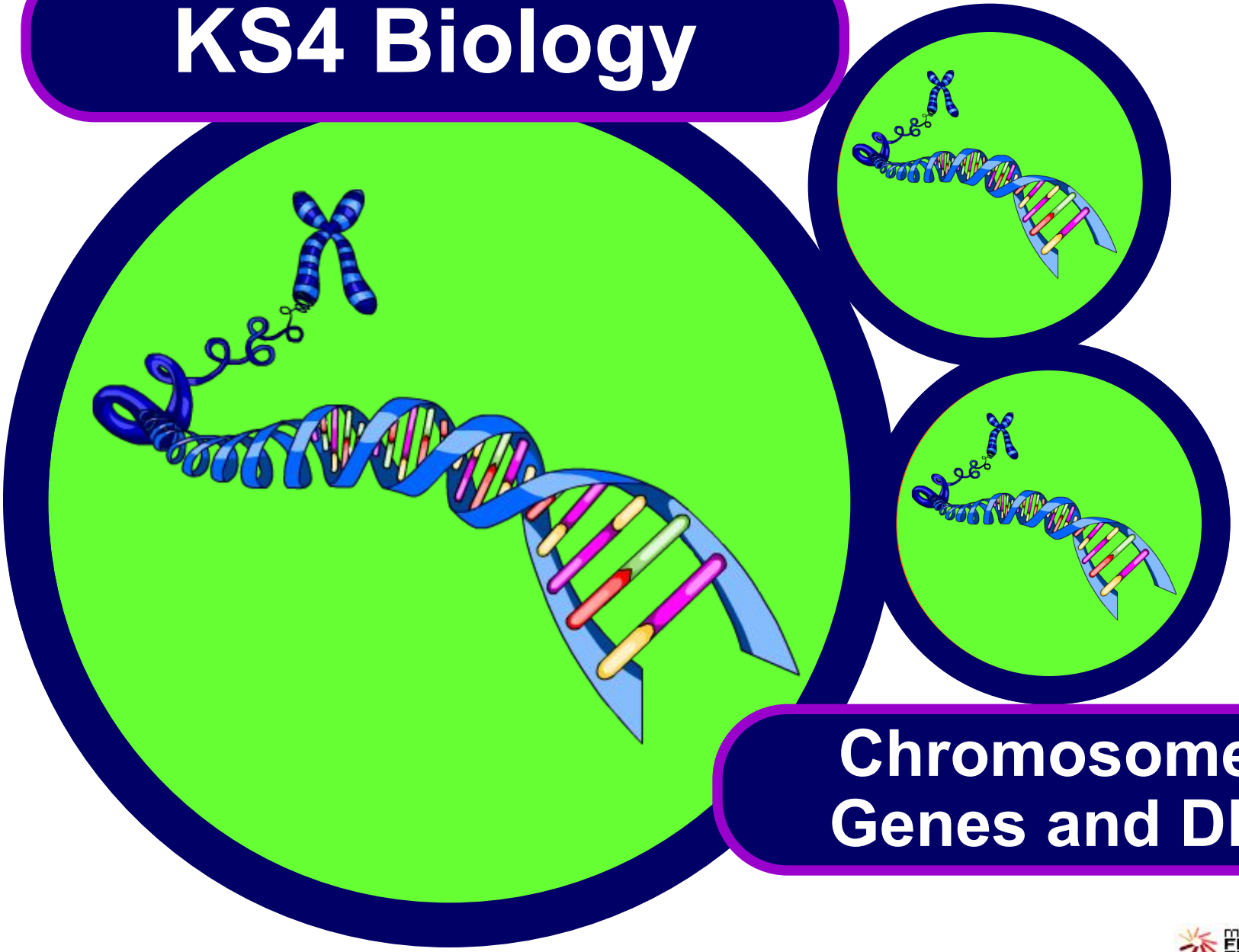
KS4 Biology



Chromosomes, Genes and DNA

Chromosomes, Genes and DNA

What are little girls and boys made of?

Sugar and spice and everything nice;
that's what little girls are made of.
Slugs and snails and puppy dogs' tails;
that's what little boys are made of.

What are little girls and boys *really* made of?

Inherited characteristics

- What makes this baby human? What determines its gender?

In all living things, characteristics are passed on in the **chromosomes** that offspring inherit from their parents.

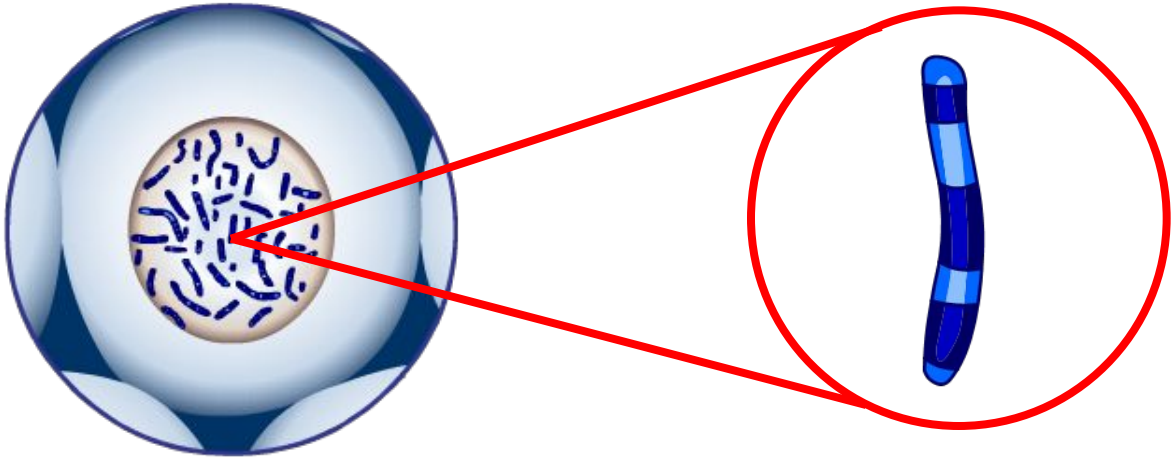
So all human characteristics, including gender, must be something to do with chromosomes.

Where are chromosomes found?

What are chromosomes?

What are chromosomes?

- Chromosomes are long strands of genetic information located in the nuclei of cells.



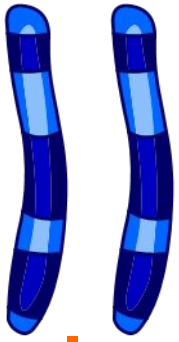
- Chromosomes are most visible during cell division when they replicate and look like this…

You will see chromosomes represented **both** ways.

