# Breast Cancer: When Good DNA Goes Bad

**TEACHER NOTES**

## Objectives

- Students will learn about the genetic mechanism behind the formation of cancer cells.
- Students will learn about treatment options for breast cancer patients.
- Students will learn the mathematical modeling of how fast breast cancer cells replicate.
- Students will learn about the STEM career—Cancer Research Scientist.

## Vocabulary

- Mammogram
- Biopsy
- DNA
- Replication
- Tumor
- Cancer
- Malignant
- Benign
- Metastasis
- Mastectomy
- Lymph Node
- Diagnosis
- Surgery
- ELSA Clinical Study
- Cyst
- Lobe (Breast)
- Duct (Breast)
- Adipose Tissue
- Oncologist
- Oncology
- Mutation
- Base Pair
- Chemotherapy
- Radiation Therapy
- Hormone Therapy
- Stage 3 Triple Negative Invasive Ductal Carcinoma

## About the Lesson

- The lesson tells the story of Dr. Kristi Egland, a breast cancer research scientist and survivor of stage 3 triple-negative invasive ductal carcinoma, an aggressive form of breast cancer.
- Students will learn about the mechanism of the development of the cancer cells and replication errors in DNA.
- Students will be introduced to the treatment options available to fight cancer, including a clinical study by Sanford called ELSA that focuses on how to precisely target specific cancer cells.
- Teaching time: one to two 45-minute class period(s).
- Students will learn key DNA concepts in a real-world context of both the problems and solutions surrounding what happens when good DNA goes bad.


**Tech Tips:**

- This lesson includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products, including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the lesson for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials.

**Lesson Files:**

*Student Activity*

- When Good DNA Goes Bad_student.pdf

*TI-Nspire document*

- When Good DNA Goes Bad.tns

## TI-Nspire™ Navigator™

- Send out the When Good DNA Goes Bad.tns file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

## Lesson Materials

- Compatible TI Technologies:

TI- Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

## Background

**STEM CAREER—**This activity introduces the diagnosis, research, and treatment associated with breast cancer. Both Dr. Kristi Egland and Dr. Anu Gaba are on the front lines trying to learn and figure out solutions to the problems associated with the disease. Dr. Egland, a survivor and research scientist, holds a Doctor of Philosophy degree (PhD) and leads a team of bench scientists who work indirectly with patient samples and tissue models to create a test to monitor patient responses to therapy and detect recurrence when the disease is still treatable.

Dr. Gaba is a Doctor of Medicine (MD), and works with patients and a team of radiologists, surgeons, oncologists, geneticists, nurses, lab technicians, physicians, therapists, and others as they practice precision oncology, trying to determine the *best* way to treat *each individual's* cancer. In addition, she is involved in clinical research where patients are directly involved with her research projects. Her current project focuses on the question: Does DNA in cancer cells continue to mutate and are there patterns to these mutations that might lead to potential treatments?

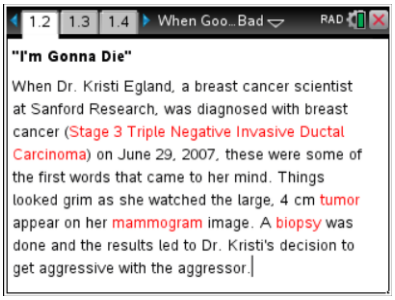
Although these teams have varied backgrounds and expertise, they are both working very hard to understand cancer, detect cancer as early as possible, and come up with the most effective ways of treating cancer, specifically breast cancer.

**OVERVIEW—**Students will use a simulation to watch a virtua tumor form within the stylized image of a breast. They will also explore the different areas of breast tissue and will find out how difficult it can be for the body to correctly replicate billions of base pairs by trying it on their own. This highly interactive lesson immerses students into the world of breast cancer research, the STEM careers associated with it, and the math and science behind the study of the disease.

