



Breast Cancer Risk: Genes and the Environment

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Part I: A Family History of Breast Cancer

My family reunion began with a memorial service for my cousin Laura, who died from breast cancer when she was only 45 years old. After the service, three of my cousins (Margie, Shelly and Alice) revealed that they had breast cancer.

My cousin Margie explained that she had a genetic test that showed she has a mutated BRCA1 gene that increases the risk for breast and ovarian cancer. Once my cousins and I realized that we might have inherited the mutated BRCA1 gene, all of my cousins agreed to be tested for the BRCA1 gene mutation.

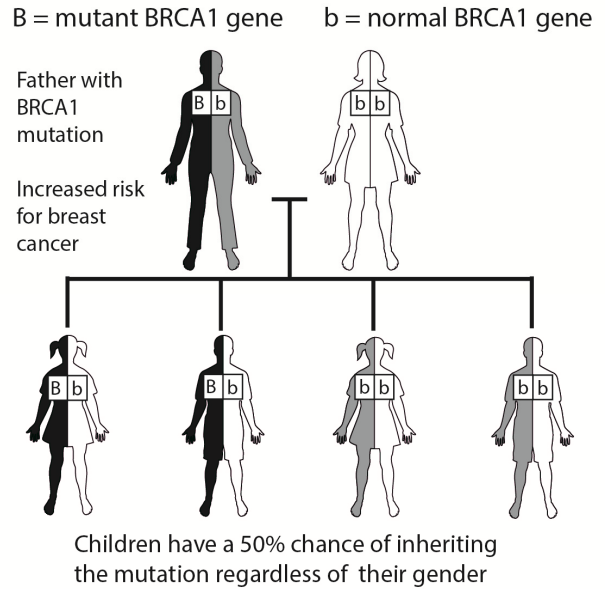
BRCA1 Gene and Cancer Risk

Mutations in the BRCA1 gene are known to increase the risk of breast and ovarian cancers in women. Approximately 50% to 65% of women born with a mutation in the BRCA1 gene will develop breast cancer by age 70, and 35% to 46% will develop ovarian cancer by age 70. For males, a BRCA1 gene mutation increases their risk for breast cancer and prostate cancer.

1. Your lab kit contains a pedigree for my family. List the names of family members who have or had breast cancer.

BRCA1 Gene and Inheritance

Because the BRCA1 gene mutation is dominant, it only takes one copy of the mutant gene to increase a person's risk for breast cancer. The BRCA1 gene is located on chromosome 17 which is an autosome, not a sex (X or Y) chromosome. This means that the mutated BRCA1 gene can be inherited from either your mother or your father.



2. Does having one normal BRCA gene and one mutated BRCA1 gene increase a person's risk for developing breast cancer? Support your answer with information from the text and diagram above.

3. Explain how a woman could inherit a mutated BRCA1 gene from her father.

4. Your lab kit contains a bag with a **BRCA1 Genetic Test** sheet that has been spotted with DNA (gene) samples from my family. You will analyze the genetic test to determine which family members inherited the mutated BRCA1 gene. *Note: Leave the test sheet in the bag.*












Me (Sue)	Kathy	Jim	Margie
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gary	Shelly	Jen	Fred
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bill	Alice	Mary	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Each circle contains a DNA (gene) sample from a family member.

5. To make the DNA visible on the genetic test, you need to stain the BRCA1 Genetic Test with a DNA stain:
 - a) Fill the plastic measuring cup with 20 ml of tap water.
 - b) Pour the contents of the **DNA Stain** tube into the water in the cup.
 - c) Stir until the DNA stain has dissolved.
 - d) Pour the DNA stain solution from the cup into the plastic bag that contains the BRCA1 Genetic Test.
 - e) Close the bag completely then lay the bag flat on your desk or table so that the DNA stain comes in contact with all parts of the BRCA1 Genetic Test paper.

6. Look at the BRCA1 Genetic Test paper in the bag. Do not remove the paper from the bag.
 - A pink spot indicates the presence of a BRCA1 gene mutation that increases the risk for breast cancer.
 - Lack of a pink spot indicates that the BRCA1 gene mutation is not present.

7. Darken the circles in the diagram below to show the pink spots that indicate the family members who have a BRCA1 gene mutation.

