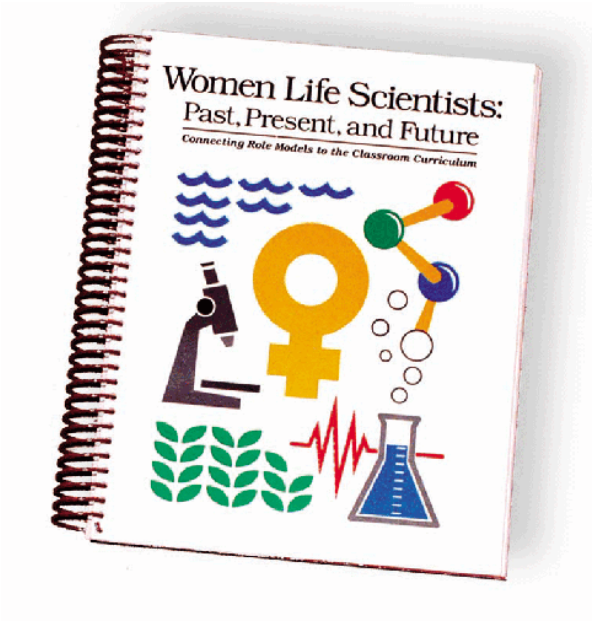

Mary-Claire King

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Copies of the activities from *Women Life Scientists: Past, Present, and Future* can be found at http://www.the-aps.org/education/k12curric/index.asp. To purchase bound copies, visit the APS store at http://www.the-aps.org/cgi-bin/ecom/productcatalog/Product_catalog.htm.

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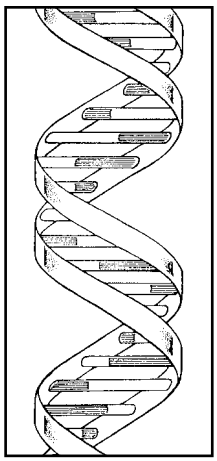
Mary-Claire King
Geneticist
1946-

Unit developed by
Ann E. Haley-Oliphant
Miami University, Oxford, Ohio

Who is Mary-Claire King?

Mary-Claire King is a geneticist with a particular research interest in breast cancer. She was born in Illinois in 1946 and grew up loving mysteries and puzzles. That influenced Mary-Claire's choice to study mathematics at Carleton College in Minnesota. Then, in 1966, she went to the University of California at Berkeley to begin graduate studies in biomathematics. These studies taught her how to apply mathematical skills to medical research. While at Berkeley, Mary-Claire became actively involved in anti-Vietnam War campaigns. She demonstrated, picketed, and organized a campaign that sent 30,000 protest letters to Congress.

Fascinating information about chimpanzees and humans



The focus of Mary-Claire's studies went from mathematics to genetics, because she decided genetics was the most mysterious puzzle of all. Unfortunately, her research ideas exceeded her knowledge of lab techniques. Frustrated with failed lab experiences, Mary-Claire took time off from Berkeley to work on a report studying the effects of pesticides on farm workers in California. Mary-Claire then went to work for Allan Wilson, a biochemist at Berkeley, in the field of genetics. Wilson and King designed a study to determine the degree of genetic difference between humans and chimpanzees. Mary-Claire established that the human and chimpanzee genome is 99 percent identical. This pioneering research earned Mary-Claire her Ph.D. in 1973, and her work was highlighted on the cover of the prestigious journal, *Science*, in 1975. Her research has been used to calibrate a molecular clock which established that apes and humans diverged genetically only about 5 million years ago.

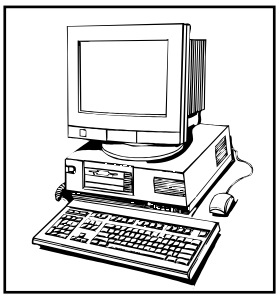
After completing her doctorate, Dr. King and her husband, ecologist Robert Colwell, moved to Chile in 1973 to teach science as part of an exchange program funded by the Ford Foundation. They then returned to California and, two years later, their daughter Emily was born.