**Move to pages 1.2–1.4.**

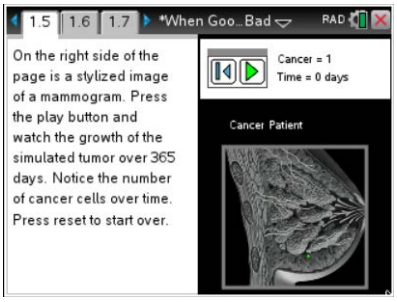
1. Students are introduced to Dr. Kristi Egland, a breast cancer research scientist, mother, and breast cancer survivor. They are guided on a journey into the world of breast cancer. Students learn what cancer is and how the different cancers are alike.

2. Pages 1.2 through 1.4 give students an emotional tie-in to Dr. Egland's story. Dr. Egland finds out she has an aggressive type of breast cancer. This is ironic because she is a breast cancer research scientist at Sanford Health, a healthcare and research network across the Midwest.



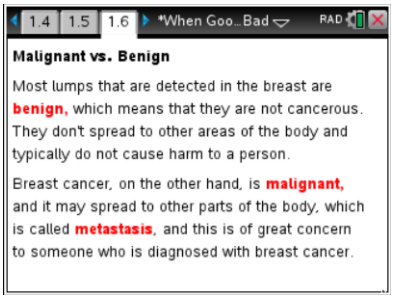

**Move to page 1.5.**

3. Page 1.5 offers students a virtual glimpse into a time-elapsed development of a tumor in the breast. The purpose of the simulation is to see how the number of cancer cells rapidly increases over time.




**Move to page 1.6.**

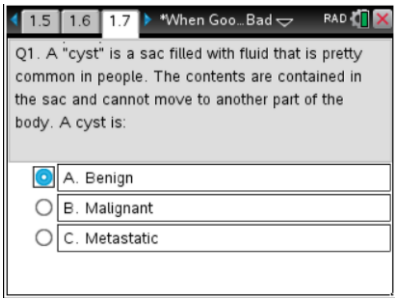
4. Page 1.6 gives students a contextual explanation of the difference between benign lumps and malignant cancer masses. When cancer cells spread to other areas of the body it is called *metastasis*.




**Move to page 1.7.**

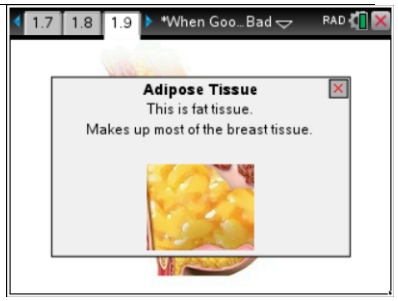
Q1. A "cyst" is a sac filled with fluid that is pretty common in people. The contents are contained in the sac and cannot move to another part of the body. A cyst is:

**Answer: A. Benign**



**Move to pages 1.8--1.9.**

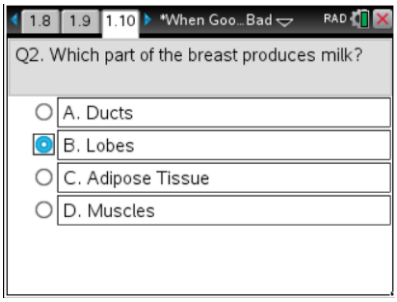
5. Pages 1.8 and 1.9 introduce students to breast anatomy. Students use a simple interactive image showing a transverse cut-away of an illustrated breast to realize that the breast is made up of multiple, functional parts. This will lay the ground work for the students to understand the concepts of metastasis and ductal carcinomas later in the lesson.




**Move to page 1.10.**

Q2. Which part of the breast produces milk?

