



Standard #: SC.912.L.16.8

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Explain the relationship between mutation, cell cycle, and uncontrolled cell growth potentially resulting in cancer.

Clarifications

Integrate HE.912.C.1.7. Analyze how heredity and family history can impact personal health.

General Information

Subject Area: Science

Grade: 912

Body of Knowledge: Life Science

Idea: Level 2: Basic Application of Skills & Concepts

Standard: [Heredity and Reproduction](#) -

Date Adopted or Revised: 02/08

A. DNA stores and transmits genetic information. Genes are sets of instructions encoded in the structure of DNA.

B. Genetic information is passed from generation to generation by DNA in all organisms and accounts for similarities in related individuals.

C. Manipulation of DNA in organisms has led to commercial production of biological molecules on a large scale and genetically modified organisms.

D. Reproduction is characteristic of living things and is essential for the survival of species.

Content Complexity Rating: [Level 2: Basic Application of Skills & Concepts](#) - [More Information](#)

Date of Last Rating: 05/08

Status: State Board Approved

Related Courses

Course Number	Course Title
2000350:	Anatomy and Physiology (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000360:	Anatomy and Physiology Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000310:	Biology 1 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000320:	Biology 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000430:	Biology Technology (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
3027010:	Biotechnology 1 (Specifically in versions: 2015 and beyond (current))
2000440:	Genetics Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002440:	Integrated Science 3 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002450:	Integrated Science 3 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000800:	Florida's Preinternational Baccalaureate Biology 1 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
7920015:	Access Biology 1 (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 and beyond (current))
2000315:	Biology 1 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000500:	Bioscience 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002445:	Integrated Science 3 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2020 (course terminated))
7920040:	Fundamental Integrated Science 3 (Specifically in versions: 2013 - 2015, 2015 - 2017 (course terminated))

Related Access Points

Access Points Number	Access Points Title
SC.912.L.16.In.4:	Identify that cancer can result when cells change or grow uncontrollably.
SC.912.L.16.Su.3:	Recognize that cancer may result when cells change or grow too fast.
SC.912.L.16.Pa.3:	Recognize that illness can result when parts of our bodies are not working properly.

Related Resources

Name	Description
Cell Cycle for 500, Alex - Cell Cycle Jeopardy Template:	This interactive website provides challenging questions for students to work cooperatively as they review for formative or summative assessments. The questions provide scaffolding as they progress in order from factual recall to inference. This activity addresses several standards including meiosis, mitosis, gamete/spore formation and independent assortment.
The Control of the Cell Cycle:	The Control of the Cell Cycle educational game is based on the 2001 Nobel Prize in Physiology or Medicine, which was awarded for discoveries concerning the control of the cell cycle.

