

Case of the Missing Gene — Breast Cancer

Secrets of the Sequence Video Series on the Life Sciences • Grades 9 — 12
Teaching materials developed by VCU Life Sciences

V i r g i n i a C o m m o n w e a l t h U n i v e r s i t y

Classroom Tested Lesson

Video Description

“Secrets of the Sequence,” Show 138, Episode 2

“Case of the Missing Gene-Breast Cancer” – approximately 8 minutes viewing time

Every year nearly 200,000 American women are diagnosed with breast cancer. A girl born today has one chance in eight of developing this disease at some point in her life. To cure breast cancer –or at least make it easily treatable - scientists say we need to know what’s happening in our genes. Researchers at the Cold Spring Harbor Laboratory in New York recently discovered a gene linked to sporadic breast cancers. Scientists talk about that gene and other inherited genetic troublemakers.

Ward Television

Producer: Julie James and Heather Ross

Featuring: Michael Wigler, Cancer Research, Cold Spring Harbor Laboratory, Sharon Folland, Dr. Gregory Critchfield, President, Myriad Genetic Laboratories, Inc.

Lesson Author; Reviewers: Beth Richert; Catherine Dahl, Dick Rezba, and Kieron Torres

Trial Testing Teachers: Edie Andress, Reuwai Hanewald

National and State Science Standards of Learning

National Science Education Standards Connection

Content Standard C: Life Science

As a result of their activities in grades 9-12, all students should develop understanding of

- The cell
- Molecular basis of heredity

Content Standard E: Science and Technology.

As a result of their activities in grades 9-12, all students should develop

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives.

As a result of their activities in grades 9-12, all students should develop understanding of

- Personal and community health

Selected State Science Standards Connections

Use <http://www.eduhound.com> (click on “Standards by State”) or a search engine to access additional state science standards.

Virginia

BIO.5 The student will investigate and understand life functions of archaeobacteria, monerans (eubacteria), protists, fungi, plants, and animals including humans. Key concepts include

- e) human health issues, human anatomy, body systems, and life functions; and

BIO.6 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include

- a) cell growth and division;
- d) prediction of inheritance of traits based on the Mendelian laws of heredity;
- e) genetic variation (mutation, recombination, deletions, additions to DNA);
- h) use, limitations, and misuse of genetic information; and
- i) exploration of the impact of DNA technologies.

Delaware

Structure/Function Relationship

4. Cells store and use information to guide their functions. DNA molecules in each cell carry coded instructions for synthesizing protein molecules. The protein molecules have important structural and regulatory functions.

Heredity

1. Hereditary/genetic information in chromosomes is contained in molecules of DNA that consist of various combinations of four different subunits (nucleotides) that encode this information. Genes are sections of DNA that direct syntheses of specific proteins associated with traits in organisms.
3. Gene mutations are alterations in normal DNA structure which can be caused by coding error in DNA synthesis, heat, radiation and certain chemicals. Mutations may be beneficial, harmful, or neutral to cell function and can be passed on to an organism's offspring. Somatic mutations are not heritable.

Health and Technology Applications

1. The expanding ability to manipulate genetic material, reproductive processes, and embryological development are being used to diagnose and treat human abnormalities as well as manufacture new consumer products. These applications raise many ethical, legal, social, and public policy questions.
2. Recombinant DNA technology, which is a form of genetic engineering, involves the insertion of DNA from one cell into another cell where the inserted DNA is expressed. Genetic engineering is being applied in many areas of biology, agriculture, and medicine.
3. DNA is analyzed to study populations, identify individuals, and diagnose genetic disorders.

Overview

Breast cancer affects numerous women but the role of genetics remains unclear - how many and which genes are involved. The video distinguishes between two types of breast cancer. One is clearly inherited and has been linked to a mutation in a gene called BRCA (from BReast Cancer) which makes proteins that repair other genes. When BRCA is missing, the damaged cells do not get repaired and their continued growth eventually spirals into cancer. 87% of women with this inherited BRCA mutation will get breast cancer but this mutation accounts for only 5-10% of breast cancer patients. The second type of breast cancer that accounts for the other 90% of women diagnosed is totally sporadic with possibly hundreds of genes being affected. One gene called DBC II (from Deleted in Breast Cancer), which is found on Chromosome 8, has recently been linked to sporadic breast cancer although its exact role is still unknown.