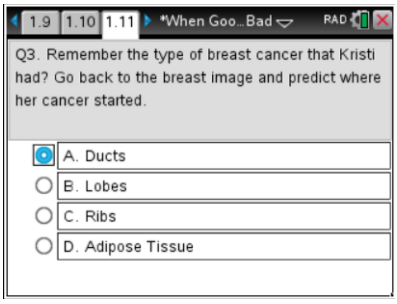
**Answer: B. Lobes**




**Move to page 1.11.**

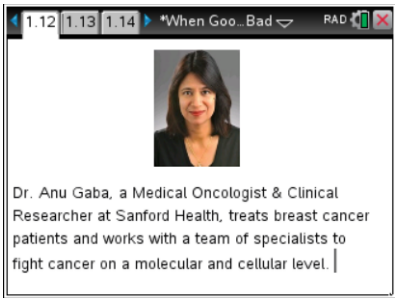
Q3. Remember the type of breast cancer that Kristi had? Go back to the breast image and predict where her cancer started.

**Answer: A. Ducts**

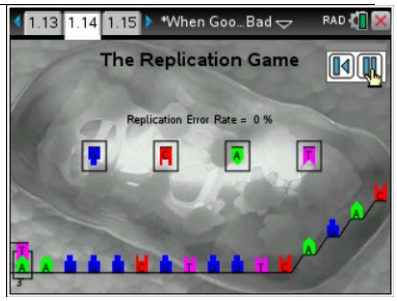



**Move to pages 1.12 – 1.13.**

6. Pages 1.12 and 1.13 introduce Dr. Anu Gaba, a medical oncologist and medical researcher at Sanford Health. Dr. Gaba's team of specialists works to understand cancer on a molecular and cellular level.

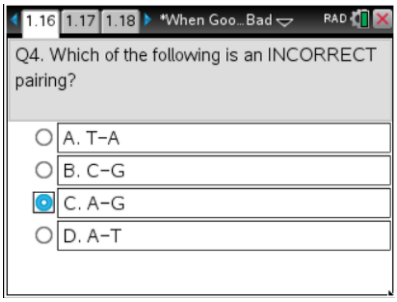


**Move to pages 1.14 – 1.15.**



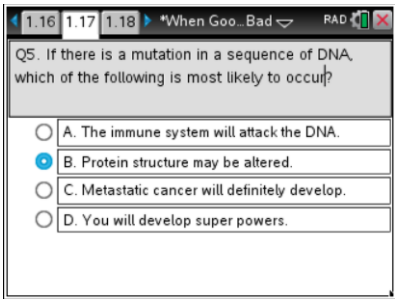

7. Pages 1.14 and 1.15 challenge students to accurately replicate a strand of DNA at varying speeds. The purpose of this exercise is to help students understand that billions of bases are replicated all the time inside their cells and mistakes can happen. Students will see that as they increase the speed of the game, their replication errors will increase. It also reinforces the relationships between cytosine and guanine, and adenosine and thymine.

**Move to page 1.16—1.18.**



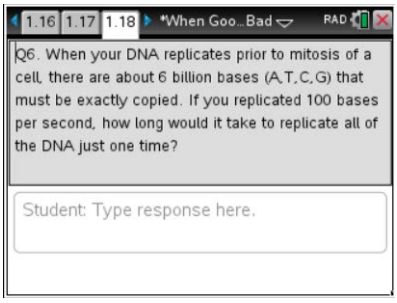

Q4. Which of the following is an INCORRECT pairing?

**Answer: C. A--G**




Q5. If there is a mutation in a sequence of DNA, which of the following is most likely?

**Answer: B. Protein structure may be altered.**




Q6. When your DNA replicates prior to mitosis of a cell, there are about 6 billion bases (A,T,C,G) that must be exactly copied. If you replicated 100 bases per second, how long would it take to replicate all of the DNA just one time?

