

The **code** that is carried in DNA determines which **amino acids** will come together in what order to form a given **protein**.

In other words, **Genes** express themselves by **specifying the order and type of amino acids** used by a ribosome when it makes a protein.

In addition to determining what proteins are made the **DNA** in a cell also **controls how much** of each kind of **protein** will be made and when.

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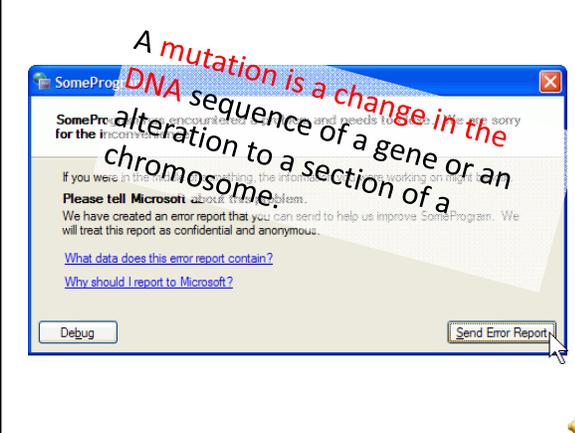
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**A mutation is a change in the DNA sequence of a gene or an alteration to a section of a chromosome**

SomeProgram has encountered an error and needs to close. We are sorry for the inconvenience.

If you were in the middle of doing something, the information you were working on might be lost. Please tell Microsoft about this problem.

We have created an error report that you can send to help us improve SomeProgram. We will treat this report as confidential and anonymous.

[What data does this error report contain?](#)  
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Debug Send Error Report

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**Most DNA variation** ("variation" is just another way to say mutation) **is neutral** (not beneficial or harmful), **but harmful sequence changes sometimes do occur**.

Changes within genes can result in **proteins that don't work** normally or don't work at all. Some of these changes can contribute to disease or affect how someone responds to medicine.

- Mutations may be passed down from parent to child (in sperm or egg cells)
- Or they may occur around the time of conception
- Or mutations may be acquired during a person's lifetime.

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Mutations can arise spontaneously during normal cell functions, such as when a cell divides, or in response to environmental factors such as toxins, radiation, hormones, and even diet.

These things are called **mutagens**



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Nature provides us with a system of repair enzymes that find and fix most DNA errors. But as our bodies change in response to age, illness and other factors, our repair systems may become less efficient.

**Uncorrected mutations can accumulate, resulting in diseases such as cancer.**



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**Genes: Are a sequence of DNA that code for a specific protein**

Genes consist of a length of DNA that contains the instructions (the code) for making a specific protein.

Through proteins, our genes influence almost everything about us, including how tall we will be, how we process foods, and how we respond to infections and medicines.

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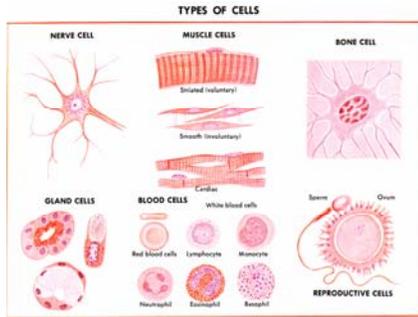
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Although most of our cells have the same genes, not all genes are active in every cell.

Heart cells synthesize proteins required for that organ's structure and function;  
liver cells make liver proteins



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Within an individual cell, the same genes may be switched on at some times and switched off at other times.

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The process of making a protein using the information stored in a gene begins with **TRANSCRIPTION**

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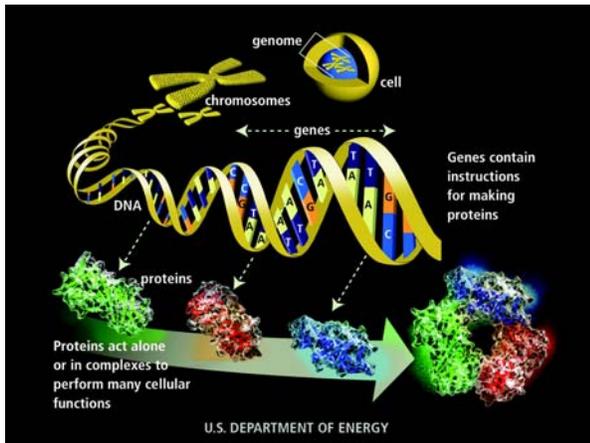
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## Transcription

- The process that creates RNA using the coding strand of DNA as a template.
- **RNA** is Ribonucleic Acid
- RNA is a single stranded polymer
- RNA is used to transmit the information from the DNA in the nucleus to the ribosomes in the cytoplasm.
- RNA exits the nucleus by way of the nuclear pores.