Homologous chromosomes

- In most cells chromosomes are **matched** in pairs based on their **size and shape**.

chromosome from female parent



chromosome from male parent

homologous chromosomes

- Matching pairs of chromosomes are called **homologous chromosomes.**

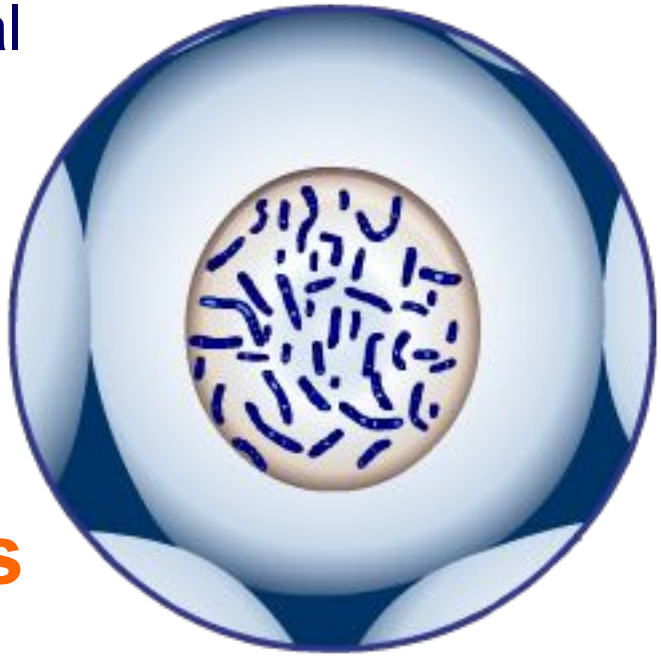
Where do homologous chromosomes come from?

Each pair of homologous chromosomes contains **one** chromosome that has been inherited from **each parent**.

Homologous chromosomes

Human chromosomes

- In human body cells there are a total of **46 chromosomes**.



How many **pairs** of **homologous chromosomes** are there in human body cells?

23 pairs of chromosomes

- You inherit **half** your chromosomes from your mother and **half** from your father.

How many chromosomes do you inherit from each parent?

23 unpaired chromosomes

Human chromosomes

X and Y chromosomes

- There are two types of sex chromosome with names that are very easy to remember!

X chromosome 

Y chromosome 

- **Females** have two **X** chromosomes, one from each parent.

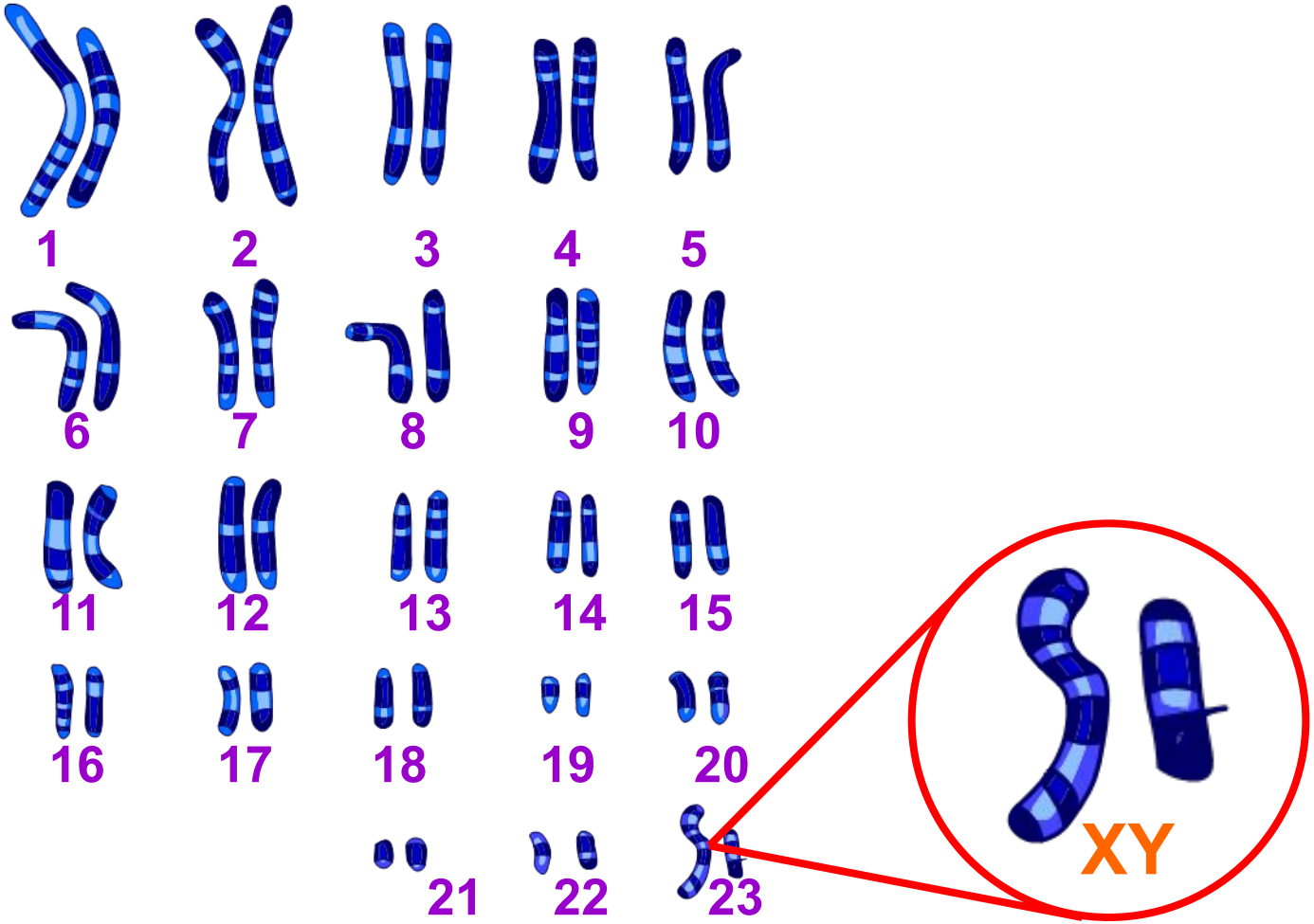
XX

- **Males** have one **X** chromosome and one **Y** chromosome.
  Which parent does a baby boy inherit its **Y** chromosome from?

XY

X and Y chromosomes

- Does this set of chromosomes come from a male or female?



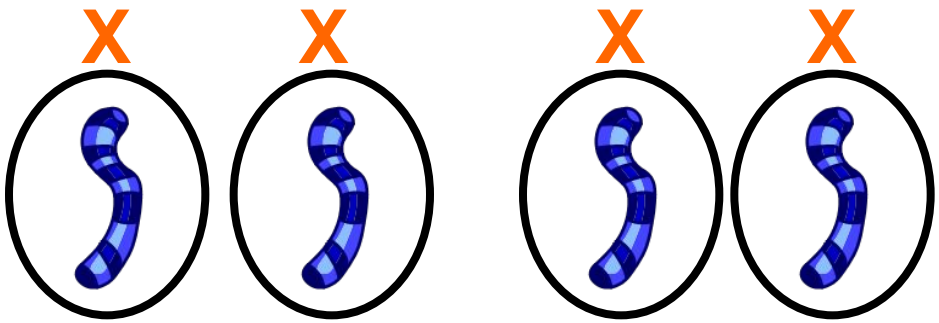
What kind of sex chromosomes are there in this person's sex cells?