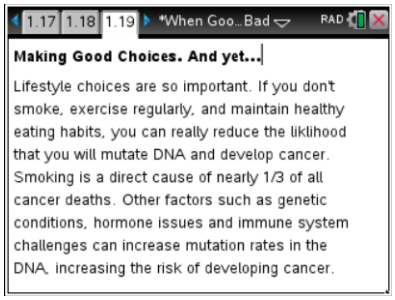
**Answer: There are multiple paths to determining the answer but students may want to convert the number of bases per second to number of bases per hour or even per day. From there, they can divide $6 \times 10^9$ by the number of bases per day. For example:**

**100 bases/second x 3,600 seconds/hour x 24 hours/day = 8,640,000 bases/day**

**6,000,000,000 bases/8,640,000 bases/day = 694.4 days to replicate 6 billion bases at a rate of 100 bases per second.**

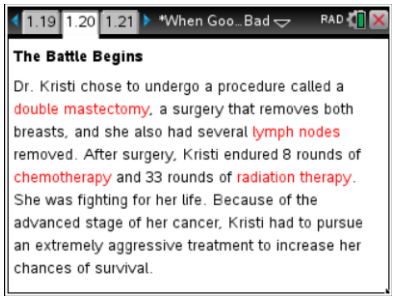
**Move to page 1.19.**

8. Page 1.19 discusses how certain lifestyle choices can increase your chance of getting cancer. Although you can reduce your chances of getting cancer by making good choices, cancer can happen to anyone at anytime.

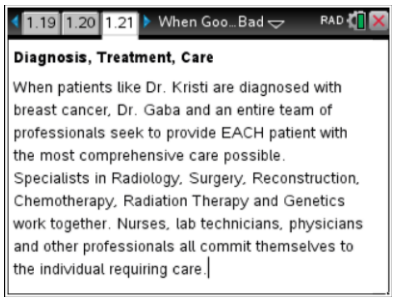



**Move to pages 1.20—1.21.**

9. These pages talk about Dr. Egland's double mastectomy and subsequent chemotherapy and radiation therapy. It may be a good idea to take a moment with students to distinguish between these treatment options.



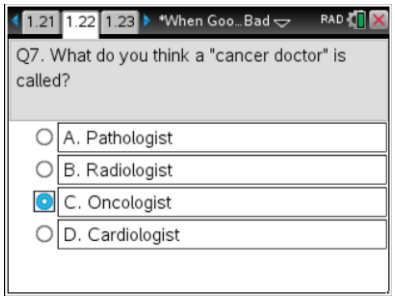

10. Dr. Gaba and a whole team of researchers are involved in identifying the specific elements to an individual patient's cancer. Cancer is specific to the person and requires a team of specialists to understand and accurately treat it.



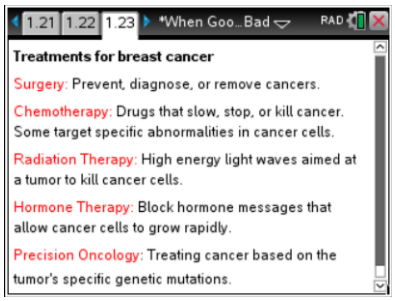

**Move to page 1.22.**

Q7. What do you think a "cancer doctor" is called?

**Answer: C. Oncologist**

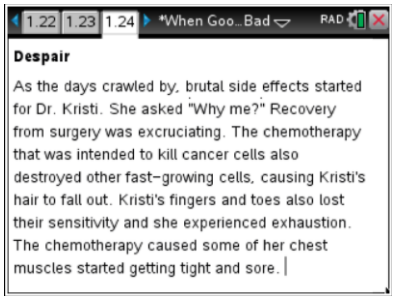


**Move to Page 1.23.**



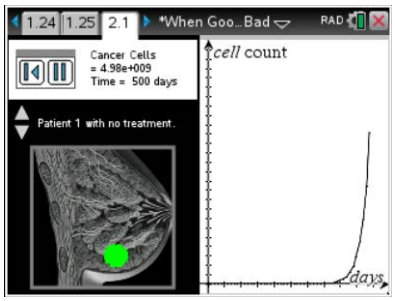

11. Page 1.23 documents various treatment options for breast cancer. Students should read through these treatments and think about the possible benefits and drawbacks of each.