Me (Sue) 	Kathy 	Jim 	Margie 
Gary 	Shelly 	Jen 	Fred 
Bill 	Alice 	Mary 	

8. Discard the bag that contains the BRCA1 Genetic Test paper.

9. On the **My Family Pedigree** sheet, write "X" under the name of each cousin (the bottom row of symbols) who has the BRCA1 gene mutation. *Note: Laura had not been tested for the BRCA1 gene mutation.*

10. Is it possible to have a mutated BRCA1 gene and not have breast cancer? Support your answer with evidence from the pedigree and results of the genetic tests.

11. Which males on the pedigree have an increased risk for breast cancer and prostate cancer?

12. List TWO reasons why it might be important that both males and females get tested to determine if they inherited the BRCA1 gene mutation.

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- ---

13. Is it possible to have breast cancer and not have a mutated BRCA1 gene? Support your answer with evidence from the pedigree and results of the genetic tests.

Part 2: A Survey - Risk Factors for Breast Cancer

Although genetics is a contributor to breast cancer development, scientific studies have estimated that inherited genes account for only 5–10% of breast cancers. Other risk factors, such as those listed in Column 1 of the chart below, may increase a woman’s chance of developing breast cancer.

1. In Column 2 of the chart below (**What Do YOU Think?**), write **Yes**, **No**, or **Possibly** to indicate whether you think each risk factor increases a woman’s risk of developing breast cancer.

Column 1	Column 2	Column 3
Possible Risk Factors for Breast Cancer	What Do YOU Think? Is it a breast cancer risk factor? Yes, No, or Possibly	Scientific Evidence? Is it a breast cancer risk factor? Yes, No, or Possibly
Aging		
Cell phones		
Being overweight or obese		
High dose estrogen birth control		
Chemicals in plastics and cosmetics		
Drinking alcohol		
Gender		
Heredity (family history)		
Caffeine		
Lack of physical activity		
Night work		
Pesticides such as DDT		
Race/Ethnicity		
Smoking or second-hand smoke		

2. Use the information in the **Breast Cancer Risks** poster to complete Column 3 of the chart above. Write **Yes**, **No**, or **Possibly** to indicate whether scientific research provides evidence that each risk factor increases breast cancer risk.

3. Some factors associated with breast cancer risk cannot be controlled (changed). List at least four risk factors for breast cancer that you cannot control.

- _____
- _____
- _____
- _____

4. Other factors associated with breast cancer risk can be controlled (changed) by making lifestyle choices. List four actions that people could take to reduce their exposure to known risk for breast cancer.

- _____
- _____
- _____
- _____

5. Many scientists recommend taking a “better safe than sorry” approach when considering exposure to possible environmental risk factors. List four things you might be cautious about using if you take the “better safe than sorry” approach to breast cancer risk factors.

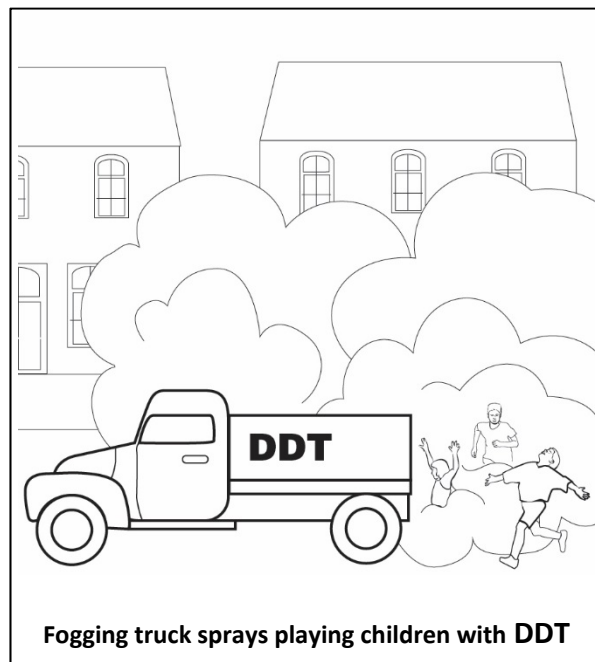
- _____
- _____
- _____
- _____

6. Do you think that avoiding all known risk factors will prevent breast cancer? Explain your answer.

Part 3: DDT, Breast Cancer, and Windows of Susceptibility

Shelly and Alice both have breast cancer. They do not have the BRCA1 gene, so they both wonder what caused their breast cancer.

