

Discovering Genetics

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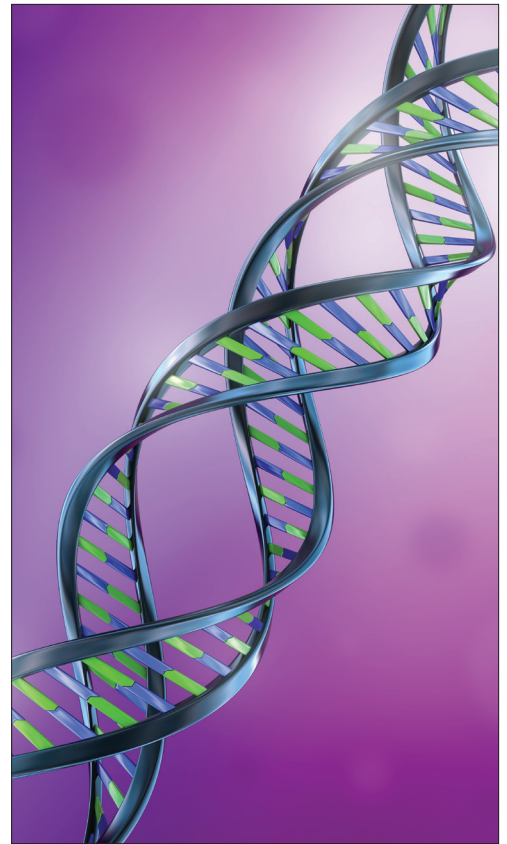
Curious about where your blue eyes came from, when the rest of your family has brown eyes? Want to know if you will have your grandmother's wrinkles or your grandfather's hairy ears? Can we make a tomato that will not rot so fast?

If you want to know the answer to these questions and how genetics affects our lives, this project is right for you. This 4-H Project Idea Starter helps you learn some basic genetic terms and information, explore your family history, and pay attention to genetic influences. Discover how working with genes has led to healthier lives, understand how farmers use genetics to grow better crops, and find out how all of this is controlled by our government.

You may think that genetics has nothing to do with you. However, did you know that you have already had genetic testing? Your life is touched by genetics every day. The science of genetics has been around for hundreds of years and began with Hippocrates 460–377 BC. Relatively recent accomplishments, like the cloning of Dolly the Sheep in 1996 and the completion of the Human Genome Project in 2003, have raised general awareness of genetics and in handling genetic material and information. It is our responsibility to use this information to make choices about our health (and illness), our food sources, and future generations.

Genetics Basics

It is called genetics but it is really about deoxyribonucleic acid (DNA). DNA is a polymer that is a series of two nucleotides bound together. A spine, made up of a type of sugar, forms a twisting ladder structure called a chromosome. So where does the gene come in? The gene is a part of the chromosome that controls all kinds of characteristics, from the ability to fight infection, to eye color and even to personality traits. All plants and animals have DNA packaged as chromosomes.



PLAN YOUR PROJECT

Use this idea starter AND publication 4-H 365 *Self-Determined Project Guide* as the starting place for your 4-H self-determined project. The *Self-Determined Project Guide* is available from your county OSU Extension office or on the Web at ohio4h.org/selfdetermined. You may choose to do a little or a lot depending on your level of interest. Be sure to register your project with your county OSU Extension office.



You have 46 chromosomes, 22 pairs of autosomes, and 1 pair of sex chromosomes (XX or XY). You received one-half of your chromosomes from your mother in an ovum and the other half from your father in a sperm. So you have one-half of your genome in common with each of your parents.

Inheriting a trait can happen with dominant, recessive, or X-linked genes. Dominant means you need only one chromosome carrying the gene to cause the characteristic. Recessive means you need two of the same genes to cause the characteristic. Males and females have an equal chance of getting dominant or recessive characteristics. When the characteristic is linked to the X chromosome, males are more likely to show the characteristic. Can you figure out why?



Health and Illness in Genes

Your health depends on the way your genes behave. Sometimes errors in coding happen. They can be in the chromosomes you inherit from your parents (when genes and DNA are duplicating), errors due to infection or something in the environment.

Within a few days of your birth, several blood samples of your DNA are taken and analyzed. This is called newborn screening and every state has different screening regulations. Many fatal, serious and correctable conditions are discovered during this screening process. It looks for common childhood diseases only, so don't expect to know if you are at risk for adult conditions like diabetes or Alzheimer's.

Sometimes children inherit disorders in the dominant, recessive or X-linked manner discussed above. If the disorder is dominant, one of your parents has the same disorder and the same gene change. If the disorder is recessive, both your parents have at least one gene that is different. When this happens, the person who has a gene change but not the disease is called a carrier. Parents who are carriers often do not know they are passing on genes that act differently. Are there any disorders that run in your family? Could they be caused by genetic differences?

Interestingly, you have repair DNA at work in your body. It fixes mistakes if your DNA duplicates incorrectly, and it fixes errors that occur from environmental damage such as sun damage to skin cells from UV rays. As we age, we are less likely to be able to repair all the errors that occur in our body.

The functioning of our genetic material depends on how you take care of it. So, be aware of what your parents keep telling you: eat your vegetables, exercise, wash your hands, and get enough sleep! Your environment (eating charred foods, smoke inhalation) and life style choices (eating more fruits and vegetables, exercising) greatly influence your DNA efficiency. This prevents disease and prepares your body in case of illness.