Chromosomes and sex cells

- What happens to the sex chromosomes when sex cells are formed?

female body cell (XX)

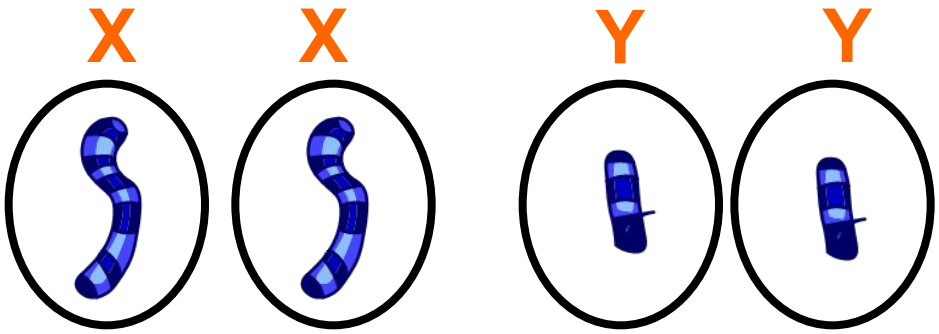
meiosis



All ova have one X chromosome.

male body cell (XY)

meiosis



Sperm have an X or Y chromosome.

Why is there an equal chance of a baby being a boy or a girl?

Chromosomes, genes and gender quiz

Chromosomes, Genes and DNA

What are chromosomes made of?

- Chromosomes carry the genetic information for making all living things – everything from a human to a gerbil!

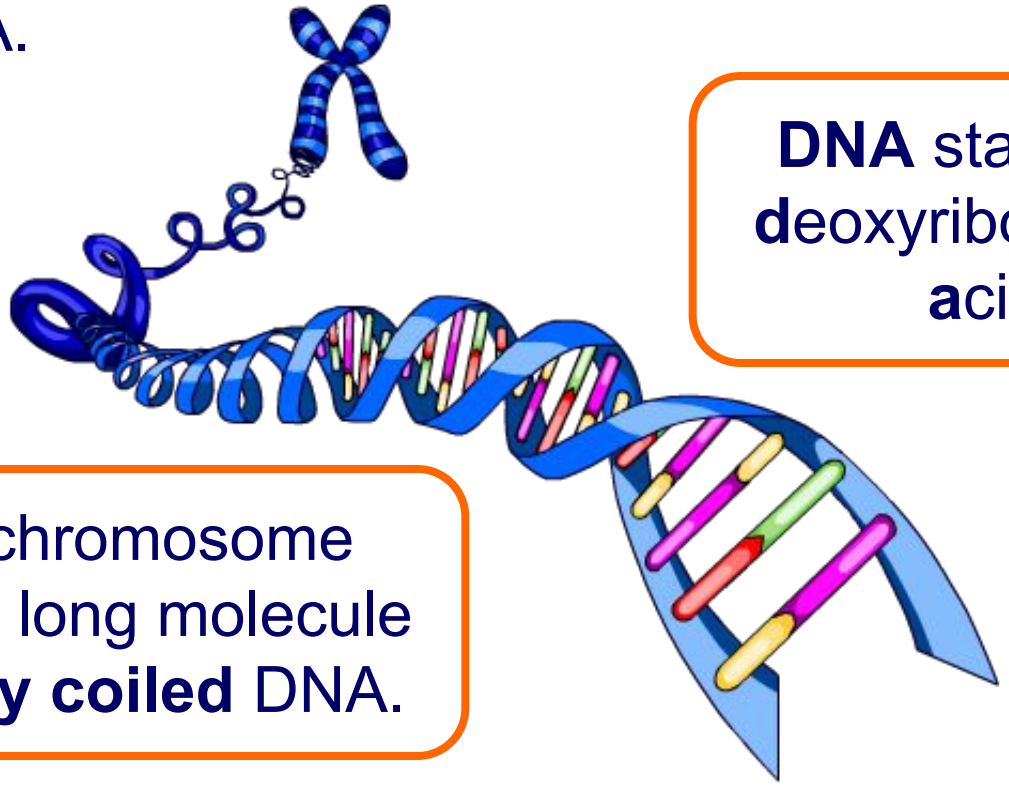
Why are chromosomes known as “instructions for life”?

What are these “instructions for life” made of?

What is DNA?

What is DNA?

- Chromosomes and their genes are made of a molecule called DNA.



DNA stands for **d**eoxyribo**n**ucleic **a**cid.

Each chromosome is a very long molecule of **tightly coiled** DNA.

- DNA molecules carry the code that controls what your cells are made of and what they do.

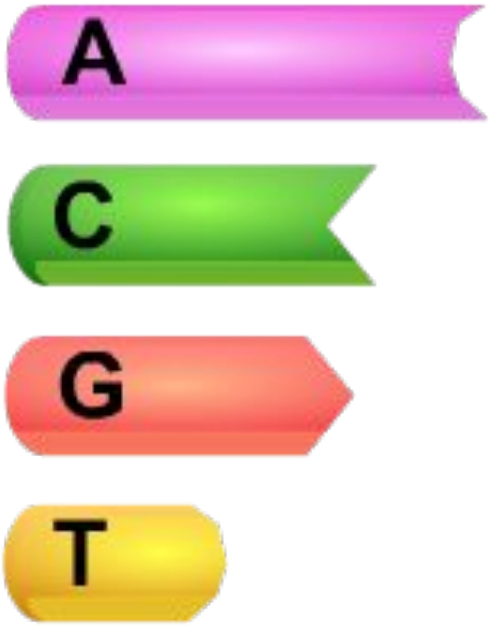
Which part of a DNA molecule holds this information?

Structure of DNA

DNA and base pairs

- The rungs of the DNA ladder are made from pairs of bases.

  There are four types of bases. They have complicated names so it is easier to use their initials instead.



- These bases **always pair** together in the **same way.**

  How do you think the four bases pair up?

DNA and base pairs

- Base pairs hold the two strands of the DNA helix together. The rules for base pairing are…

A always pairs with T

C always pairs with G

- There are millions of base pairs in a DNA molecule that always follow these rules.

  Amazingly, it is the sequence of bases along a DNA molecule that forms the **genetic code** – it's that simple!

