



## DNA AND YOUR GENES

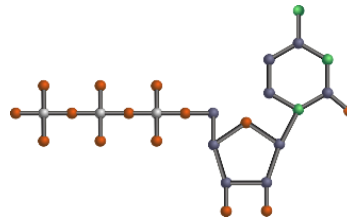


These three letters, **DNA**, represent one very big word and an important, complex branch of science known as **genetics** (the study of how living organisms, including people, inherit traits from their parents). **DNA** is the chemical name for **deoxyribonucleic acid**, and it is found within the cells of every living thing on Earth. It is the substance that passes on traits from one generation to the next. You may resemble other members of your family because of characteristics passed down in DNA. This can include things like hair color, body build, eye color, and even artistic or athletic ability.

DNA is a long thin **molecule** (two or more atoms joined together) shaped like a curved ladder, known as a **double helix**. The outside of the double helix consists of two strands or backbones, which twist together. These are made of special molecules called **phosphates**, which make up the main structure of bones, and sugars. Attached to each sugar and phosphate is another type of molecule known as a **base**. Each sugar-phosphate-base unit is called a **nucleotide**.



**DNA strand illustration**

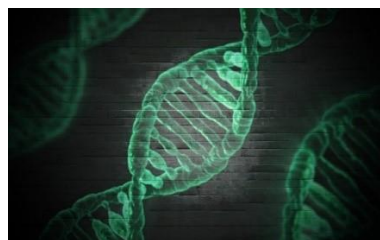
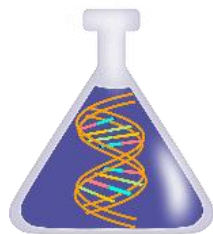


**Nucleotide molecule**

There are four types of bases that make up DNA, and these are DNA's special alphabet.

- adenine (A)
- thymine (T)
- cytosine (C)
- guanine (G)

The four letters of the DNA alphabet, A, T, C, and G, connect and make up the rungs of the DNA ladder. Each rung on the ladder is made of two bases. A and T always pair together. G and C always pair together. These **base pair** rungs are sandwiched between the sugar and phosphate molecules that make up the double helix backbone.



DNA is like a cookbook or a set of instructions. The order of bases in a DNA strand encodes **genes**, or specific sequences of bases. Depending on what a cell needs, different genes in your DNA are copied, and these



instructions are used to create **proteins**, large molecules which carry out all the cellular processes within your body.

Although they use only four letters, DNA molecules are very long. There are billions upon billions of different possible combinations! DNA is organized within cells into structures called **chromosomes**. Special scientific instruments with very powerful magnification are needed to see the double helix shape of DNA.

### ***Interesting facts about DNA:***

- ★ We are more alike than different. The genetic difference between individuals is about 0.1%.
- ★ We share 99% of our DNA with the chimpanzee, our closest living relative!
- ★ DNA can be used to identify people by testing hair, blood samples, and even saliva. It can be used to catch criminals, to reunite parents and children who have been separated, or identify bodies of people who have died.
- ★ The study of DNA can help doctors and scientists understand diseases and how to treat them. Doctors can use genetic testing to identify potential diseases.
- ★ The study of genetics is beneficial in farming and agriculture, helping farmers to improve their crops to produce more food.
- ★ Each of our cells contains 46 chromosomes in 23 pairs. These pass along genetic information that makes us who we are. In each pair, 23 come from the father and 23 come from the mother.
- ★ If all the DNA in your body was untangled and stretched out, it would reach the sun and back!
- ★ DNA strands can separate into single strands and form exact copies of themselves to form new double helixes.
- ★ Mistakes made by cells when copying DNA are called **mutations**. Genetic mutations may be harmful, beneficial, or neutral to an organism.
- ★ Viruses use DNA or RNA to infect organisms.
- ★ **Clones** are living things that have identical genetic material.

### **Genetics, the branch of science that studies DNA, has evolved over many years:**

- Gregor Mendel, who lived in the mid-1800s, is known as the "Father of Genetics". His research on peas paved the way for the discoveries that followed.
- 1869: Swiss biologist Friedrich Meischer first identified **nucleic acid**, a building block of DNA only found in chromosomes.
- 1929: The letters of the DNA alphabet (A,C,G,T) and the sugars and phosphates that make up DNA were identified by Phoebus Levine.
- 1953: Credit for the discovery of the structure of DNA was awarded to Dr. James Watson and Francis Crick. They received the Nobel Prize for their contribution to genetics. However, the work of chemist Rosalind Franklin contributed greatly to the discovery of the double helix structure of DNA and preceded the work of Watson and Crick. Her role in this discovery was largely unrecognized.
- 2001: Scientists completed a map of all the genes that make up a person. This complete DNA sequence, known as the **human genome**, has led to many new discoveries in medicine and other fields.