Women can choose to take a test that is now available to determine if they indeed have inherited the BRCA mutation. This in turn will help them to decide on how radically they wish to approach preventative treatment. However, for the majority of women, there is not yet a test to determine whether or not they will be among the unlucky ones to be afflicted with the random type of breast cancer. Researchers continue to study and compare cancer cells looking for "biomarkers" like the DBC II that may be starting points for this disease.

Note: Field test teachers suggested this video and lesson is a useful follow up to any Protein Synthesis unit.

Testing: A sample related multiple choice item from State Standardized Exams

The chain below represents three codons. Which of the following changes would be expected in the amino acid chain if the mutation shown below occurred?

Codon Chart

Second Position

		U	C	A	G		
First Position (5')	U	Phenylalanine	Serine	Tyrosine	Cysteine	Third Position (3')	U
		Phenylalanine	Serine	Tyrosine	Cysteine		C
		Leucine	Serine	Stop	Stop		A
		Leucine	Serine	Stop	Tryptophan		G
	C	Leucine	Proline	Histidine	Arginine		U
		Leucine	Proline	Histidine	Arginine		C
		Leucine	Proline	Glutamine	Arginine		A
		Leucine	Proline	Glutamine	Arginine		G
	A	Isoleucine	Threonine	Asparagine	Serine		U
		Isoleucine	Threonine	Asparagine	Serine		C
		Isoleucine	Threonine	Lysine	Arginine		A
		Methionine	Threonine	Lysine	Arginine		G
G	Valine	Alanine	Aspartic acid	Glycine	U		
	Valine	Alanine	Aspartic acid	Glycine	C		
	Valine	Alanine	Glutamic acid	Glycine	A		
	Valine	Alanine	Glutamic acid	Glycine	G		

5' AGAUCGAGU 3' → 5' ACAUCGAGU 3'

- F The amino acid sequence would be shorter than expected.
- G The identity of one amino acid would change. *
- H The amino acid sequence would remain unchanged.
- J The identities of more than one amino acid would change.

Source: Texas end-of-course biology test

Video Preparation

Preview the video and make note of the locations at which you will later pause the video for discussion.

Before Viewing

The National Cancer Institute has said that a girl born today has a one in eight chance of developing breast cancer at some point in her life.

Ask: "What do you know that you could you do to minimize getting breast cancer? Listen carefully to the video to see what other options are available."

Self examination, routine doctor's examination, regular mammograms

During Viewing

1. **START** the video.
2. **PAUSE** the video (2.44 minutes into the video) after the narrator says, "...but scientists do know it is not inherited."

DBC II (from Deleted in Breast Cancer) is a gene on Chromosome 8 that has recently been found to be linked to the sporadic type of breast cancer. The video describes two basic abnormalities in genes that can lead to the development of cancer – one where the gene propels too much growth in the cells and one where the gene inhibits or prevents the growth of the cells.

Ask: "Which type of gene is DBC II?"

DBC II is a tumor suppressor gene, which means that DBC II normally inhibits the growth of tumor cells. Cancer will occur when DBC II is missing, mutated or not expressed because the body will then not be able to suppress the unhealthy cells.

3. **RESUME** the video
4. **PAUSE** the video (7.07 minutes into the video) after the narrator says, ".... woman who choose surgery often have no detectable cancer."

The video mentions the following statistics: Of those women found to have a BRCA (from Breast Cancer) mutation, 87% will get breast cancer, 44% will get ovarian cancer and 93% will get one or both of the two types of cancer.

Ask: " Can you list the 3 options that are mentioned as preventative treatment?"

Note: These options are all used by healthy individuals as preventative treatment if they believe they are in a high-risk bracket or are aware they have the BRCA mutation.

- *Undergoing early and regular mammograms*
- *Taking the drug Tamoxifen that reduces the risk by one third*
- *Electing surgery to remove healthy breast or ovaries, which reduces the risk by 90%-95%*

5. **RESUME** the video and play to the end.