Build your own DNA molecule

Matching genetic pairs – numbers

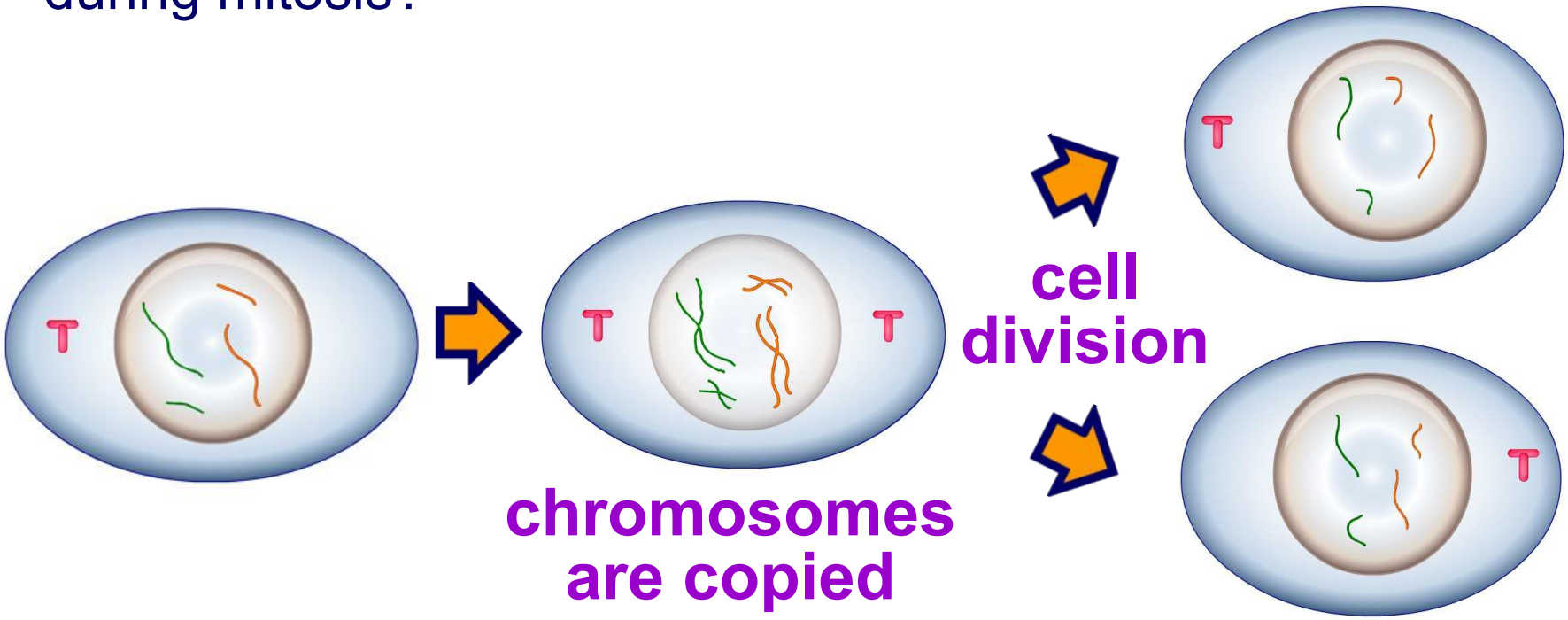
Matching genetic pairs – sequences

DNA – true or false?

Chromosomes, Genes and DNA

DNA and cell division

- What happens to the chromosomes when a cell divides during mitosis?

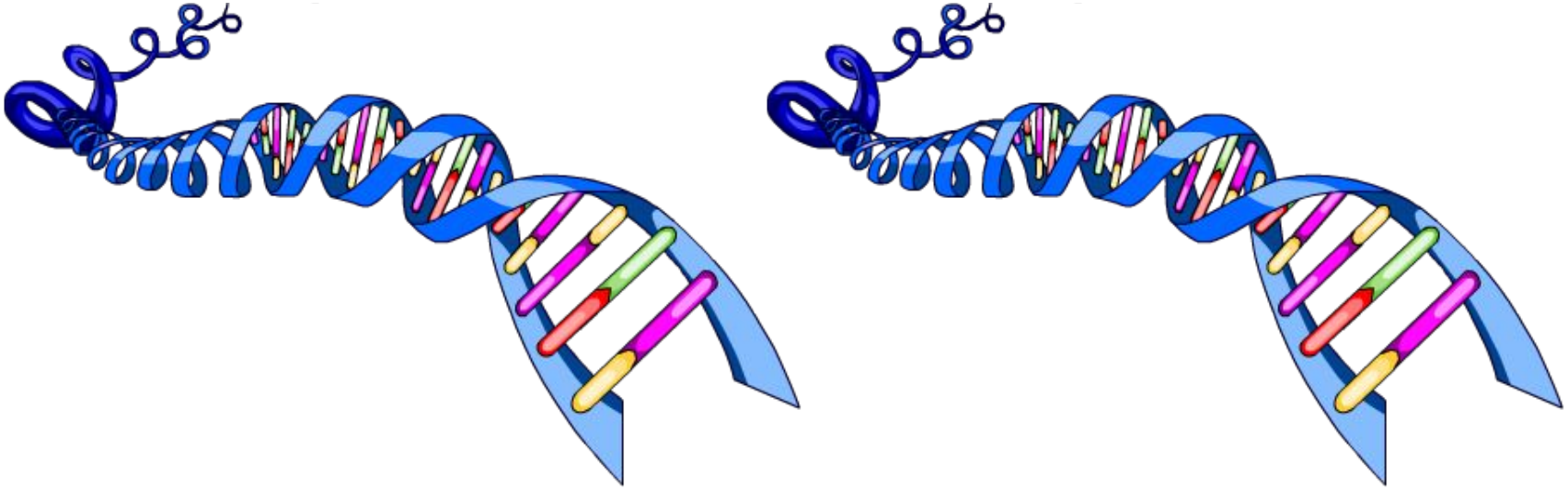


Why must chromosomes be copied before a cell divides?

What must happen to DNA during this same process?

DNA and cell division

- A DNA molecule is able to make a copy of itself.



This is how chromosomes are copied before cell division.

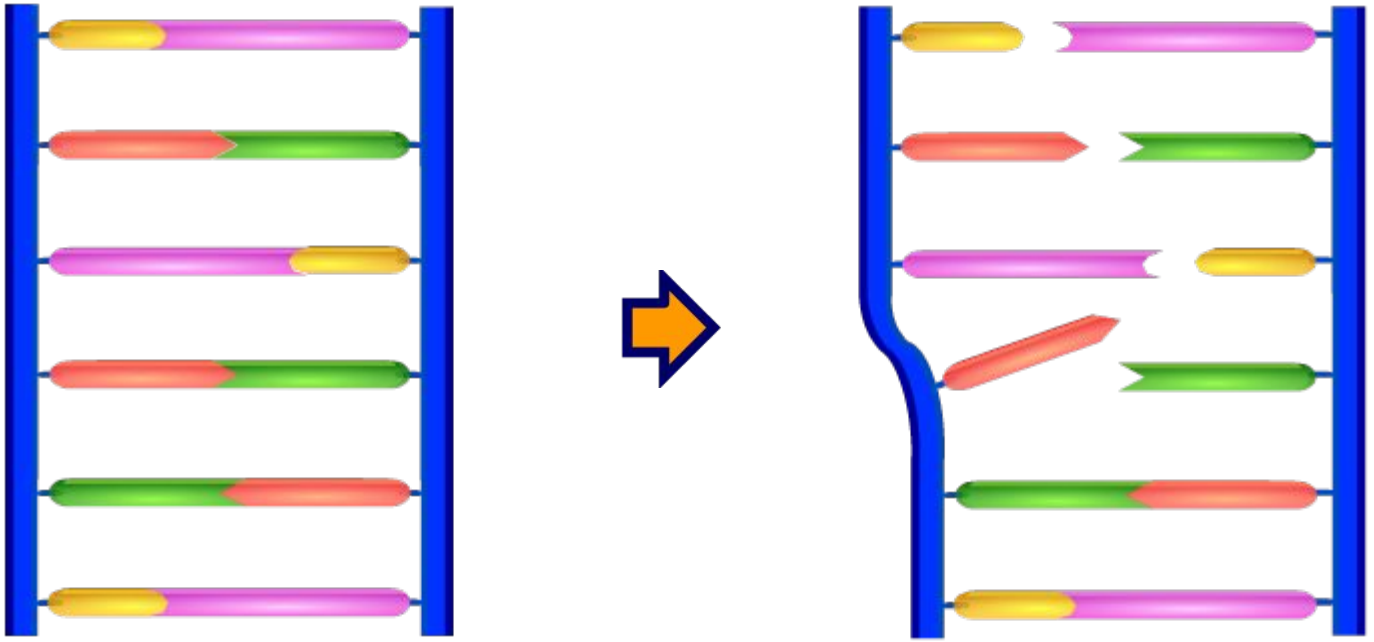
DNA's ability to copy itself means that all the genetic information is passed on to new cells.