**Move to page 1.24.**



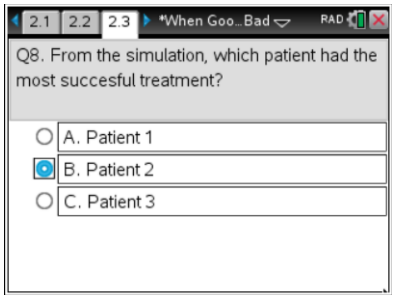

12. Read through page 1.24 to get a sense of the side effects of some of the treatments that Dr. Egland had to go through. Treating cancer can be tough on the body. Challenge students to think about how they would feel, emotionally, going through the fight that Dr. Kristi Egland went through. Would they stay positive? Would they become saddened?

**Move to pages 2.1–2.2.**




13. Students should explore the simulation on page 2.1. There are three virtual patients with breast cancer. Students should see that Patient 1 has an increase in cancer cells rapidly, with no decrease. This patient has a massive tumor. Patient 2 shows an increase but the cell count abruptly drops to zero and stays there. Challenge students to infer what may have happened (mastectomy with chemotherapy and radiation?). Patient 3 has a similar experience (to day 100) but the cancer, unfortunately, metastasizes. Discuss with your students each of these patients and find out what they believe may have happened with each patient as a result of the cancer. The data is captured on page 2.2.

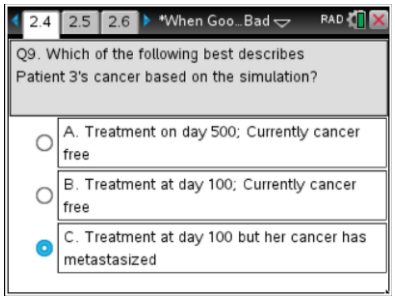
**Move to page 2.3.**




Q8. From the simulation, which patient had the most successful treatment?

**Answer: B. Patient 2**

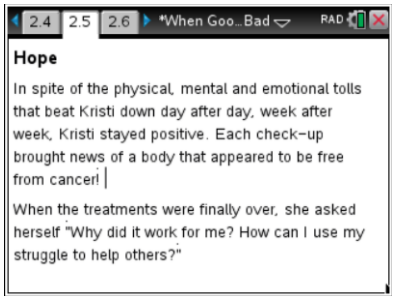
**Move to page 2.4.**




Q9. Which of the following best describes Patient 3's cancer, based on the simulation?

**Answer: C. Had treatment at day 100 but her cancer has metastasized.**

**Move to page 2.5–2.7.**




14. Pages 2.5 through 2.7 conclude the lesson with news that Dr. Kristi Egland is cancer free. Page 2.7 talks about the future of breast cancer research and treatment through innovative studies such as the ELSA Clinical Study. ELSA uses blood and tissue samples from breast cancer patients to help Dr. Gaba and her team, answer the question, *"Does DNA in cancer cells continue to mutate and are there patterns to these mutations?"* Because breast cancer is different between different people, there is a need for better diagnostic tools and treatments that are tailored to the individual's cancer. The ELSA Clinical Study hopes to serve as a basis for the development of those tools and treatments through the information collected from individuals participating in the study.

**TI-Nspire Navigator Opportunities**

Make a student the Live Presenter to demonstrate his or her asteroid simulation graphs.

**Assessment**

- Students will answer questions throughout the lesson to ensure they understand the concepts of breast cancer research, the mechanisms that are behind the disease, and STEM careers involved.

**Going Further**

- To add to this lesson you can share personal stories, ask students to share some of the things they already know about breast cancer, and talk about what's been reported it in the news. For example,
    - In recent years, some pretty famous people have tested positive for mutated BRCA genes, which substantially increases their risk of breast cancer. Some of these people have elected to have mastectomies and/or hysterectomies. Why do you think they made the decisions to do so? If you tested positive for mutated BRCA genes, what do you think you would do?

**For more information about Breast Cancer and the work at Sanford Research check out these links:**

**Edith Sanford Breast Cancer Center—www.edithsanford.org**
**Sanford Research—www.sanfordresearch.org**