Genetically Modified Foods

Gregor Mendel (1822–1884), an Augustinian priest, experimented with garden peas and discovered a lot about genetics and inheritance patterns. Farmers, ranchers and weekend gardeners have been doing the same for years: observing plants and animals for characteristics they like and then breeding for that characteristic. We now have cows that give more milk, apples that are sweeter, hens that lay more eggs, and roses that have a certain color. What advantages or disadvantages do you see in growing or breeding only certain types of plants and livestock?

In 1994, CalGene, a biotechnology company, produced the first genetically engineered tomato. In tomatoes, the softening that occurs during ripening is partly due to an enzyme. CalGene produced the FlavrSavr tomato that stopped production of that enzyme and slowed the ripening process.

*It is advised that genetic testing information not be shared with 4-H peers or leaders. When doing activities that generate this information, share it only with family members or health care providers. A note from a parent should verify that the member completed this exercise. A sample family tree can be produced or copied from the Internet and used by the member in place of the actual family tree.

U.S. Laws of Genetics

You can see that genetic knowledge and handling of genetic material and information can lead to great discoveries and innovations, but this same knowledge has the potential to lead to serious results. Think of the guard dog that was bred to protect its family, and now it is too unfriendly to keep around small children.

Learn about your own genetics by completing a family history or by doing a blood sample for specific or general markers on chromosomes*. Looking at this information with a doctor can help you make smart choices regarding your health. Other groups may look at this information differently. Insurance companies or employers may use the information to deny coverage or a job. There are laws in place to protect the privacy of this information (HIPPA) and to protect your information from certain insurance companies and employers (GINA). People have been labeled and treated differently when their genetic information was known in their community. What is this called? What protections might be in place to help in this situation?

There are so many areas to explore in genetics. Pick a few now and see where they lead you. Your discoveries may leave you with as many questions as answers. Write them down and discuss them with your family, friends and other adults.

AREAS OF INTEREST AND THINGS TO DO

Every self-determined 4-H project can be broken down into areas of interest. These are the specific things members want to address during their project adventures. Using 4-H 365 *Self-Determined Project Guide*, identify at least three areas of interest with at least three activities per area to explore. Take your ideas from the list below or make up your own.

Genetics Basics

- Create Punnett Squares to illustrate dominant and recessive inheritance. Pick traits of your mom's or dad's parents (eye color, facial dimples or balding). Does your parent have the characteristic? Do you think it might be dominant or recessive? Check your guess on the Internet.
- Learn more about at least two people who made important genetic discoveries.

Suggestions:

Maurice Wilkins and Rosiland Franklin, Charles Darwin, Hippocrates, Walter Sutton, Archibald Garrod and Joe Hin Tjio.

- Make a word-of-the-day calendar for one month on your computer dealing with genetics.
- Make a model of a double helix DNA. Share it with your 4-H club or group and explain each part.
- Create a game using genetics facts and names of important people in the field of genetics. Make all the pieces and parts to play the game with at least four people.
- Once complete, play your game with family members to find out whether they have any suggestions for improving your design.
- Describe how the gender of a child is determined. Then, find myths, legends or facts about how to have a girl or a boy.

Health and Illness in Genes

- Produce a three- or four-generation family tree using the correct symbols. Instruct others how to construct their own.

Suggestions:

- Note birth dates and dates of death.
- Indicate diseases or disorders in each family member.
- While you are building your own family tree, get a substitute from the Internet. This will help you see how to build a tree, and you will be ready for instructing others using this substitute.
- If you breed livestock, produce a three-generation pedigree of your favorite animal. What characteristics do you like most? Which do you like least? Did you specifically notice these characteristics in each generation?
- Explore the flexibility of our genome.

Suggestions:

- What are “repair genes”?
- What is polymorphism?
- How do genes react to prevent infection?
- What do genes do in response to a vaccine?
- Discover at least two X-linked disorders. What does the disorder look like in males vs. females? Does the disorder look different from one generation to the next?

Genetically Modified Foods

- Create a list of foods (from at least two food groups) that were created through genetic selection or engineering. Pick your favorite food from the list and compare it to the same food type that you know has NOT been produced by this process. Do you taste any differences in flavor? Do you see differences in appearance?
- Discuss with at least two adults, and make a list of, the advantages or disadvantages of selecting to grow or breed only certain types of plants and livestock. Remember to think about biodiversity and economics.
- Define carcinogenic. Discover at least three foods, food preparation styles, or food additives that can alter genes in a carcinogenic way. This can also include nutrients or foods that we lack in our diets.

- Search the Internet to find at least two chemicals that were made to control certain plants. What are the advantages and disadvantages of herbicides?

U.S. Laws of Genetics

- Investigate two laws that provide protection related to genetics in the United States. Discuss the purpose of each law (how it protects) and what might happen if it is not followed (harmful effects).

Suggestions:

- Americans with Disabilities Act (ADA)
- Health Insurance Portability and Accountability Act (HIPAA)
- Genetic Information Non-discrimination Act (GINA)
- Take a case from your favorite TV or podcast crime drama. How was DNA used to solve the case? Was the solution realistic (the time frame; could you get DNA from the sample they used)?
- Discover the tests that are included in Ohio’s newborn screening. Pick one of the disorders to learn what would happen if the disease or disorder was not discovered or treated.
- Learn about the services provided on the Internet related to genetics. Are the tests accurate? How are these services regulated? Are there consumer protections in place?

RELATED RESOURCES

Genetic Science Learning Center, learn.genetics.utah.edu

National Human Genome Research Institute, genome.gov/genetics-glossary/Family-History

Timeline: History of Genomics, yourgenome.org/theme/timeline-history-of-genomics/

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