How Are Cancer Cells Different From Normal Cells?

Welcome to NSTA's Daily Do

Teachers and families across the country are facing a new reality of providing opportunities for students to do science through distance and home learning. The Daily Do is one of the ways NSTA is supporting teachers and families with this endeavor. Each weekday, NSTA will share a sensemaking task teachers and families can use to engage their students in authentic, relevant science learning. We encourage families to make time for family science learning (science is a social process!) and are dedicated to helping students and their families find balance between learning science and the day-to-day responsibilities they have to stay healthy and safe.

What is Sensemaking?

Sensemaking is actively trying to figure out how the world works (science) or how to design solutions to problems (engineering). Students do science and engineering through the science and engineering practices. Engaging in these practices necessitates students be part of a learning community to be able to share ideas, evaluate competing ideas, give and receive critique, and reach consensus. Whether this community of learners is made up of classmates or family members, students and adults build and refine science and engineering knowledge together.
Introduction
Cancer is a topic often covered in high school biology class at the end of a unit on cells as an example of what happens when cells do not divide properly or divide uncontrollably without regulatory mechanisms. However, when used as a phenomena, it can allow for students to use cancer as a vehicle for understanding cell division. In today’s Daily Do, we use the phenomenon of a teen diagnosed with Stage III melanoma (see video below) to prompt students to think about cancer differently than they have in the past.

Today's task, How are cancer cells different from normal cells?, creates an opportunity for students to look at examples of how normal cells divide and compare them to how cancer cells divide. Students engage in science and engineering practices to figure out what happens in cells that make them grow the way they do.

This task has been designed to be used by students, parents, and teachers in distance and home learning. While students could complete this task independently, we encourage them to work virtually with peers or in the home with family members.

Before you begin the task, you may want to access the accompanying How are cancer cells different from normal cells? Google Slides.

Presentation of Phenomena (What am I exploring today?)
Many traditional classroom discussions about cancer focus on cause, treatment and prevention. Today, we look at cancer from a new perspective – how cell regulation affects normal cell division. Although cancer can affect different kinds of cells throughout an animal and grows at different speeds, cancers all start the same way - with a mutation. So, How are cancer cells different from normal cells? Let's investigate!

Guidance: The goal is to get students thinking about what they know and think they know about cancer including how it grows. Presenting a phenomenon and asking students to generate questions about it creates a need to figure out the answer to those questions. This is authentic engagement and a powerful learning process.

Presenting the Phenomenon:
Have students observe the video above (slide 2) and write down what they notice and wonder about the phenomenon presented. This is a critical step in eliciting further questions about cell growth. Our goal here is to promote student thinking about questions they have related to this. ALL student questions are okay at this point. Our goal is to motivate curiosity and not distinguish between "good questions" and "bad questions" or "right questions" and "wrong questions". Common questions will arise for most students, which is what this task builds upon.

Investigative Questions (What questions do I have about what I just saw?)
Investigative questions are common questions kids may ask after they are introduced to the
phenomenon. Although questions may vary, many students are curious about what causes cancer and why it presents in so many different ways.

**Guidance:** It is important to allow time for thinking. Many students have ideas and questions but need time to formulate their idea or question into words. Some students may also benefit from writing their ideas down before they share. As adults we may be tempted to give them questions we feel might be important to explore, however we need to refrain from this and allow our students to practice asking their own questions.

**Common Questions: (slide 3)**
- Why would she only have 5 years to live?
- So was it a mole or a blackhead that grew into cancer?
- Where did the mole come from - how did it grow there?
- What is a melanoma?
- Are a mole and melanoma the same thing or does a mole turn into a melanoma?
- Why is she still on medicine if she is cancer-free?
- What did the doctor mean by cancer "travels through the lymphatic system"

**We want to focus on one question in particular at this point: (slide 4)**
- Why would she only have 5 years to live?
- So was it a mole or a blackhead that grew into cancer?
- **Where did the mole come from - how did it grow there?**
- What is a melanoma?
- Are a mole and melanoma the same thing or does a mole turn into a melanoma?
- Why is she still on medicine if she is cancer-free?
- What did the doctor mean by cancer "travels through the lymphatic system"

**Connection Guidance:** Students may make connections to previous concepts in other grade levels. For example, students may mention that when cells don't divide the way they're supposed to they can cause a tumor. Students may also bring up ideas of how to "kill" cancerous cells through a variety of different treatment options. We know that many students have been affected by cancer and want to ensure we are sensitive to their experiences. It is important to acknowledge and validate what each students bring to the table, but also move the discussion forward.

**Narrowing the Scope**
Tell students, "Now that we have identified the first question we want to figure out, it would be helpful to know what we think we know about cells and cancer." Have students individually create a table like the one on slide 5 and record their thinking. Also, ask them to document any new questions and ideas about what we need to figure out next.

Discuss the ideas that surfaced from students completing their tables. (You might create a class table to record students' ideas.) Students will likely share some or all of the following ideas and questions:
- We think cells grew into a mole and then the mole turned into cancer, but we are not sure.
- We think the melanoma is cancer but we are not sure if the mole and melanoma are the
same thing.