[Flash Animation](#)

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## Transcription

[Flash Animation](#)

### There are three kinds of RNA

- **mRNA**- Messenger RNA- contains the recipe for making protein
- **tRNA**- Transfer RNA- brings amino acids to the Ribosome from the cytoplasm
- **rRNA**- Ribosomal RNA- is what ribosomes are made from

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RNA Polymerase assembles the RNA using the following RNA substitution rules:

- |                    |             |
|--------------------|-------------|
| • DNA              | • RNA       |
| • If you have a T  | • You get A |
| • If you have a G  | • You get C |
| • If you have a C  | • You get G |
| • If you have an A | • You get U |

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A-T-C-G-C-G-T-A-T-G-C-A-T-A-C-T-A-G  
 T-A-G-C-G-C-A-T-A-C-G-T-A-T-G-A-T-C

TRANSCRIPTION USES THE CODING STRAND (BLUE) TO MAKE

A-U-C-G-C-G-U-A-U-G-C-A-U-A-C-U-A-G

mRNA – Single stranded – Brings message (or recipe for a protein) to ribosome

mRNA is used in groups of 3 nucleotides called CODONS.

There are 6 codons in the strand of mRNA above

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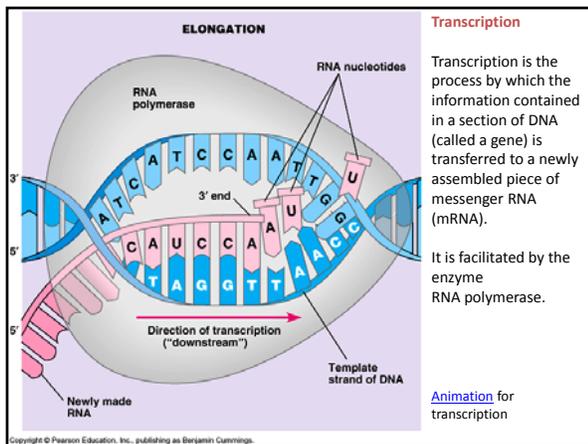
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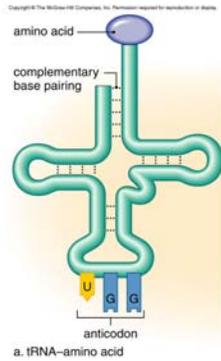
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## tRNA has Anticodons

Transfer RNA (tRNA) is a small RNA chain that **transfers a specific amino acid** to a growing polypeptide chain at the **ribosome** during protein synthesis (translation).



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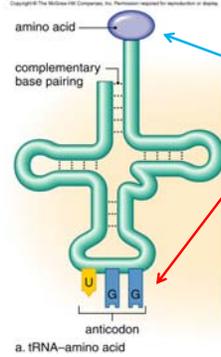
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## tRNA has Anticodons

Each tRNA has a site for **one amino acid to attach**.

Opposite of the amino acid there is a three-base region called the **anticodon** that fits together with the corresponding three-base codon region on mRNA.



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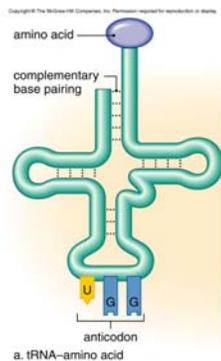
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## tRNA has Anticodons

Each type of tRNA molecule can be attached to **only one type of amino acid** but...

The genetic code contains multiple codons that specify the same amino acid.

This means that multiple types of tRNA molecules each with a different anticodon may carry the same amino acid.



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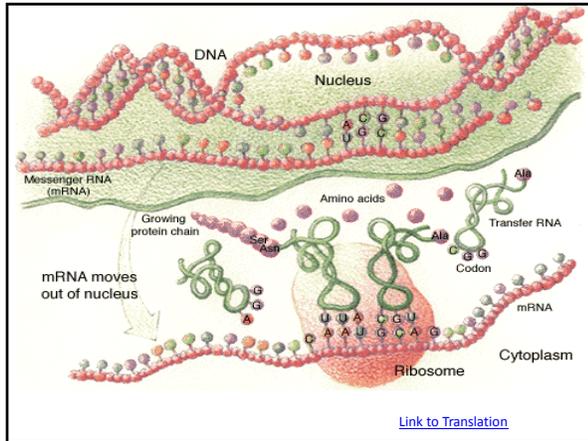
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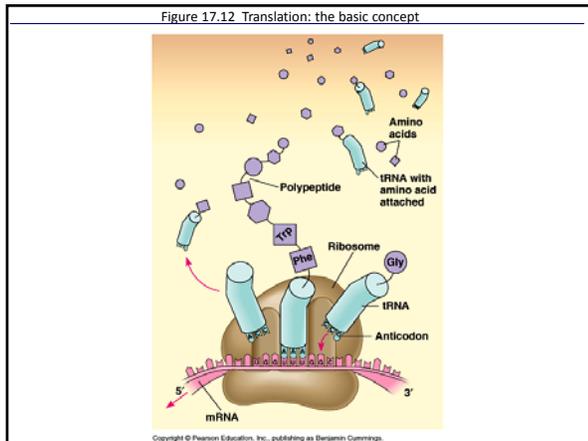
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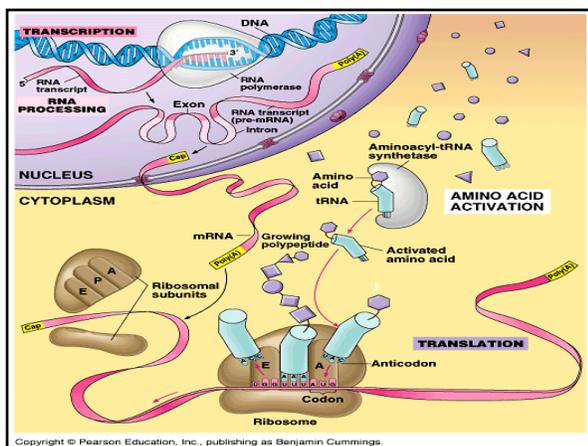
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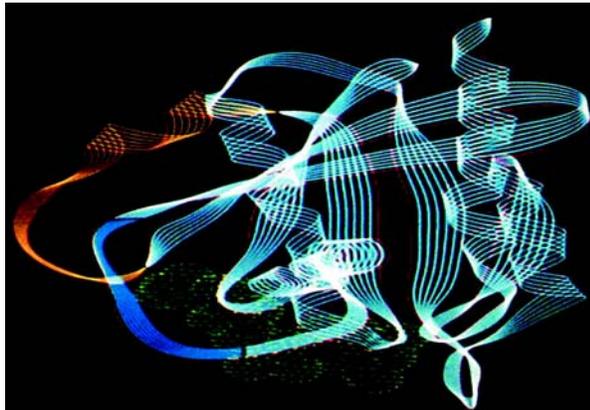
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3D model of a ras protein. [http://genetics.gsk.com/flash\\_genes\\_actual.htm](http://genetics.gsk.com/flash_genes_actual.htm)