The missing link

In 1975, a civil war began in Argentina. The military kidnapped and captured great numbers of people, including pregnant women and women with babies. The pregnant women were kept until the babies were born and then the women were killed. The babies were sold or placed for adoption. In June 1984 Dr. King was asked to go to Argentina to help the *Abuelas de Plaza de Mayo* (Grandmothers of the Plaza of May) find their grandchildren who had been kidnapped during the war. Dr. King worked with the grandmothers, proving their relationship to children suspected of being kidnapped during the reign of terror. Dr. King was the first to develop a test that would prove grandpaternity through DNA analysis. With her help, 50 cases have been solved through genetics, and many children have been reunited with their grandparents. The Argentinian parliament has set up a voluntary national genetic data bank so that children can be matched with families in the data bank.

What other genetic puzzles does Dr. King try to solve?

Dr. King is best known for her work with breast cancer. She began searching for the genes involved in the disease in 1975. Her first priority in research was to show that breast cancer can be inherited. Her findings suggest that inherited breast cancer accounts for 5 percent of



the total number of breast cancer cases. One woman in 200 inherits the gene responsible for causing breast cancer. Those who inherit the gene have an 80-90 percent chance of developing the disease. From the inheritance pattern, the genes appear to be dominant. A single copy of the gene inherited from either parent increases cancer risks substantially.

The biological puzzle Dr. King most wants to solve is to find the exact location of the breast cancer gene. Fifteen years after beginning her search, Dr. King found the approximate location of the breast cancer gene somewhere on chromosome 17. Once the exact location of the gene is found and sequenced, genetic screening for women may be possible. Dr. King believes that in the near future a "molecular mammogram" will be available to detect altered cells years before they develop into a tumor large enough to be detected by a mammogram.

Some additional accomplishments

Dr. King also identified the gene responsible for inherited deafness, and she is searching for the gene responsible for a disease characterized by inflammation of the connective tissues of the body, called *systemic lupus*. She is a director of the Human Genome Diversity Project, the goal of which is to map and sequence human mitochondrial DNA. Dr. King is also involved with AIDS research, and she believes that variations in the genes that control our immune responses make some people more resistant to HIV. It has already been shown that AIDS progresses at different rates in different individuals.

Dr. King is still involved with genetic testing in Argentina. She keeps a book, given to her by the grandmothers, filled with photographs of Argentinians whose lives she has touched. She is now working with a human rights group in El Salvador to identify the skeletons of villagers massacred in 1981 by analyzing DNA extracted from teeth. The same method is being used to identify remains from Vietnam and Cambodia that may be those of American soldiers who are M.I.A. (Missing in Action).

Dr. King's views about women scientists

Dr. King believes that many women have a somewhat different style from men in the way they approach scientific research. As to whether there are differences between male and female scientists, she says

> *In terms of the way we carry out experiments and interpret results — no. However, I do think women tend to tackle questions in science that bridge gaps. We're more inclined to pull together threads from different areas, to be more integrative in our thinking. That may be related to being able to take care of children and do everything else as well. We really do walk and chew gum at the same time. I sometimes wish things were more cooperative. And that will only happen when there are a lot more women in the field. People from different fields in biology don't talk to each other enough, and that has got to change if we're going to get anywhere in understanding cancer (Angier, 1993, p. 182).*

Dr. King continues to work hard at "bridging the gap" by solving some of the most complicated puzzles in science.

SUGGESTIONS FOR TEACHERS

ACTIVITY #1: Inquiring About Genes and the Environment

Purpose

This activity provides students with an opportunity to design an experiment that will determine the effect of environmental factors on the growth and development of normal and mutant plants.

Objectives

1) To design an experiment that tests the effects of environmental factors on plant growth and development.
2) To employ scientific methods accurately.
3) To reach conclusions supported by the data collected during the experiment.