After Viewing

This video shares some fairly devastating statistics with the viewer. Every year hundreds of thousands of women are diagnosed with breast cancer. Only about 5-10% has inherited a predisposition to breast cancer so 90% of these women have developed it by pure chance – similar to being hit by a truck when crossing a street.

1. Ask: "If a test were available to you and affordable, would you want to know whether or not you were likely to be in this high-risk group? What factors would you take into consideration in making your decision?"
Family history, sibling/family attitudes.
2. Ask: What would be the pros and cons of knowing this information about yourself?
Possible change in attitude towards life (pro or con), increased awareness for early detection (pro), relief (pro) or further anxiety(con), possible guilt if free of it while siblings are not (con), possibility of medical insurance problems (con),

Teacher Notes for the Student Activity: Designing an Educational Brochure on Breast Cancer

This activity is adapted from the Breast Cancer Scenarios found at www.lbl.gov/education/elsi/frames/screening-class1-activity-f

Students will be designing tri-fold brochures to inform and educate various groups of people about breast cancer.

Students will be given a breast cancer scenario and asked to design a brochure that will specifically address that scenario. Students will research breast cancer information on the Internet and in the library to include in their brochures.

Note: If sufficient time is not available to construct brochures, you may wish instead to have the groups research the scenario questions in preparation for a class discussion of breast cancer.

Procedure:

1. Make copies of the scenarios to distribute.
2. Place students into groups of four and distribute a different scenario to each group. [Some groups may have the same scenario depending on the size of the class.]
3. Have group members brainstorm the kinds of information that may be important to inform and/or reassure the person(s) in their scenario. Ensure that students include information that answers the discussion questions included with each scenario.
4. It may be necessary to guide some groups to issues such as diagnosis, treatment and side effects, survival rates, genetic counseling, and so on.
5. After students have brainstormed as a group, have a member of each group read aloud their scenario and share two or three types of information their group thinks should be included in their brochure.
6. Note that some types of information may be unique to one group's brochure while others may be common to more than one brochure.
7. Prepare a scoring rubric for each scenario that includes the 5 or 6 main topics to be covered for assessment of both rough draft and completed projects. The rubric should address completeness, informational value, and appeal of the brochure. (See sample rubric provided.)
8. Provide time for students to use the Internet and the library to gather the information they need for their particular breast cancer scenario.
9. After students have completed their research, gather the class together to share the types of information they have been able to find and address any problems they may have encountered.
10. Have each group make a rough draft copy of their brochure. Encourage students to include illustrations, graphs, charts, and color to increase interest and understanding. You may wish to have some examples of professionally prepared medical brochures available for student to peruse.
11. Have each group turn in its rough draft copy for initial assessment. Use the rubric you designed to assess the completeness, appeal, and informational value of each project.
12. Return rough drafts and allow groups to make improvements before they submit their final draft.

Note: While not required, students will find that using a template when creating their tri-fold brochure will help them organize their ideas and focus on how they will present their information. A Microsoft Word tri-fold brochure template can be downloaded free from:

<http://office.microsoft.com/templates/directdownload.aspx?AssetID=TC060874601033&Application=WD&Result=2&Version=8>

Sample Breast Cancer Brochure Rubric:

Aesthetics

The use of color throughout the brochure was well planned and appealing 0 1 2 3 4 5

The use of graphs, charts and illustrations was appropriate and added to the information and/or appeal of the brochure. 0 1 2 3 4 5

The narrative was well placed on the brochure and added to the information and/or appeal of the brochure. 0 1 2 3 4 5

Information

Information includes all required areas determined during the brainstorming session. 0 5 10 15 20

Information is appropriate in content and in educational level for your target audience. 0 5 10 15 20

Total Points: _____

Comments and suggestions for improvement:

Student Handout: Designing an Educational Brochure on Breast Cancer

In this activity you will be divided into small groups to design a tri-fold brochure to inform and educate various groups of people about breast cancer. Each research group will be given a different breast cancer scenario and will be asked to design a brochure that will specifically address that scenario. You will use the Internet and the library to research breast cancer information to include in your group's brochure. You may wish to use a tri-fold template when creating your brochure.

