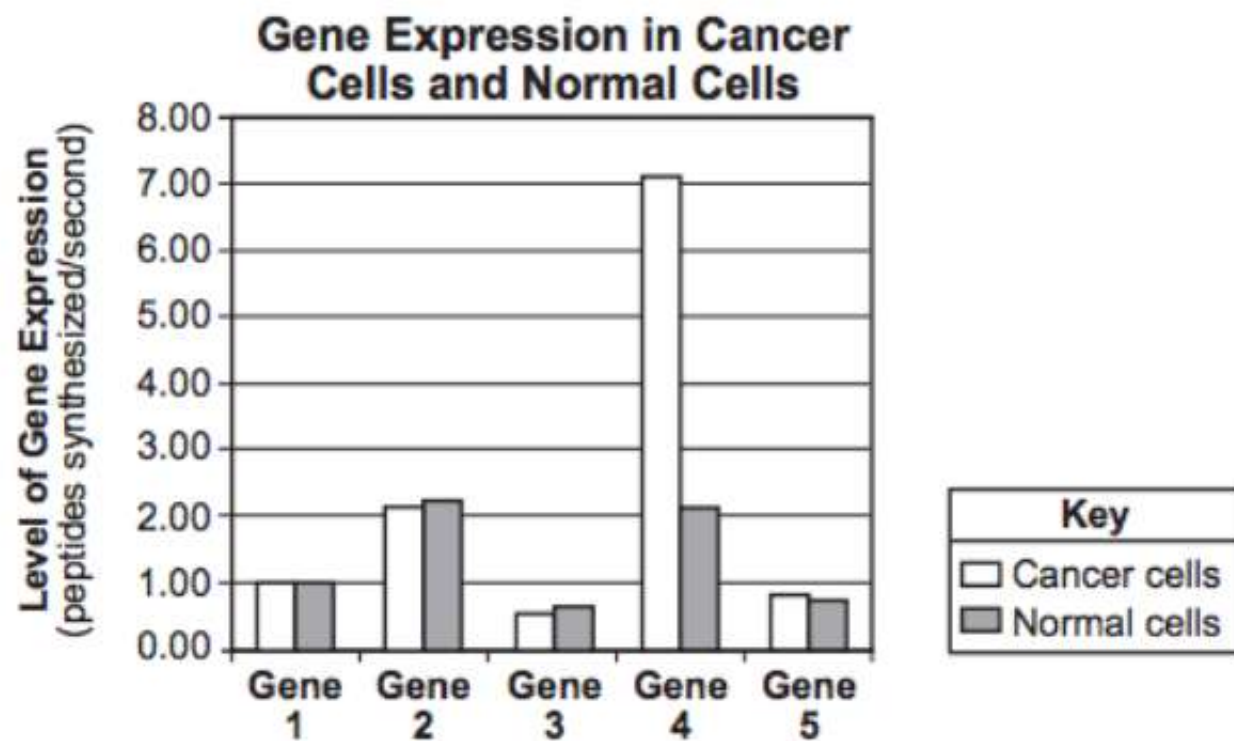
(1) change in a starch molecule

(2) mutation in the genetic material

(3) mutation in a protein

(4) change in a fat molecule

The graph shows the level of gene expression of five different genes in normal and cancerous cells.



4. Which statement is a valid inference that can be made based on the data in this graph?

- (1) The change in the level of gene expression in gene 4 could indicate it plays a major role in the development of cancer.
- (2) Slight decreases in gene expression will always result in the formation of cancer cells.
- (3) Cells will develop cancer if the gene expression of these five genes remains below four peptides per second.
- (4) An increase in the level of gene expression in these five genes is necessary for cancer to develop in cells.

5. Which situation would most likely produce a gene mutation in a squirrel?

- (1) The squirrel stops using its claws for digging.
- (2) The squirrel is exposed to radiation for several days.
- (3) Oak trees gradually become less common.
- (4) The weather becomes wetter for a short period of time.