



Smithsonian

Working with **DNA** and **Genetics**



TCM | Teacher
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Materials

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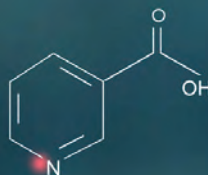


Table of Contents

Unlocking the Past.	4
Instructions for Life	6
Ancient Secrets	12
Once Upon a Time	18
Return to Dino Days?	22
The Past Informs the Present	26
STEAM Challenge	28
Glossary.	30
Index.	31
Career Advice	32

Unlocking the Past

Studying the ancient past can be a difficult task. Scientists look at clues in the modern world to learn what they can. They study **artifacts**, such as tools and jewelry, that ancient humans once used. They examine fossils to piece together the skeletons of **extinct** animals. All over the world, scientists examine these items and learn how early humans and animals lived. But many questions remain. Which people used these items? What did these people and animals look like? Why did these animals become **extinct**?

The answers to these questions can be found in an itty-bitty **molecule** called DNA, short for deoxyribonucleic acid. All organisms are made up of cells that have DNA. That includes humans, moths, blades of grass, and even bacteria! DNA was first discovered in 1869, and scientists have been studying it in-depth since the mid-1900s. Working with DNA is a delicate and careful **process**. Special labs and lab equipment help scientists **complete** this complex job. In recent years, scientists **have also** developed new methods for studying ancient DNA. This has allowed them to gain insight into how humans and animals lived and **evolved**.

dinosaur
skeletons at
the Natural
History
Museum in
Los Angeles,
California



DNA might be microscopic, but the amount of information scientists gain from it is enormous. Let's take a closer look at DNA and how it changes over time, as well as **genetics**. And let's explore some questions of our own, including whether DNA could bring dinosaurs back to life!

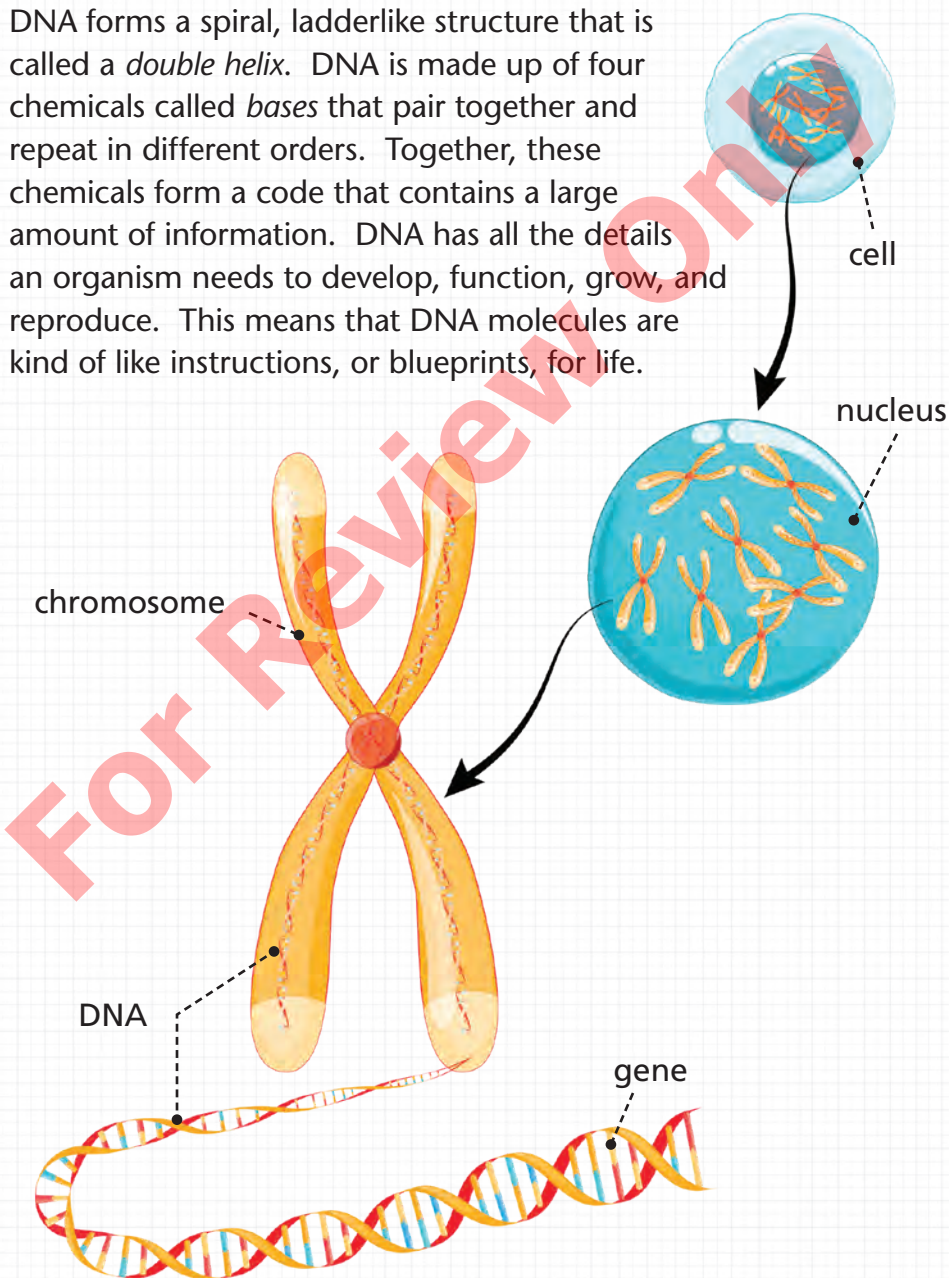


Scientists use a variety of technology to study delicate strands of DNA.