How does a DNA helix make a copy of itself?

How does DNA copy itself?

How DNA copies itself

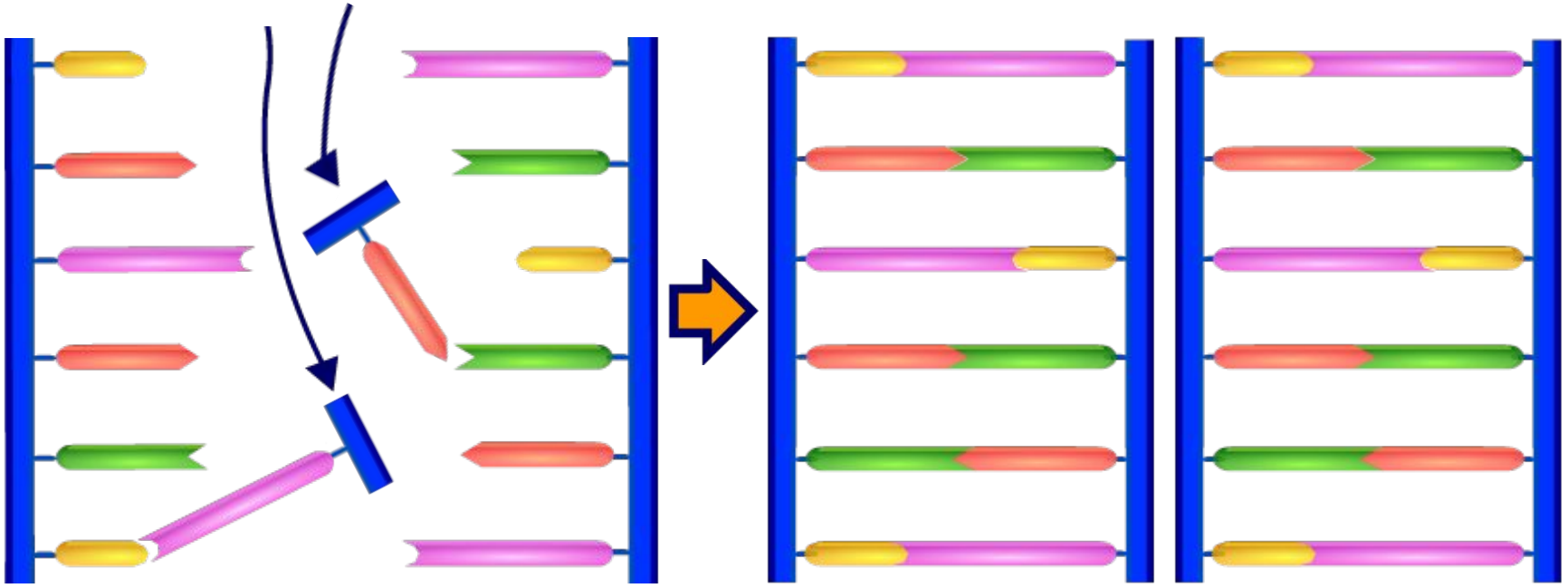
- DNA can make copies of itself because it is double stranded.



- The DNA molecule “unzips” as the rungs of the ladder separate and the molecule splits into two single strands.

How DNA copies itself

- **New bases** from the cell move in and, following the pairing rules, match themselves to the bases on the single strands.



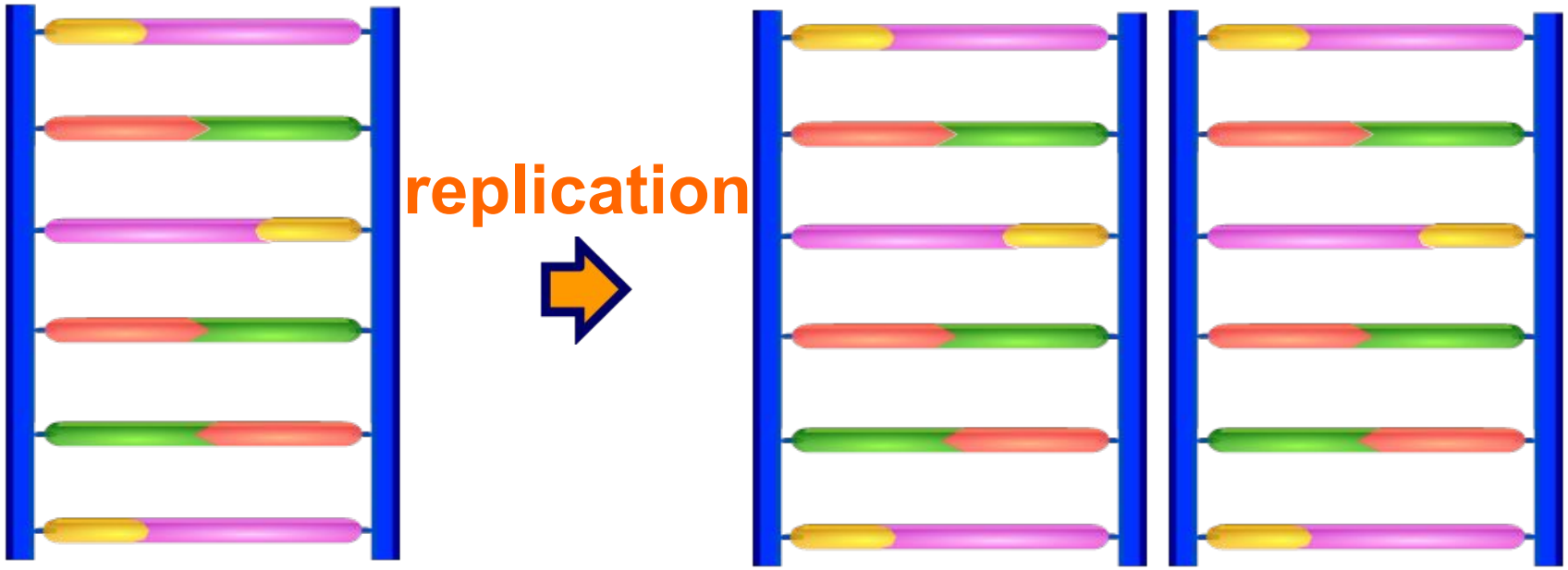
new DNA molecules

- Each single strand builds up into a new double strand.

What do you notice about the new DNA molecules?

How DNA copies itself

- The new DNA molecules are **identical** to each other and the original DNA molecule.