**ACTIVITY: Extract DNA from a strawberry**



**Materials**

- Zip-locking type (resealable) plastic bag
- 2 strawberries, fresh or frozen
- Measuring spoons
- Measuring cup
- 2 teaspoons of liquid dish soap/detergent
- ½ teaspoon of salt
- 2 cups or glasses
- 1 coffee filter
- ½ cup water
- ½ cup of isopropyl (rubbing) alcohol
- Craft stick or coffee stir stick



**Materials**



**Procedure**

1. Take the green leaves off the strawberries.
2. Place the strawberries in the plastic bag.
3. Close the bag tightly and squish the strawberries.
4. In one of the cups, mix 2 teaspoons of dish soap, ½ teaspoon salt, and ½ cup water.
5. Add 2 teaspoons of this liquid to the bag of strawberries.
6. Seal the bag and squish the berries for one more minute. Do not do this too vigorously because you do not want to make too many bubbles.
7. Place the coffee filter inside the other cup.
8. Pour the strawberry liquid into the filter. Hold the top of the filter and gently squeeze the liquid into the cup.



9. Gently pour alcohol down the side of the cup that contains the strawberry extract. The amount should be equal to the amount of strawberry liquid. **DO NOT mix or stir!**
10. Watch for a white, cloudy material to form in the top layer above the strawberry extract. This is the strawberry DNA.
11. Tilt the cup and remove the DNA with a thin stick, like a craft stick or a coffee stir stick.



#1 & 2 Leaves off, berries in bag



#3 Squish!



#4 Mix solution



#5 & 6 Add solution/squish



Step #7



Step #8



Steps #9 & #10



Step #11 – DNA!

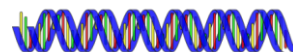
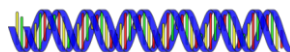
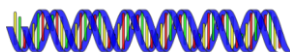


### Discussion

- ◆ Squishing the strawberry in the plastic bag broke down the cell walls of the strawberry and helped to release the DNA.
- ◆ The mixture of dish soap, salt, and water was the first step in making your DNA extraction liquid. Adding it to the strawberries helped to further break down the strawberry cells. You assisted this process by squishing them again.
- ◆ Filtering the strawberry liquid and adding alcohol isolated the DNA from the rest of your mixture.
- ◆ You saw the DNA rise to the top level of your DNA extract.
- ◆ The stringy white substance you removed with a toothpick or stir stick is strawberry DNA!

You can watch scientists from the National Human Genome Research Institute perform this experiment here:

How to extract DNA from strawberries <https://youtu.be/hOpu4iN5Bh4>



## **ADDITIONAL RESOURCES**

### **Books available from the Washoe County Library System:**

[\*Amazing DNA\*](#) by Rebecca L. Johnson

[\*The Discovery of DNA\*](#) by Camilla de la Bédoyère

[\*DNA\*](#) by Alvin Silverstein

[\*DNA and Genetic Engineering\*](#) by Robert Snedden

[\*DNA: The Master Molecule of Life\*](#) by Stille, Darlene R.

[\*Genetics\*](#) by Christine Peterson

[\*Genetics: From DNA to Designer Dogs\*](#) by Kathleen Simpson

[\*Guilty by a Hair! Real-life DNA Matches\*](#) by Anna Prokos

[\*Stronger than Steel: Spider DNA and the Quest for Better Bulletproof Vests, Sutures, and Parachute Rope\*](#) by Bridget Heos

[\*What Makes You You?\*](#) by Gill Arbuthnott

[\*The World of the Cell: Life on a Small Scale\*](#) by Robert Snedden

### **Videos:**

FreeMedEducation, "What is DNA and How Does it Work?" - Basics of DNA <https://youtu.be/6rv5Z8EBXwY>

Genomics Education Programme, "What is DNA?" <https://youtu.be/S9aWBbVypeU>

TED-Ed, "How to sequence the human genome - Mark J. Kiel" <https://youtu.be/MvuYATh7Y74>

### **Websites:**

American Museum of Natural History, The Gene Scene: What is Genetics?

<https://www.amnh.org/explore/ology/genetics>

National Institute of Environmental Health Sciences, Kids Environment: Kids Health, You and Your Genes

<https://kids.niehs.nih.gov/activities/stories/you-and-your-genes/index.htm>

PBS, NOVA, The Legacy of Rosalind Franklin <https://www.pbs.org/wgbh/nova/article/rosalind-franklin-legacy/>

