

Explainer: What is a gene?

By The Conversation, adapted by Newsela staff on 03.28.17

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TOP: DNA is found in the form of a double helix. Our DNA makes up our genes which play an important role in determining physical traits like the color of our eyes or hair. Photo from Getty Images. MIDDLE: An illustration of Gregor Mendel's famous pea flower experiment. This chart shows two red pea plants crossing to have red and white pea flower offspring. Photo from Wikimedia Commons. BOTTOM: The human genome is comprised of millions of DNA pairs such as these illustrated. The Human Genome Project works to identify all of them. Photo from Wikimedia Commons

The definition of the word "gene" is not always clear. The meaning may depend on whether one is talking about carrying or transferring a gene, or about how many genes we have.

One reason the definition is so confusing is that the term was coined in 1909. This was before we really knew what a gene was. The effects of genes – inherited characteristics – were observed before we understood genes.

As our knowledge has advanced, the definition of the word gene has evolved. And with all the information from the latest scientific discoveries, the definition needs updating again.

Genes Allow Certain Characteristics To Be Inherited

The Austrian monk Gregor Mendel first experimented with genetics in the 1850s. His experiments showed that characteristics were inherited.

We have always known that pea seeds grow into pea plants, not into kangaroos. What's more, plants with red flowers usually have offspring that have red flowers.

Mendel showed that crossing a red flower pea with a white flower pea would not produce pink flowers. Instead, it produced flowers that were either white or red.

We miss this point sometimes because we have features from our two parents, and many features seem to blend. However, Mendel showed that distinct characteristics could be inherited whole. We can think of each characteristic as being encoded by a gene.

Mendel never used the word "gene." The word was first used in 1909 by Danish botanist Wilhelm Johannsen to refer to "determiners" for many characteristics.

In the 1940s, Oswald Avery showed that an enzyme that chews up DNA could destroy genes.

We finally knew that the genetic material was DNA.

The First Official Definition Of A Gene

In 1953, James Watson and Francis Crick showed DNA was found in the form of a double helix. It was made of two matching strands that formed a spiral chain.

What exactly was a gene? Crick explained how DNA could produce ribonucleic acid (RNA) and how RNA could be "translated" into protein. Think of a protein as a tool that does something, such as the hemoglobin that carries oxygen in your blood.

This gave us our first solid definition. A gene is a stretch of DNA that encodes a piece of RNA that encodes a chain of protein.

The details are complicated, but let's imagine how you might make a metal ax, or many axes. Picture a piece of DNA bundled in the shape of an ax-head. RNA settles in and forms the outline of the ax-head, like a mold or cast. You pour in liquid iron, wait for it to harden and out comes an ax-head. Another mold is used to make the handle. The ax-head and the handle bounce around in the cell, find each other and join together, producing an ax.

It is important to note that there are no actual molds or liquid iron but instead strings of Lego-like blocks of different shapes. A section of the DNA blocks is read into RNA blocks.

The RNA blocks are read into protein-building blocks that fold up to make things. In this case, they might make an ax handle.

The order of blocks is decided by the order in the DNA, through a code called the genetic code.

Now we have a definition for a gene. Genes are stretches of DNA that might create a tool or a characteristic, such as a red color in the pea flower.

Genes Carry The "Code" For A Certain Characteristic

A gene is a section of DNA – of a chromosome – that does something for a plant or animal. There are thousands of genes on each human chromosome.

At first, each gene was thought to produce one protein tool. However, one gene can actually make more than one protein tool.

In humans, several gene products are usually made from each gene.

This discovery offers an updated definition of a gene. A gene is a union of DNA that can produce a set of working products, or protein tools.

We can now explain what it means for a plant to carry the gene for red flowers. It may mean that the plant has DNA that encodes a protein tool to make a red color.

But is there a gene for white flowers? There may just be a mistake in the red flower gene causing the protein tool not to work, leaving the flowers with no color.

What does carrying the gene for breast cancer mean? It doesn't mean a special gene has evolved with the job of causing breast cancer.

It means a gene has changed and no longer works, so the chance of a cancer growing is increased. The gene makes the person carrying it more likely to get cancer – but it doesn't cause it.

We still don't know how many genes we have for certain.

There are probably about 20,000 genes encoding proteins and perhaps as many encoding working RNAs. We don't know the exact number because it is hard to know which pieces of DNA produce working products.

As our knowledge increases, we are sure to discover new genes we didn't know were there.

Quiz

- 1 Read the sentence from the introduction [paragraphs 1-3].

As our knowledge has advanced, the definition of the word gene has evolved.

Which of the following words, if it replaced the word "advanced" in the sentence above, would CHANGE the meaning of the sentence?

- (A) developed
 - (B) quickened
 - (C) grown
 - (D) progressed
- 2 Read the following paragraph from the section "Genes Allow Certain Characteristics To Be Inherited."

We miss this point sometimes because we have features from our two parents, and many features seem to blend. However, Mendel showed that distinct characteristics could be inherited whole. We can think of each characteristic as being encoded by a gene.

Which of the following phrases from the paragraph helps you understand the meaning of the word "inherited"?

- (A) We miss this point sometimes
- (B) we have features from our two parents
- (C) many features seem to blend
- (D) We can think of each characteristic

- 3 Which selection from the article is BEST illustrated by the graphic in the section "Genes Allow Certain Characteristics To Be Inherited"?
- (A) The Austrian monk Gregor Mendel first experimented with genetics in the 1850s. His experiments showed that characteristics were inherited.
 - (B) We have always known that pea seeds grow into pea plants, not into kangaroos. What's more, plants with red flowers usually have offspring that have red flowers.
 - (C) Mendel showed that crossing a red flower pea with a white flower pea would not produce pink flowers. Instead, it produced flowers that were either white or red.
 - (D) Mendel never used the word "gene." The word was first used in 1909 by Danish botanist Wilhelm Johannsen to refer to "determiners" for many characteristics.
- 4 Based on the information in the article, why does the graphic show five red flowers and only one white flower?
- (A) because genes are inherited as wholes and don't mix, so some inherited genes don't appear at all
 - (B) because red flowers are generally more common than white flowers due to their genes
 - (C) because it would be almost impossible for two red flowers to produce a white flower
 - (D) because sometimes genes blend to produce genes that neither parent has