Instructions for Life

Although you can't see it with the naked eye, DNA is everywhere. It exists inside the nucleus of every living cell. DNA is found in chromosomes, which are threadlike structures in a cell's nucleus. Some DNA also exists in mitochondria, the oval-shaped structures in a cell.

DNA forms a spiral, ladderlike structure that is called a *double helix*. DNA is made up of four chemicals called *bases* that pair together and repeat in different orders. Together, these chemicals form a code that contains a large amount of information. DNA has all the details an organism needs to develop, function, grow, and reproduce. This means that DNA molecules are kind of like instructions, or blueprints, for life.





different eye colors



different fur colors

Chromosomes have segments of DNA bases called *genes*. Genes carry information about the physical **and** behavioral characteristics of an organism. These characteristics are also called *traits*. In humans, traits can include eye color, skin tone, and height. In animals, traits can include skin or fur texture, eye shape, and body color. Plants have traits, too! Height, stem width, and leaf size are some plant traits. DNA holds all this information in one place.

All the DNA inside a person's cells makes up the human genome. This is all the genetic information that makes up a human. The genome is like an instruction manual, keeping everything in order.

A Small Percentage

The human genome has about 25,000 genes that are arranged in the same order. About 99.9 percent of everyone's genome is the same. The remaining 0.1 percent is where all the differences among people come from. Our genes in that 0.1 percent are what make us unique!



Heredity

In families, each **generation** contains some of the same DNA as the previous one. Through **reproduction**, DNA is passed from a parent organism to its **offspring**. This is called *heredity*. In humans, only a portion of DNA gets

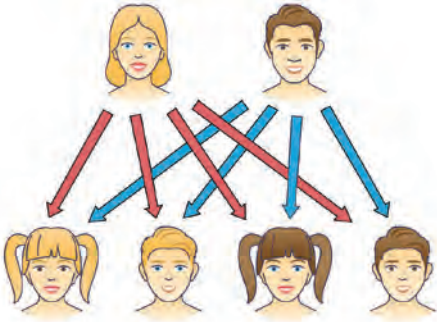
passed down. If all of it were passed down, everyone would have the same exact traits. Everyone would look and act the same.

Every human baby gets half of their genes from one parent and half from the other parent. Because they share some genes, children typically look like their biological parents or siblings.

However, this is not always the case. That's because the copy of each gene that gets passed from the parent to the child is random. So, each child has a unique combination of genes, meaning they have a unique set of traits, too. This is why two siblings in the same family might have different colored hair or eyes. The only exception to this rule is identical twins. Identical twins share the same genes.



HEREDITY



DNA Over Time

As DNA is passed down over time, it can change. First, when organisms reproduce, their genes become mixed in their offspring. This mixing leads to genetic **variation** over generations. This is why a child might look very different from their biological great-grandparents. Next are **mutations**. These are mistakes or natural changes to the DNA itself, and they happen rarely. Most mutations are not noticeable. But some of them can cause health problems, such as cancer or other diseases. Last, some changes in DNA create **variants** in traits that make it more likely for a species to survive in its environment. These helpful variations are called *adaptations*. When they are passed down over many generations, adaptations may spread and become a trait for the species.



Some humans and animals are born with heterochromia, which causes different colored irises as the result of a mutation.



STEAM CHALLENGE

Define the Problem

When paleontologists discover an ancient item at a site, they have to transport the item without damaging or contaminating it. They must be able to take the item from the site to a lab where they can study it and extract DNA from the specimen. Your task is to design and create a closed container that paleontologists can use to hold and transport ancient artifacts from a site to the lab without contaminating the specimen.



Constraints: You may only use the materials provided to you. The container must protect the artifact from damage and contamination.



Criteria: Your container must hold an artifact in place without moving when carried. The model must include an opening to place the artifact inside, and you must be able to see the artifact inside.



CAREER ADVICE

from Smithsonian

**Do you want to study DNA
or be a scientist?**

**Here are some tips
to keep in mind for the future.**

"Take classes in genetics and molecular biology of course, but don't forget to take classes in evolution and ecology (and mathematics) to analyze and make sense of the genetic data you find."

*– Robert C. Fleischer, Senior Scientist and Center Head,
Center for Conservation Genomics*

"See if you can find ways to engage in community service projects with local conservation organizations that connect you with nature, and learn about the importance of being environmentally conscious."

*– Jesús Maldonado, Research Geneticist,
Center for Conservation Genomics*



Read and Respond

1. What is DNA, and where can it be found?
2. What are some traits that you have?
3. How do scientists extract DNA from a cell?
4. How did peppered moths change over time?
5. What information can scientists gain from DNA found on ancient artifacts?
6. Is it possible that dinosaurs will be brought back to life? Why or why not?