- We aren't sure what "stage III" melanoma means.
- We wonder if all moles are cancerous or if only moles that seem to appear out of nowhere are cancerous.

**Gathering Information Investigation**

We decided we need to know more about cells and how they could grow into a cancerous mole. Have students watch the short video *DNA Damage and Mutations* (slide 6) to learn more about what is going on inside the cells. As students watch the video, have them respond to the *Damage to DNA Leads to Mutation* questions (student activity sheet). When they are done, have them add any new questions they have to bottom or back of the activity sheet. Next, have a whole group discussion about the information they gathered from the video and to share any new questions that arose. Common questions include (slide 7):

- What are free radicals?
- How do mutations change DNA?
- How can mutation cause some cells to be different?
- What does radiation do?
- What kinds of changes occur?
- How do mutations make the cells different?
- How are mutations corrected?
- Does this cause other diseases?

Tell students that is sounds like they have more questions than answers. Next, show them the *Cancer: Unregulated Cell Division* video (slide 8) that will help them figure out what is going in Megan’s (the teen from the first video) skin cells. Play this video one time without stopping, and then have students make observations at specific times, using *How is division of cancer cells different from normal cell division?* student activity sheet as a guide, to figure out some things about normal cell division and atypical cell division.

**Guidance:** It is not necessary (during this activity) for students to figure out the intricacies of mutations and cell division. The focus right now is not on the structure and function of cells or the DNA it contains, but instead on figuring out uncontrolled cell growth is what causes cancers to grow and spread.

**Building Consensus**

It is valuable for learners to stop periodically and reach consensus about what they currently understand to be true. Teachers do this often in the classroom, periodically pausing instruction to be sure students have achieved the learning milestones necessary in order to move forward.

**Let's look back at what we've figured out up to this point.** After gathering information from the video, students will have figured out (slide 9):

- Mutations can cause cells to behave differently than they should.
- Cells contain DNA that can be damaged from things like free radicals and UV light from the sun.
- Cancer causes cells to keep dividing even when they should stop.
- Mutations are common but DNA can correct itself most of the time.

Engage students in a discussion to help them recognize they need to figure out what exactly is going on in the cells that allows for uncontrolled cell growth. This requires them to first understand how cell division works in normal cells. Tell students that cells divide through a process called mitosis.

**Additional Investigative Research**

We engage in additional research by engaging with the HHMI Biointeractive "Click and Learn" activity, The Eukaryotic Cell and Cancer (Slide 10). Have students take notes as they click through the activity. Remind them that they should make sure they click on the different buttons located in the middle of the circle as well as all the checkpoints. If your students would benefit from extra scaffolding for this activity use the Cell Cycles and Checkpoints student activity sheet to ensure they write down important information.

When students are finished with the The Eukaryotic Cell and Cancer "Click and Learn" activity, have them gather in small groups to discuss what they have learned that will help them answer the question, 'How do cancer cells divide differently from normal cells?'

**Teacher Guidance**: This" Click and Learn" activity contains a lot of information. The purpose of the activity is to gather basic information about the process and importance of cell division. The activity does have a downloadable activity form that can be used, however it is very detailed and will take students a considerable amount of time to complete.

**What Did We Figure Out?**

To answer our question, "**How are cancer cells different from normal cells?**", we need to take a look back at all of the scientific information we have gathered from our research (slide 11).

Looking back, it didn't make sense that a pea size mole would just appear out of nowhere where there was one normal skin. We figured out:

- Cells contain DNA.
- Cells divide and reproduce through a process called mitosis, which has several different stages.
- Mitosis has checkpoints in place to ensure cells divide correctly, however sometime mutations get through.
- Mutations are changes in the cells DNA.
- Mutations happen all the time but are usually repaired.
- Some mutations can cause uncontrolled cell growth.
- Uncontrolled cell growth can happen in different ways but each result in too many cells being produced
- Uncontrolled cell growth can lead to cancer, among other things.
- Melanoma is a skin cancer.
Based on what we have figured out and our current understanding about cells and cancer, can we answer our question? Here, students have the opportunity to develop an explanation based on all of the connections they have made between cancer, cells and mitosis.

**Connection Guidance:** Almost everyone as been impacted by cancer in some way by the time they get to high school. As this can be a stressful topic for some students, be cautious when asking students to make personal connections about this topic.

**NSTA Collection of Resources Today's Daily Do**
NSTA has created a *How are cancer cells different from normal cells?* resource collection to support teachers and families using this task. If you're an NSTA member, you can add this collection to your library by clicking ADD TO MY LIBRARY located near the top of the page (at right in the blue box).

**Check Out Previous Daily Dos from NSTA**
The NSTA Daily Do is an open educational resource (OER) and can be used by educators and families providing students distance and home science learning. Access the entire collection of NSTA Daily Dos.

**Acknowledgement**
This Daily Do is inspired by and uses materials from the *The Disease* storyline developed by the ISTA supported NGSS Biology Storyline Working Group and HHMI BioInteractive. These are an open-source resources that can be used by parents and teachers to implement student driven learning and can be found on the Illinois Science Teaching Association website.