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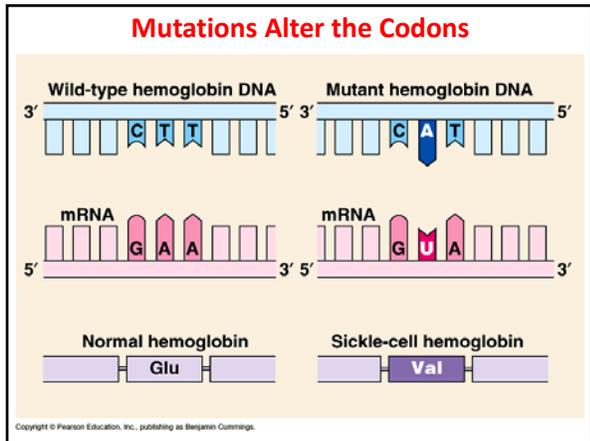
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Point mutations and base-pair insertion or deletion

A **Point Mutation** is when one single base is altered. Will only change one codon.

A **Base Insertion** is when one is added

A **Base Deletion** is when one base is removed

Insertions and Deletions are worse for protein synthesis as they will change all of the codons from the point of the mutation forward.

**Wild type**

mRNA 5' A U G A A G U U G C U C U A A 3'

Protein Met Lys Phe Gly Stop

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**Base-pair insertion or deletion**

**Frameshift causing extensive missense**

Missing

A U G A A G U U G C U C U A A ...

Met Lys Leu Ala ...

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**Frameshift causing immediate nonsense**

Extra U

A U G U A A G U U G C U C U A A

Met Stop

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**Insertion or deletion of 3 nucleotides:**

no frameshift; extra or missing amino acid

Missing

A U G U U G C U C U A A

Met Phe Gly Stop

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Why do children so often resemble their parents?

Why do some brothers and sisters share similar traits, while others are very different?

To a large degree, it's a function of the genes (which are the basic units of heredity) they have in common.

How does this happen?

To understand that we will need to find out a little bit more about what genes are and how we inherit them.

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**When chromosomes are preparing to divide the DNA replicates itself into two strands called chromatids**

**Replicating chromosome**

**The same chromosome under normal conditions**

A chromosome is a long strand of DNA, packaged together with proteins and other kinds of molecules. Each chromosome has a centromere, which plays an important role during cell division and also divides each chromosome into a short arm and a long arm. Scientists can tell different chromosomes apart based on their size, the relative lengths of their arms, distinctive staining patterns, and other characteristics.

Humans have two types of chromosomes: sex chromosomes and autosomes. Two sex chromosomes determine the sex of an individual, and they are called the X chromosome and the Y chromosome.

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If you are female, you have two Xs, and if you are male, you have one X and one Y (although there are genetic conditions in which this varies). The autosomes comprise the other 22 chromosomes. The longest of the autosomes is referred to as chromosome 1, the next largest as chromosome 2, and so on, down to the smallest autosomes, chromosomes 21 and 22.

Each cell nucleus contains two copies of each autosome (44 chromosomes), plus two sex chromosomes (either two Xs or an X and a Y) for a total of 46. With few exceptions, the chromosomes and genes found within any two cells of your body will be identical.

The mystery as to why you resemble your family members is solved by discovering how you inherited your chromosomes from your parents.

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