<http://office.microsoft.com/templates/directdownload.aspx?AssetID=TC060874601033&Application=WD&Result=2&Version=8>

Procedure

1. Your teacher will distribute a different breast cancer scenario sheet to each group. [Some groups may have the same scenario depending on the size of the class.]
2. Read your scenario silently and think about the issues raised.
3. In your group, spend some time brainstorming the kinds of information that may be important to educate and/or reassure the persons in your scenario. Be sure that you provide information that will help answer the discussion questions included with each scenario. Take notes on what you and your group members decide will be needed for your group's brochure. You will be sharing these ideas later with the rest of the class.
4. After you have brainstormed as a group, one member of your group will read aloud your scenario to the class and then share two or three types of information your group thinks they should include in their brochure.
5. Note that some types of information may be unique to one group's brochure, while other information may be common to more than one brochure. You may decide to include in your group's brochure some of the types of information that other groups suggested.
6. Your teachers will design a rubric for each scenario that includes the main topics to be covered for assessment of rough draft and completed brochures. The rubric will address completeness, informational value, and appeal of the brochure.
7. Use the Internet and library to research the information you need for your group's particular breast cancer brochure.
8. Your teacher will re-convene the class for the groups to share the types of information you all have been able to find and address any problems you may be encountering with your research.
9. After refining the information you have gathered, your group will make a rough draft copy of your brochure. You are encouraged to include one or more of the following: illustrations, graphs, charts, and color to increase interest. Your teacher may have some examples of informational medical brochures available for you to see.
10. Once your group has completed its rough draft, turn it in for initial assessment. Remember that you and other group members will be assessed on the completeness, appeal, and informational value of your brochure.
11. After your rough draft has been evaluated, you will be asked to make suggested improvements in your final draft.

Scenarios for Students

Breast Cancer Scenario 1

Mary Jane Smith is a 42-year-old woman who has been diagnosed and treated for breast cancer. Mary Jane has a married sister, Samantha, who has three children - two daughters, Fran and Irene, and a son, Don; all three are in their teens. Mary Jane and Samantha's mother died of breast cancer at the age of 48; their father died of an unrelated illness.

Mary Jane's doctor is a breast cancer researcher at a local university hospital who tested her to determine if Mary Jane's breast cancer was the inheritable type. Test results showed that Mary Jane has a gene called BRCA-2 that accounts for about 2% of the breast cancer cases diagnosed each year. The BRCA-2 test was not available while Mary Jane and Samantha's mother was alive, so there is no way to tell if Mary Jane inherited the gene from her mother or her father. Mary Jane has the gene; therefore there is a 50% chance for each of her children to have inherited the gene from her. This gene triggers breast cancer in both males and females, and 85% of females having the BRCA-2 gene develop cancer. Although only 1% of breast cancer occurs in men, most of these cases occur in men with the BRCA-2 gene.

Research on the BRCA-2 gene is very new, and the doctor asks Mary if she can study the family to determine their risk for this disease. She needs the cooperation of all family members in order to include them in the study. Mary Jane knows that early detection is extremely important for survival. She has recommended that all family members be tested.

Her sister Samantha is 40 years old and *is not sure* if she wants to be tested. She would like more information before she decides. However, her daughters are interested in participating in the research and better understanding their risk for breast cancer. Samantha's son does not have an opinion. If any of the children has the gene, Samantha will know that they have inherited it from her.

Design an informational brochure for Samantha and others with similar needs and concerns. Be sure that your brochure includes sufficient information to answer the following questions:

- a. *Who should be tested and why?*
- b. *Should teenagers decide for themselves?*
- c. *How might having the results affect a person's mental state?*
- d. *What impact could a positive test result have on future employment or health insurance eligibility?*
- e. *What statistical information is available about people with the BRCA gene?*
- f. *Could negative test results lead to complacency?*

Breast Cancer Scenario 2

Maria Fernandez is a 30 year old mother of two young boys. She recently lost both her mother and an older sister to breast cancer. After learning about the availability of genetic testing to determine a person's risk for a particular form of breast cancer, Maria decided to have the test done. The gene for which Marissa was tested (BRCA-2) is responsible for causing 2 percent of breast cancers. Women who test positive for this genetic mutation have an 85 percent chance of developing breast cancer by age 80.