Materials

For each team

- the "Student Experimental Design" sheet on page 263
- 4 flats or containers capable of holding 5-6 plants
- vermiculite
- potting soil
- 20 mutant seeds
- 20 normal seeds
- 1 marking pen
- masking tape
- water bottles
- plant food
- various household and lab chemicals (nail polish remover, vinegar, alcohol, peroxide, detergent, tub cleaner, and others)
- conventional oven, microwave, freezer, UV light
- safety goggles

Before You Begin

1) Obtain mutant and normal plant seeds from a biological supply company, university, or a local agricultural supply company. Tobacco, wheat, and corn seeds work well.
2) Be sure students are well acquainted with basic lab procedures, such as designing an experiment, collecting data, and reporting the results and the conclusions.
3) Be sure students are familiar with basic genetic information such as dominant genes, recessive genes, mutations, etc.
4) Organize lab materials needed for student experiments.
5) The following are results you could expect to see: UV light can cause mutations that will affect plant growth and appearance; harsh chemicals may destroy or harm areas of the seeds that produce enzymes which are needed for plant growth; chemicals will affect plant growth and appearance.
6) Begin the activity by asking any of the following questions: What causes skin cancer? What causes lung cancer? What causes breast cancer?
7) Have a brief class discussion that focuses on the effects of genes and environmental factors on the overall health of a living organism. Conclude the discussion with the statement: "Your mission as scientists is to design an experiment that will provide you with data about the effect of environmental factors on a living organism."
8) Show the students the materials they have available to them for their experiment. Give each team 20 mutant seeds and 20 normal seeds of the chosen plant. Share with students the various environmental factors available to them. Remind students that they will be trying to determine to what extent any changes in the seedlings are due to the plants' genes or to the environmental factors.
9) Have students design an experiment. All teams need to gain approval from you prior to proceeding with the experiment using the "Student Experimental Design" page on page 263. The teams need to record all their procedures and data in their lab books. Be sure to provide the students with the necessary guidance as to what you want them to include in their lab books, e.g., sections, tables, graphs, etc. You may want them to address any of the following questions in their report: How did the experimental seedlings compare with the control seedlings? What dif-

ferences and similarities exist? How can you account for any differences? What differences existed between the mutant and the normal seeds? Did your results support or refute your hypothesis? Do you have any evidence that the genes of your seedlings were altered as a result of the environmental treatment? Are any changes due only to the plants' genes? What additional questions would you like to investigate as a result of this experiment? What were the limitations of your experiment?

10) Provide students with an opportunity to collect data periodically over the next 10 days. Students will need at least one or two days to summarize their findings into a formal lab report.
11) Have each team present its results to the rest of the class.

Safety Considerations

- Wash seeds if they are treated with pesticides or fungicide.
- Do not eat or drink any seeds, chemicals, or any other materials.
- Wear safety goggles when using chemicals.
- Have a spill kit available in the event of any spills.
- Wash hands after working in the lab.
- Use hot pads to prevent burns when using ovens.
- Do not look directly at UV light because it can cause eye damage.

Questions to Ask

- What factors affect the growth and development of living organisms? How can we find out?
- What is cancer? Why do researchers study both genetic factors and environmental influences with regard to cancer?
- What effect do genes have on organisms?
- What effect do various environmental factors have on organisms and their health? What evidence is there to support your ideas?

Where to Go From Here

- Hold a scientific seminar in which the teams of student researchers present their results. Invite university and industrial scientists to attend and offer feedback.
- Prepare a journal/magazine providing student-generated articles about their findings.
- Encourage students to continue their research with other organisms, factors, etc.

Ideas for Assessment

- Evaluate the experimental lab report. Assign a reflection for the students to complete at the end of the experiment in which they address the following: What did I learn from the experiment? What aspect of the experiment forced me to struggle the most? Why? How has my approach to scientific investigations changed during this school year?

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✓*Photo credit:*

Photo on page 257 by Jane Scherr, (1985). Courtesy of the University of California at Berkeley Public Information Office, Berkeley, CA.

ACTIVITY #1: Inquiring About Genes and the Environment

Student Experimental Design

Discuss the following questions with your research team. Prepare thoughtful responses and present this completed page to your teacher prior to beginning the experiment. Prepare your lab book according to directions given by your teacher. You will need to carefully observe, collect data, and record this information in your lab book.

1. What question will be guiding your research?

2. To what environmental factor are you going to expose your seeds during the experiment?

3. How long will you expose the seeds to the environmental factor? How did you determine the length of exposure?

4. What kinds of changes will you be looking for during the experiment? For instance, will you be determining the germination rate? Will you be collecting plant height data? Will you be looking for color changes? Will you be looking for evidence of disease?