Shelly saw a news program about animal research on breast cancer. The research showed that rats exposed to the chemical DDT had higher rates of breast cancer than rats that were not exposed to DDT. Shelly thinks that her breast cancer and Alice's breast cancer were caused by DDT that was sprayed to kill mosquitos in the town where they lived when they were children. Shelly and Alice remember playing outdoors when the DDT fogging trucks came through their neighborhood. Alice even has a picture that her mother took of them playing in the DDT fog cloud.



Alice did some Internet research and the information below summarizes what she learned about DDT and breast cancer.

DDT and Breast Cancer

DDT (dichlorodiphenyltrichloroethane) is a chemical insecticide that was used during the 1940s through the 1960s. DDT spraying is an effective way to kill mosquitos that carry diseases such as malaria, encephalitis, and West Nile virus. However, the use of DDT in the United States was banned in 1972 because research showed that DDT persisted in the environment and had devastating effects on some wildlife. Many women were exposed to DDT spraying before DDT was banned. DDT is still sprayed in some countries where diseases caused by mosquitos are a serious health problem.

The chemical structure of DDT is similar to the chemical structure of estrogens (female sex hormones). Because of this, DDT can act as an **endocrine disruptor**. Endocrine disruptors are chemicals that interfere with the normal action of hormones produced by the body's endocrine system. Because estrogen has been associated with breast cancer risk, it was suggested that DDT exposure might also be a risk factor for breast cancer.

Until recently, most research studies found no evidence that DDT exposure increases the risk of breast cancer in humans.

1. What was DDT used for when Shelly and Alice were children?

2. Why was the use of DDT banned in the United States?

3. Why is DDT still used in some countries?

4. What is an endocrine disruptor?

5. Why does DDT interfere with the normal action of female sex hormones?

6. Does DDT increase the risk of breast cancer for women?

Alice saw a TV news interview with a scientist who had done research on the link between DDT exposure and breast cancer. The scientist had a theory that there are certain times during human development, called “windows of susceptibility”, when people are more susceptible to (affected by) exposure to environmental risk factors. The scientist hypothesized that females who were exposed to DDT before puberty (before their breasts are fully developed) or before birth have an increased risk of breast cancer later in life.

7. How would you define “windows of susceptibility”?

8. What is the “window of susceptibility” that the scientist is investigating?

9. Observe the bead model in the bag labeled “**Not Exposed to DDT in Insecticides.**” This bag contains 40 beads. **Do NOT open this bag.**
- White beads represent women who did not develop breast cancer before age 60.
 - Red beads represent women who developed breast cancer before age 60.
10. How many of the 40 beads in the “**Not Exposed to DDT in Insecticides**” model are red beads representing women who developed breast cancer before age 60. _____
11. What is the approximate chance of a woman developing breast cancer before age 60 if she was not exposed to DDT in insecticides? Express your answer as % chance. Explain how you arrived at your answer.

_____ % chance

The scientist found that women who were exposed to DDT before puberty (either during childhood or before birth) were 4 times more likely to develop breast cancer before they reached age 60. Exposure to DDT after puberty did not increase a woman’s risk of developing breast cancer.

12. What is the approximate chance of a woman developing breast cancer before age 60 if she was exposed to DDT before puberty? Express your answer as % chance. Explain how you arrived at your answer.

_____ % chance

13. Make a model using 40 beads to represent the results for 40 women who were exposed to DDT before puberty. Put the appropriate number of white and red beads into the bag labeled “**Exposed to DDT in Insecticides Before Puberty.**” Show your work or explain how you arrived at your answers.

- How many white beads did you put in the bag? _____
- How many red beads did you put in the bag? _____

Show your work or explain how you arrived at your answers.

14. What is the approximate chance of a woman developing breast cancer before age 60 if she was exposed to DDT after puberty? Express your answer as % chance. Explain how you arrived at your answer.

_____ % chance

15. Make a model using 40 beads to represent the results for 40 women who were exposed to DDT after puberty. Put the appropriate number of white and red beads into the bag labeled **“Exposed to DDT in Insecticides After Puberty.”**

- How many white beads did you put in the bag? _____
- How many red beads did you put in the bag? _____

Show your work or explain how you arrived at your answers.

16. Some communities today are considering using DDT spraying programs to control rising mosquito populations.

- What is one benefit of DDT spraying?

- What are two risks of DDT spraying?

- Why are people most concerned about exposure of pregnant women and children to DDT?

- Would you support the use of DDT spraying in your community? Explain why or why not by weighing the risks and benefits?