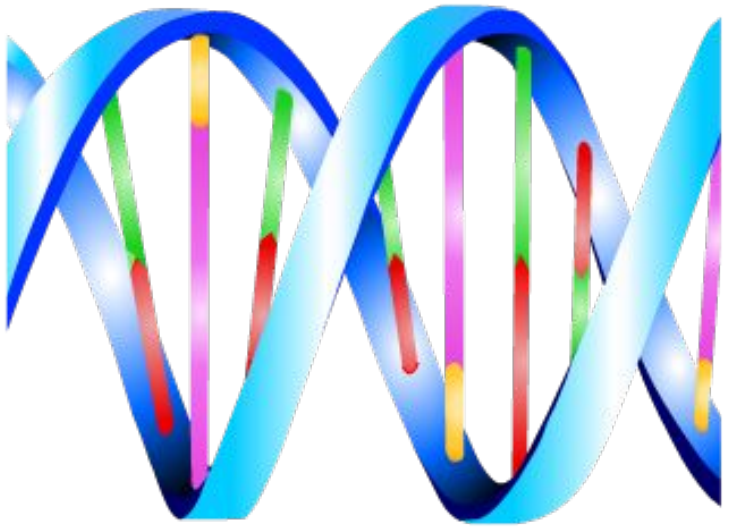
original DNA molecule **new DNA molecules**

What is the copying of DNA also called?

Copying DNA and mutations

- Sometimes **mistakes** are made in the copying of DNA and the sequences of bases is changed.

  How does this affect the genetic information carried by the DNA?



- If the sequence of bases on the DNA molecule is changed by mistake, the genetic information is also changed.

  This type of change is called a **mutation**.

  Why can mutations be harmful?

What's the order?

DNA multiple choice

Chromosomes, Genes and DNA

Why are cells different?

- An oak tree has about 30 different types of cells.

  How many different types of cells are humans made of?

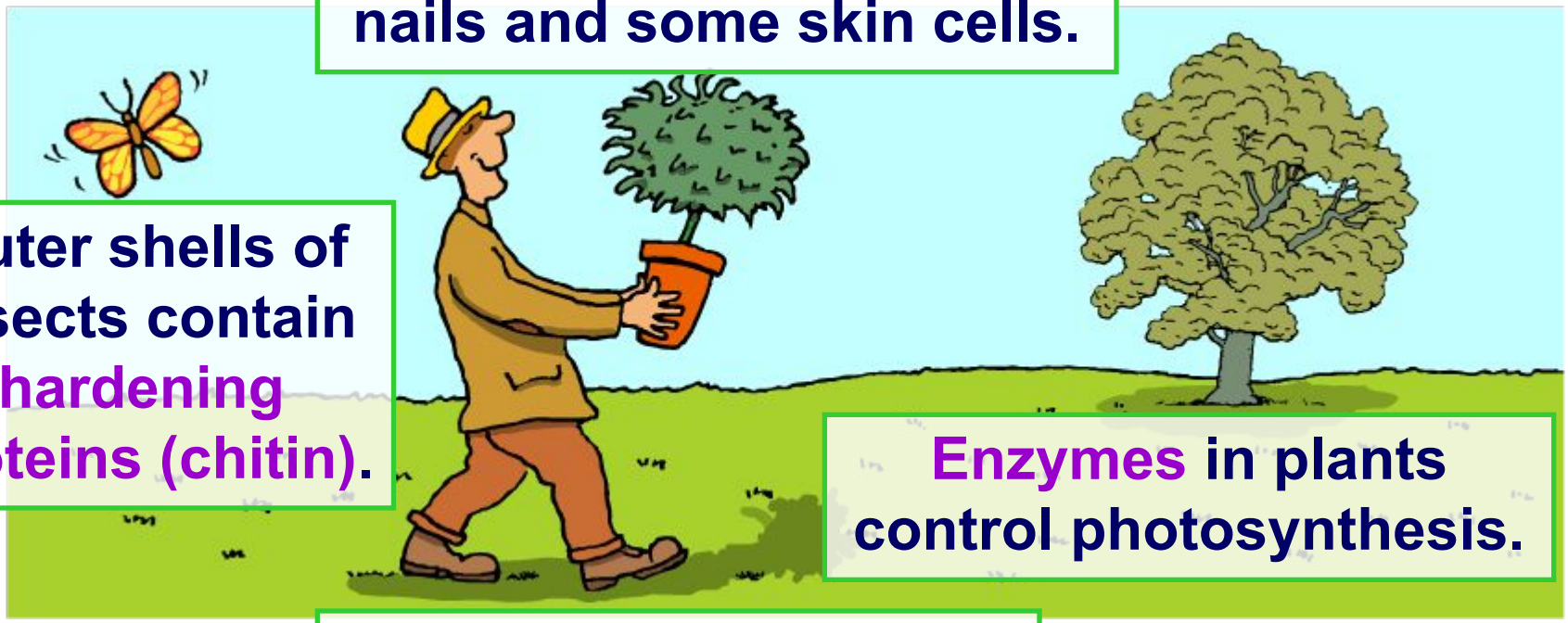
Our bodies have more than **300 different types of cells**.

Why do cells have different characteristics?

Why are cells different?

- Different types of cells produce different types of **proteins**.

Keratin is a protein in hair, nails and some skin cells.



Outer shells of insects contain **hardening proteins (chitin)**.

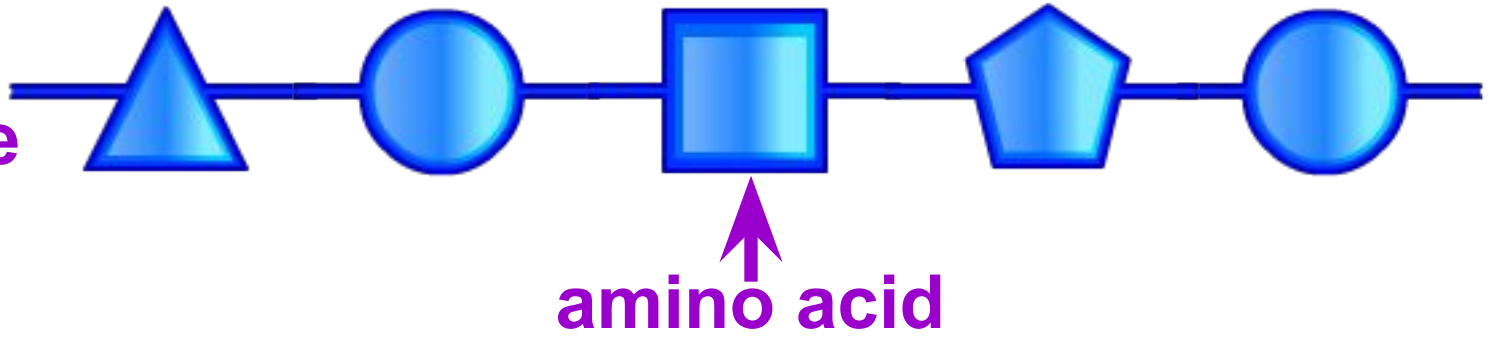
Enzymes in plants control photosynthesis.

Elastin and **collagen** are other proteins in skin.

What are proteins made of?

What are proteins made of?

- Proteins are long molecules made from chemical units called **amino acids**.



What happens if amino acids are combined in a different order?

Different combinations of amino acids make different proteins.

Connecting proteins and genes

- Consider the following two statements…

Genes carry the **instructions** for inherited characteristics.

Cells have different characteristics because they make different types of **proteins**.

What is the connection between **genes** and **proteins**?