Maria's test came back positive. She was given four possible courses of action. She could have both of her breasts removed as a form of prevention, enter a preventative drug therapy program, become a subject in experimental clinical trials for a new drug, or she could simply continue to have regularly scheduled follow-up visits and check-ups.

Design an informational brochure for Maria and others with similar needs and concerns. Be sure that your brochure includes sufficient information to answer the following questions:

- a. Are all physicians in agreement about the importance of genetic testing?*
- b. Are there reasons why someone shouldn't be tested?*
- c. Do you consider the surgery option to be preventative medicine? Why or why not?*
- d. When the genetic test is positive, at what age should a woman choose surgery over the other options?*
- e. What are the risks and benefits of the four options?*

Breast Cancer Scenario 3

Leticia Gress is a 40-year old African-American woman with two small children. To her knowledge she has no family history of breast cancer. However, like most women, she is concerned about her chances of developing breast cancer and seeks advice from her doctor. She has heard conflicting advice about various preventative steps and effects of lifestyle choices, such as diet, exercise, and weight gain. In addition she has heard that race plays a factor in the prevalence of this and other diseases.

Design an informational brochure for Leticia and others with similar needs and concerns. Be sure that your brochure includes sufficient information to answer the following questions:

- a. What is the role and importance of self-examination, regular check-ups, and annual mammograms in the prevention and treatment of breast cancer?*
- b. Although expensive, genetic testing is now available. Should physicians recommend it to all their patients?*
- c. Should a woman seek the advice of a specialist such as a obstetrician/gynecologist who may have more information on risks than a primary care physician?*
- d. To what extent does diet, exercise, weight and other life style behaviors affect a person's risk for breast cancer?*
- e. Does where you live (demographics) or who you are (ethnicity) affect your risk of breast cancer?*

Breast Cancer Scenario 4

Kathleen is a quiet 15 year old girl. Her mother's youngest sister has been diagnosed with cancer. Kathleen has overheard parts of their phone conversations and thinks that it is breast cancer. Her mother is so upset that Kathleen is reluctant to ask her mother any questions about the disease. She has also heard at school conflicting stories about how a person gets breast cancer. Kathleen wonders if any of her behaviors can affect her risk of getting this kind of cancer or if it is contagious.

Design an informational brochure for Kathleen and others with similar needs and concerns. Be sure that your brochure includes sufficient information to answer the following questions:

- a. What is breast cancer?*
- b. What causes breast cancer?*
- c. What are some of the various types of breast cancer?*
- d. How is breast cancer detected?*

Additional Resources:

Because Web sites frequently change, some of these resources may no longer be available. Use a search engine and related key words to locate new Web sites.

Family Issues Involving Breast Cancer

<http://www.medicinenet.com/script/main/art.asp?articlekey=17340>

Preventative Therapies

<http://www.health.state.mn.us/htac/ptbc.htm>

Breast Cancer Screening

<http://www.lbl.gov/Education/ELSI/screening-main.html>

[SHAREing & CAREing Breast Cancer Support and Advocacy Group.](#)

Breast cancer support and advocacy group. We are breast cancer survivors sharing our experience, strength and hope. ... organization, is providing grassroots support services to breast cancer victims and their families

www.shareing-careing.com

[A COMPREHENSIVE BREAST CANCER EDUCATION PROJECT](#)

A Comprehensive Breast Cancer Education Project.

www.aces.edu/urban/breast.html

[Breast Cancer Options - MIDHUDSONOPTIONSPROJEC](#)

... Breast Cancer Options. Breast Cancer E-mail Newsletter ... activity, process, or chemical exposure is harmless. Breast Cancer Options provides information on ways that people can ...

www.breastcanceroptions.org

[Breast Cancer Diagnosis](#)

Return to main page. Methods of Breast Cancer Diagnosis. Mammography. A mammogram is an X-ray of the breasts. Mammography is useful for spotting early changes in the breast, when it may be difficult to feel a lump.

<http://research.umbc.edu/~lgiles1/biopsy.html>

Genomic Revolution

http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml

The Web site to the government-funded Human Genome Project with links about genomics, the history of the project, and more.

Secrets of the Sequence Videos and Lessons

This video and 49 others with their accompanying lessons are available *at no charge* from www.vcu.edu/lifesci/sosg