Lesson Plans

Name	Description
Gene Transfer and Cancer: Are They Linked?:	In this lesson, students will analyze an informational text intended to support reading in the content area. The article addresses a recent discovery linking bacteria and cancer cells in human tissue. Researchers believe that lateral gene transfer might play a role in cancer and other diseases associated with DNA damage. These results may lead to personalized medicine and might possibly be used as preventive measures. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric.
Cancer: A result of mutation?:	In this lesson, students will learn that genetic mutations can occur during the S phase of the cell cycle when DNA is replicated. When mutations arise in genes that control cell division, cancer may result.
Cell Cycles, UV Damage, and Cancer:	This lesson asks students to investigate the potential risks of cancer associated with everyday carcinogens, including UV gel manicures, a popular beauty regimen in nail care.
Mutation Manipulation Simulation Lab:	DNA replication, mutations, the cell cycle, and cancer are often taught separately in high school biology. Composing an activity that connects the understanding of these concepts and how they are interrelated is not always done effectively. DNA replication is a normal task for all cells, yet some cells become cancer cells because of changes to their DNA. This unwanted mutation can surpass the check points in the cell cycle and overtake normal cells. In this two day lesson, students will be reminded of those DNA concepts using reading strategies needed to support scientific explanation with research evidence in a concise activity. This lesson builds a scaffold of background knowledge from Day 1 to enhance the simulation lab of cancer cell engulfing normal cells in Day 2, which often causes the demise of otherwise healthy individuals. The entire lesson should take about 45 minutes each day.
Let's Cure Cancer!:	This a Model-Eliciting-Activity (MEA) that provides students with the opportunity to investigate the process of cancer as they research new chemotherapeutic agents to reduce cancer mortality rates and improve outcomes for cancer patients.
Protein Synthesis: Transcription & Translation:	Students will explore the process of protein synthesis, specifically transcription and translation, using a sequenced graphic organizer and an interactive simulation (Lesson 1 & 2). This resource contains 3 lessons: <ul style="list-style-type: none"> • Lesson 1: Transcription & Translation • Lesson 2: Lac Operon • Lesson 3: Proteins & Cancer As an extension (Lesson 3) the students will justify the applications of biotechnology that uses transcription and translation to synthesize proteins that target cancer cells or reason the possibilities of the amplification of antibodies using immortal cells. They will explore how mutations, genetic or epigenetic (lifestyle-chemicals, radiation, viruses), resulting in cancer. The student will connect changes that occur in the genetic code, during transcription and translation, to the deleterious impact on proto oncogenes that promote cell division and tumor suppressor genes that normally inhibit it.
Evaluating Claims About Cancer:	Students identify claims about UV exposure presented in a selection of media items, then design, execute, and report the results of an experiment designed to test one such claim.
Cancer and the Cell Cycle:	Students use five web animations and four videos to help them construct an explanation for how cancer develops, then use their new understanding to explain several historical observations about agents that cause cancer. After completing this activity, students will: <ul style="list-style-type: none"> • understand that many different agents can cause cancer, • understand that cancer represents a breakdown of the processes that regulate the growth of normal cells and tissues, • recognize that cancer develops as a result of genetic damage that occurs to cells across time, • be able to explain that cancer is associated with the occurrence of damage to particular classes of genes involved in the normal regulation of the cell cycle, and • understand that studying the processes involved in the development of cancer has led to a significantly increased understanding of the normal cell cycle as well as to new strategies for treating cancer.
Cancer as a Multistep Process:	This lesson is the third in a series, preceded by "The Faces of Cancer" and "Cancer and the Cell Cycle." In this lesson, students use random number tables and an Internet-based simulation to test several hypotheses about the development of cancer. After completing this activity, students will: <ul style="list-style-type: none"> • understand that cancer results from the accumulation of genetic damage to cells across time, and • be able to explain the increase in cancer incidence that occurs with an increase in age in terms of a multiple hit

(mutations in a number of genes) hypothesis for cancer's development.

Students assume the roles of federal legislators and explore several Cell Biology and Cancer website resources to identify reasons to support or oppose a proposed statute that would require individuals under the age of 18 to wear protective clothing when outdoors.

After completing this activity, students will:

- understand that science can help us improve personal and public health,
- be able to explain that good choices can reduce an individual's risk of developing cancer and can improve an individual's chance of survival if he or she does develop it,
- understand that ethics brings to public policy debates two presumptions: that we should protect individual autonomy and that we should protect individual and societal health and well-being,
- recognize that ethical values sometimes conflict in public policy debates about strategies for reducing the risk of cancer, and
- understand that it is possible for people to hold different positions on a controversial topic and still participate in a reasoned discussion about it.

[Acting on Information About Cancer:](#)

This lesson focuses on: how cancer is caused by mutations that accumulate over time in cells' DNA, how the genes mutated in cancer are involved in normal cell growth & division, and how different types of mutations affect the functions of these genes. We recommend that this lesson be the first BLOSSOMS lesson on cancer, that the students use, from the series of three cancer lessons made by scientists at the Broad Institute of MIT & Harvard. It would be helpful if the students already knew basic information about DNA structure & function, and how mutations can affect the RNA & protein encoded by this DNA. Only paper and writing utensils, and the ability to print out or display the provided handouts, are necessary to complete this lesson. This lesson is intended to take one or two class periods. The two most central hands-on activities in the lesson are as follows:

- Students do an activity with a "mutation mat" (which is much like a bingo board) that shows how mutations accumulate in cells over time. This activity demonstrates why cancer is a disease of old age, because the more years that pass, the higher the chance that enough mutations have occurred in the relevant genes in a single cell, to cause it to become a cancer cell.
- Students complete a worksheet about various examples of "mutations" that could affect a steam engine train and cause it to barrel out of control (for example: if the train's brakes aren't working, or if the coal shovelers are shoveling too quickly).

The lesson ends with two additional discussion topics: how a person can be pre-disposed to cancer if he/she inherits a mutation from his/her parents; and how different tissues in the body get exposed to different mutagens, thus causing different types of cancer.

[From Teenage to Old Age: How Cancer Develops Over Time:](#)

[Cancer: Cells Make Mistakes Tool!:](#)

Students will practice reading in the content area and answer questions regarding cancer and how it spreads.