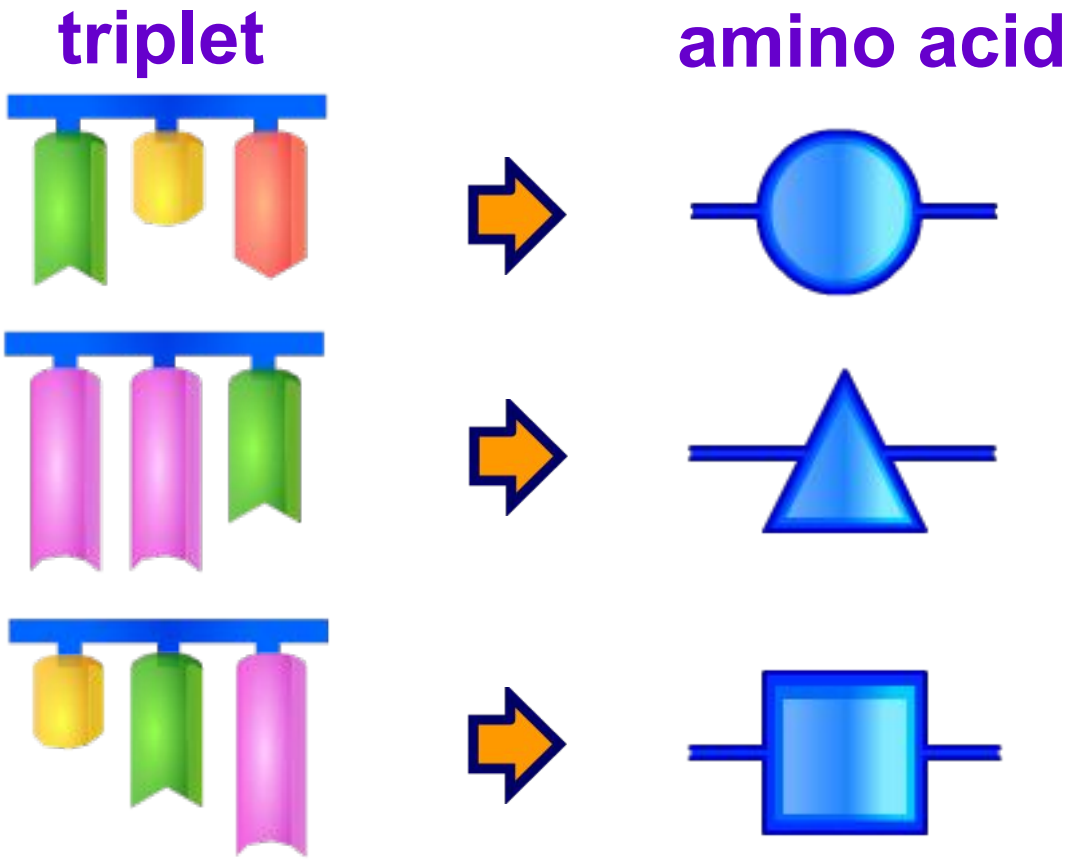
Genes contain the instructions for making proteins.

What molecule has the instructions for making proteins?

How do genes make proteins?

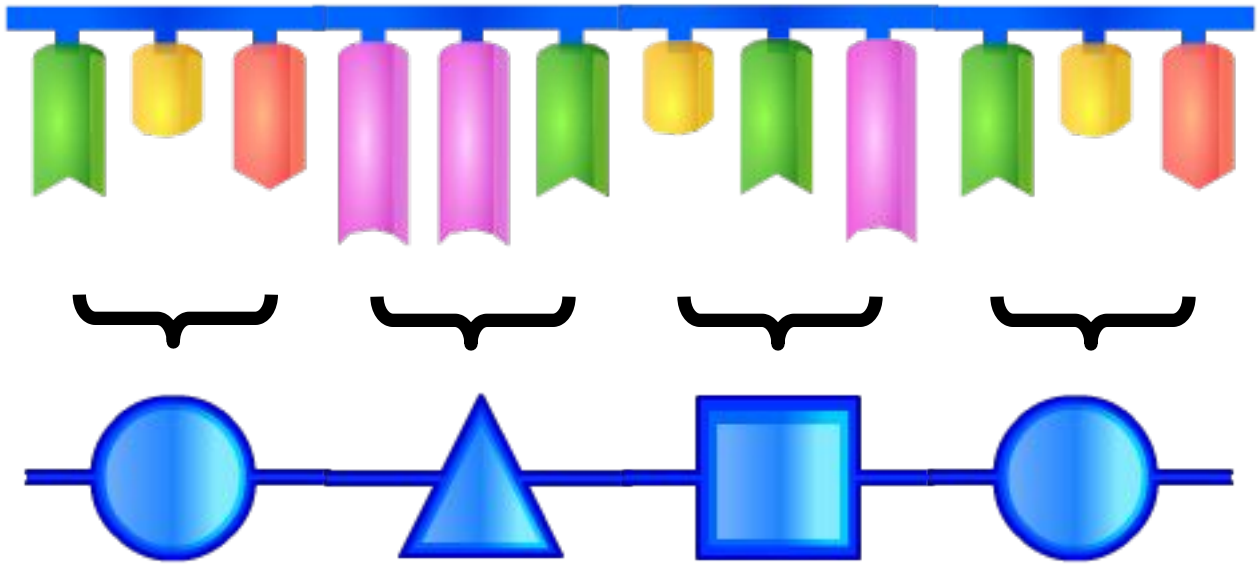
- Genes are made of DNA. Proteins are made of amino acids.

  Each amino acid is coded for by its own special sequence of **three** bases called a **triplet**:



How do genes make proteins?

- The order of triplets in a gene determines the sequence of amino acids.

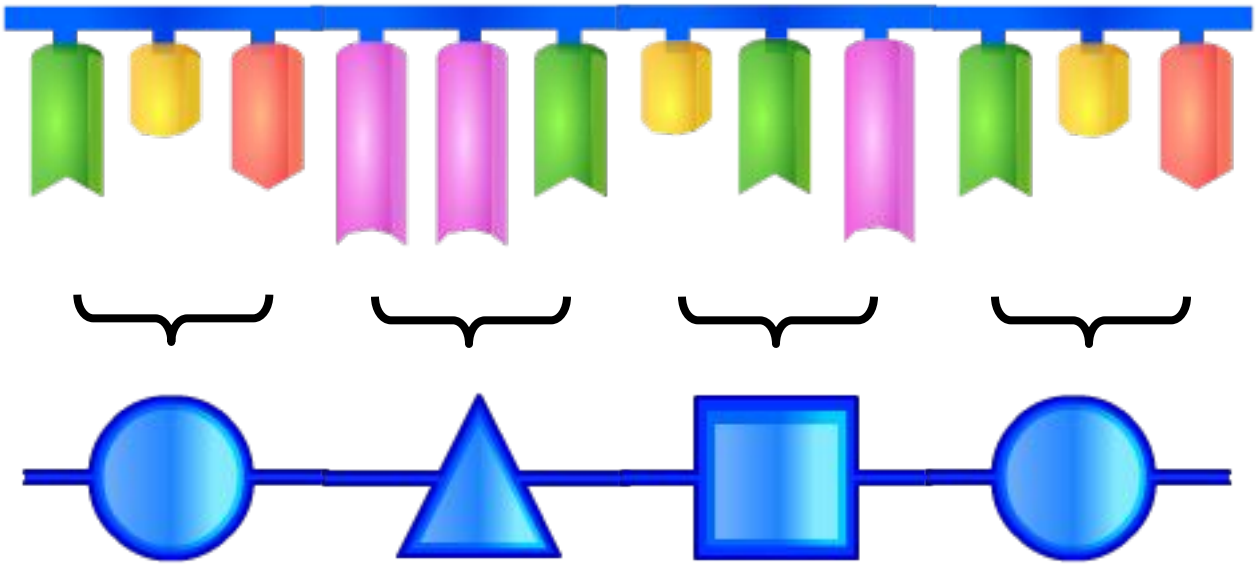


The amino acids join together to form a protein molecule.