5. What are your variables in this experiment? What will be your controls?

6. What is your hypothesis? Why did you select that particular hypothesis?

7. What planting requirements are needed for the particular seeds you will be using, e.g., soil depth, germination time, time to see mutations, etc.?

Teacher Approval _____ **Date** _____

? ? ? ? ? ? ? ? ?

SUGGESTIONS FOR TEACHERS

ACTIVITY #2: Stop a Killer

Purpose

Students will create inventions made of junk to prevent or fight breast cancer. The inventions will not really work, but they need to serve as a prototype.

Objectives

1) To become familiar with the breast cancer disease.
2) To work in pairs to design an invention that will prevent or fight breast cancer by using junk and other recyclables.
3) To improve cooperation skills by working with partners.

Materials

For each pair of students

- the Resource Sheet on page 265, "Breast Cancer Factoids"
- clean junk, e.g., nuts, bolts, plastic pieces, yarn, napkins, plastic spoons, plumbing pieces, old broken appliances, wood, craft materials, 2-liter plastic bottles, flower pots, old mugs, plastic garbage bag ties, etc.
- glue, tape, nails, hammer
- markers, crayons, scissors, stapler

Before You Begin

1) Be sure students are familiar with cancer and how it affects healthy cells.
2) Request that students bring in odds and ends from home. If students are unable to bring in junk, then provide each pair of students with paper plates, napkins, plastic spoons, yarn, paper cups, etc.

Safety Considerations

- Be sure that the junk meets safety standards. Do not use materials that have jagged edges, glass, rusty metal pieces, etc.

Questions to Ask

- How do cancer cells affect healthy cells?
- You are a researcher. There is a deadly disease spreading through the country. How might you go about finding a cure?
- Look around your environment. What things in your environment may be cancer-causing agents? Explain why they are hazardous.

Where to Go From Here

- Hold an inventor's fair and have each pair of students present their invention.
- Display the students' inventions around the school.
- Discuss cancer as an inherited disease and as a disease induced by the environment.
- Provide updates periodically about breast cancer as they appear in the media.

Ideas for Assessment

- Criteria for evaluating the students' inventions include originality, creativity of concept, unusual use of materials, cooperation between partners, effort and dedication to the project, evidence of outside research, thoroughness of explanations, and quality of presentation.

References and Resources

See listing at end of *Activity #1*, "Suggestions for Teachers."

Resource Sheet
Breast Cancer Factoids

- In 1950 the breast cancer rate was 26.4 per 100,000 women; in 1990 the rate was 27.4 per 100,000 white women and 31.7 per 100,000 for African-American women.
- The risk of breast cancer in an American woman over her lifetime is close to 10%; this is equivalent to the risk of lung cancer in a heavy smoker.
- Inherited breast cancer makes up about 5% of the disease. As many as 600,000 American women may carry the breast cancer gene.
- One woman in 200 inherits the breast cancer gene. Those who inherit the gene have an 80-90% chance of developing breast cancer.
- From inheritance patterns, breast cancer genes appear to be dominant. A single copy of the gene from the biological mother or father increases the cancer risk substantially.
- Over 180,000 women in the U.S. alone are diagnosed with breast cancer each year.
- The breast cancer gene is thought to be located somewhere on chromosome 17 in a region 2 million or 3 million base pairs long.

ACTIVITY #2: Stop a Killer

Your Mission

You will work with a partner to stop a killer. You and your partner will invent a breast cancer fighter or preventer from "junk" provided by your classmates and/or teacher. Your invention does not have to really work, but it must serve as a prototype.

Do the following:

1. Read the Resource Sheet, "Breast Cancer Factoids."

2. Read additional articles about breast cancer provided by your teacher or found at the library.

3. Begin the process of designing an invention that could be made to battle breast cancer. Your invention needs to be based on your research about breast cancer.

4. Create the invention.

5. Justify your invention below.

This is an explanation of our idea:

This is a sketch of our invention with each part labeled:

This is an explanation of how our invention would fight or prevent breast cancer:

This is an explanation of how our invention addresses what research says about breast cancer:

Name of Invention _____

Date _____

Inventor Signature _____

Inventor Signature _____