[Profile: Judah Folkman Cancer Research:](#)

This PBS/NOVA lesson combines a discussion of the Nature of Science using a renowned Cancer researcher (and supported by the profiles of several other renowned scientists in the activities) to study concepts of creativity and tentativeness in the Nature of Science with a study of the biological characteristics of cells in disease (cancer).

Original Student Tutorial

Name	Description
Cancer: Mutated Cells Gone Wild!:	Explore the relationship between mutations, the cell cycle, and uncontrolled cell growth which may result in cancer with this interactive tutorial.

Perspectives Video: Experts

Name	Description
Cancer, a patient's story:	Basic cancer mechanisms and current treatment options. Download the CPALMS Perspectives video student note taking guide .
Mutations, the Cell Cycle, and Cancer:	Sometimes the cell cycle gets derailed a bit, which can lead to the development of tumors. Learn more about mutations! Download the CPALMS Perspectives video student note taking guide .

Text Resources

Name	Description
Bacterial DNA May Integrate into Human Genome More Readily in Tumor Tissue:	This informational text resource is intended to support reading in the content area. The article describes how scientists have recently found that lateral gene transfer occurs more rapidly into cancer or tumor cells than in normal, healthy cells. Scientists are going to further their research to see if there is a link between lateral gene transfer from the microbes that live on or around us and cancer. They believe this will also lead to a more personalized type of medicine.
Genetic Solution to Cancer, Diabetes?:	This informational text resource is intended to support reading in the content area. The text describes a rare form of dwarfism called Laron's Syndrome, which is associated with an unusually low incidence of cancer and diabetes. This combination of characteristics allows scientists to speculate on the relationship between all three conditions. It appears that a mutation that causes dwarfism protects against the common diseases of cancer and diabetes.
Cell Cycle and Cell Division:	This informational text resource is intended to support reading in the content area. The phases of the cell cycle are described, along with scientists' methods of studying the process. The proteins and cyclins involved in cell division are explained as well. The text ends by exploring future opportunities for discovery in this field.

Body's Immune System Kills Mutant Cells Daily:	This informational text resource is intended to support reading in the content area. This article explores how scientists discovered that the immune system naturally suppresses cancer while they were researching how B cells change during the growth of lymphoma. The text explains how T cells work as an "immune surveillance" and can be a way of preventing blood cancers. Through experimentation, scientists discovered how vitally important those cells are to possibly suppressing other forms of cancer in the future.
What is Cancer? What Causes Cancer?:	This informational text is intended to support reading in the content area. This article both identifies cancer and some of its causes; specifically, the fact that uncontrolled cell growth may result in a cancerous tumor.

Tutorials

Name	Description
Diagnosing Words: Effective Vocabulary Strategies:	Click "View Site" to open a full-screen version. This tutorial is designed to help secondary science teachers learn how to integrate literacy skills into their science curriculum. This tutorial will demonstrate a number of strategies teachers can impart to students to help them use context clues to determine the meaning of unfamiliar words within science texts. It will also help them teach students how to select the appropriate definition from reference materials. The focus on literacy across content areas is intended to help foster students' reading, writing, and thinking skills in multiple disciplines.
Cancer:	This Khan Academy video discusses the basics of cancer. The relationship between mutation, the cell cycle and uncontrolled cell growth is explained.
How Does Cancer Spread Through the Body?:	This TED-ED original lesson explains the three common routes of metastasis. Cancer usually begins with one tumor in a specific area of the body. But if the tumor is not removed, cancer has the ability to spread to nearby organs as well as places far away from the origin, like the brain. How does cancer move to these new areas and why are some organs more likely to get infected than others? Ivan Seah Yu Jun explains the three common routes of metastasis.
How Do Cancer Cells Behave Differently From Healthy Ones?:	How do cancer cells grow? How does chemotherapy fight cancer (and cause negative side effects)? The answers lie in cell division. George Zaidan explains how rapid cell division is cancer's "strength" -- and also its weakness.

Video/Audio/Animations

Name	Description
Exploring Mutant Organisms:	<ul style="list-style-type: none"> • Interviews with expert scientists about the genome and mutant organisms • Examples on model organisms used in genome research • Animation explaining how mutations occur
Cancer:	An introduction to what cancer is and how it is the by-product of broken DNA replication.

Student Resources

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Educational Game

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Perspectives Video: Expert

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Mutations, the Cell Cycle, and Cancer:	Sometimes the cell cycle gets derailed a bit, which can lead to the development of tumors. Learn more about mutations!
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Parent Resources

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