Each gene contains the sequence of bases for one protein.
Why is the sequence of bases in DNA called the genetic code?

How do genes make proteins?

- The **genetic code** is the order of DNA bases which determines the sequence of amino acids in a protein.



How many **triplets** code for a protein of 20 amino acids?

1 amino acid = 1 triplet

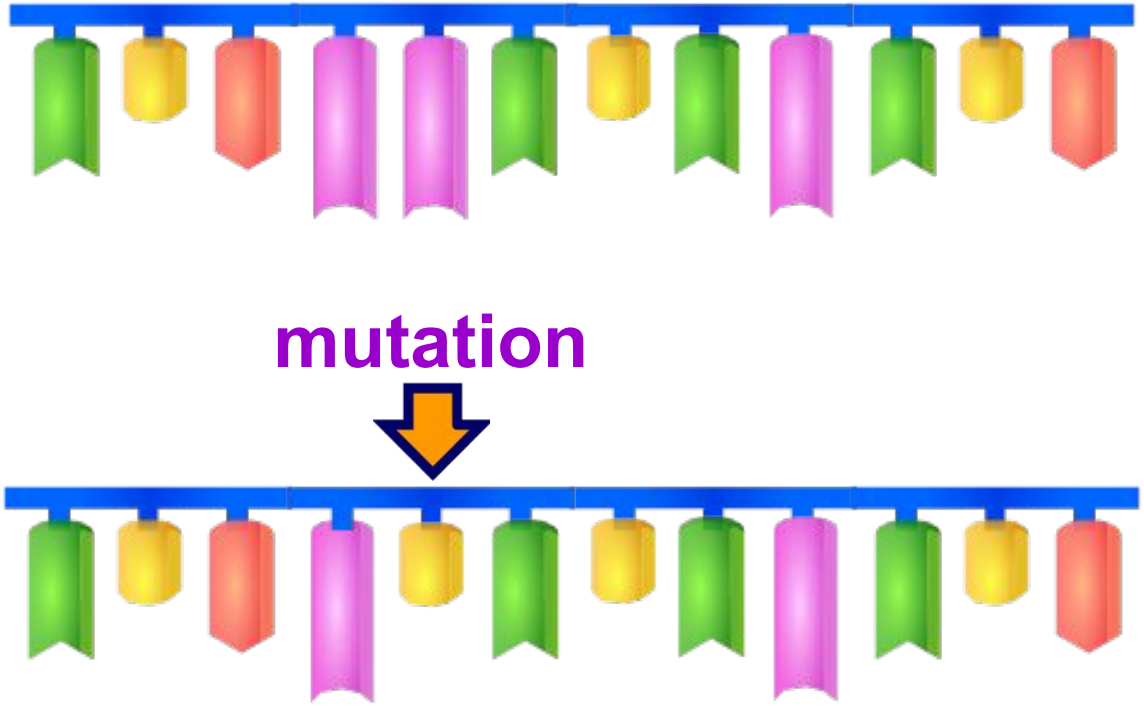
20 amino acids = 20 triplets

How many **bases** code for a protein of 20 amino acids?

Build your own protein molecule

DNA mutations and proteins

- A **mutation** is a change in the sequence of bases in DNA.

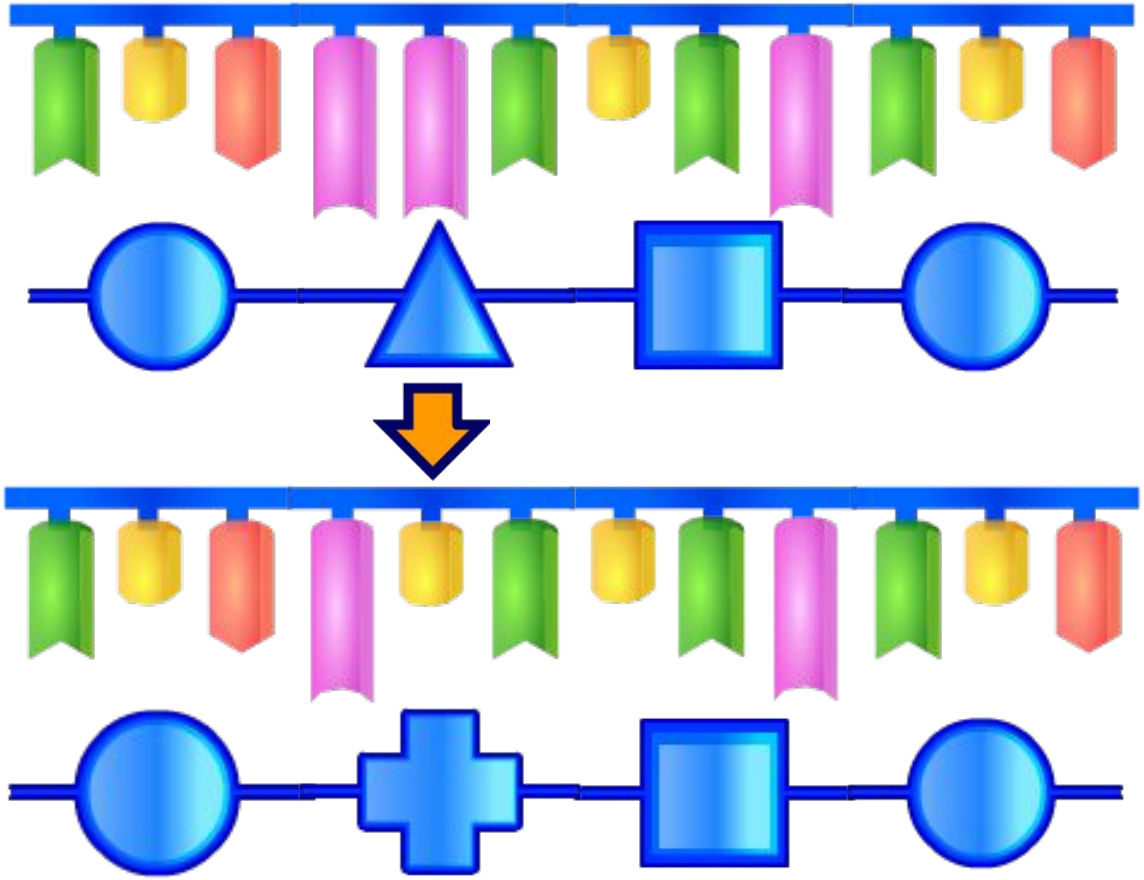


Mutations can be caused by mistakes in copying DNA or the effects of radiation and heavy metal ions.

Will the mutated version of DNA make the same protein?

DNA mutations and proteins

- A DNA mutation changes the amino acid sequence and so a different protein may be produced.



If genes produce incorrect proteins, cells may not function properly. This is the cause of many inherited diseases.

Genetic code quiz