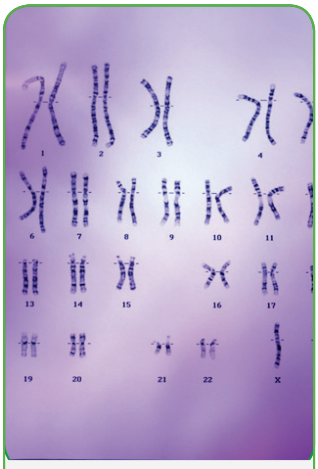
DNA

Section 1: What Is DNA?

• What is DNA?

DNA is a long macromolecule inside cells, which carries the genetic information to instruct the cells what proteins to make. The genetic code consists of four bases, called adenine, thymine, guanine and cytosine, which are arranged in long sequences along the length of the molecule. The order in which the bases are arranged determines what proteins are made by the cell. The DNA sequence of every individual is different, unless of course they are identical twins!



Human DNA is packaged within 46 chromosomes

• Suggested Films

- **What Is DNA?**
- **FactPack: DNA**

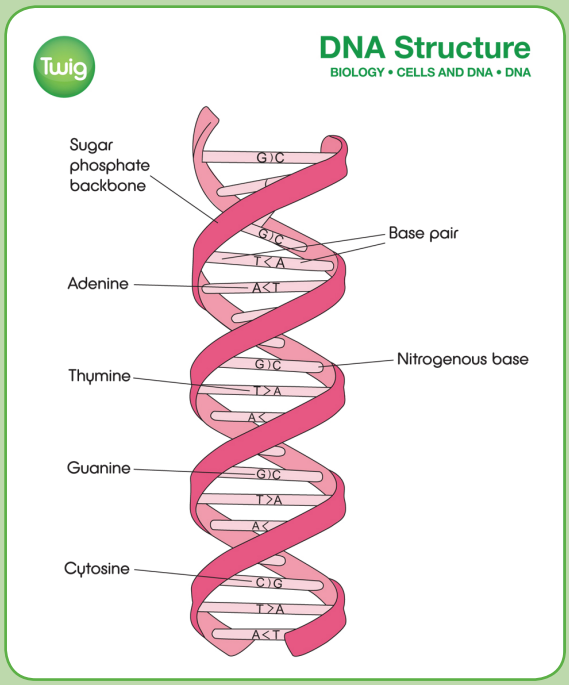
Extension Question

Q1. What does DNA stand for?

DNA stands for deoxyribonucleic acid.

• What is the structure of DNA?

DIAGRAM 01:



The molecule itself is a double stranded molecule twisted into the shape of a helix. The two strands are complementary to each other because the bases adenine (A), cytosine (C), thymine (T) and guanine (G) pair up in a precise way according to the base pairing rule: A always pairs with T and C always pairs with G. Only one of the strands carries the actual genetic instructions for the cell. The other half is complementary to the coding strand, and is needed when the DNA is replicated before cell division.

• Suggested Film

- **Discovery of DNA**

Extension Question

Q2. What holds the bases in place?

The bases are held in place by a long chain of sugar molecules, called deoxyriboses, each bound to phosphate groups. This is called the sugar phosphate backbone. The complementary bases are held to each other by hydrogen bonds.

Section 2: What Does DNA Do?

• How does DNA code for proteins?

The genetic code in the DNA consists of the four bases: adenine (A), thymine (T), guanine (G) and cytosine (C), and these bases can be arranged in any order. The cell reads the code three letters at a time (for example, GGA or CGA etc), and this code can be translated into an amino acid sequence, which builds a protein. So if a protein is 100 amino acids long, it is coded for by a length of DNA which is 300 base pairs long.

The proteins that a cell makes determine what the cell is, and what it does. For example, red blood cells contain the protein haemoglobin for oxygen transport, and muscle cells contain the proteins actin and myosin for contraction.

• Suggested Film

– How Does DNA Make Protein?

Extension Questions

Q3. What is a gene?

A gene is the term used to describe a length of DNA which codes for the production of a particular protein. For example, there is a gene for haemoglobin, and a gene for insulin, but there are also genes which determine features such as hair and eye colour, intelligence and behaviour.

Q4. How many genes are there in a human cell?

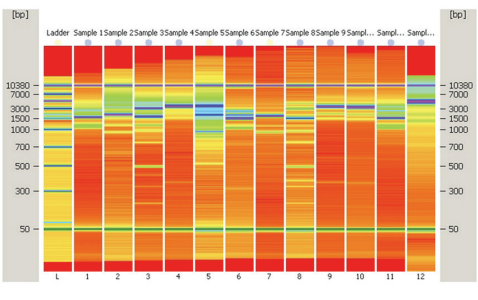
A human cell contains about 25,000 – 30,000 genes. In order to package them all inside one nucleus the DNA has to be tightly coiled up into structures called chromosomes. Human cells contain 46 chromosomes, whereas the number of chromosomes in other species differs. For example, the genes for dogs are found on 78 chromosomes.

• How can DNA be used to identify people?

DNA is the genetic code of life, and no two individuals' DNA is the same – unless they are clones, such as identical twins. This means that DNA can be extracted from different people and compared using techniques known as genetic fingerprinting (or DNA profiling). Today these techniques can be used in forensic science to help solve crimes such as murder and rape. The same techniques can be used in paternity testing.

• Suggested Film

– DNA and Crime



DNA bases can be separated onto a gel, giving distinct bands for different individuals

Extension Question

Q5. What can be used to provide a DNA sample at the scene of a crime?

Any cells that contain nuclei can be used as a source of DNA. Examples include blood, skin and sperm cells.

Section 3: How Does DNA Replicate?

• How does DNA replicate?

DNA is a double stranded molecule, and each strand is complementary to the other thanks to the base pairing mechanism. This means it can easily be split to expose the bases that provide a template upon which a new, complementary strand can develop. Eventually, one original molecule of DNA is replicated to form two new strands, each of which consists of half the original strand. This is known as semi-conservative replication.

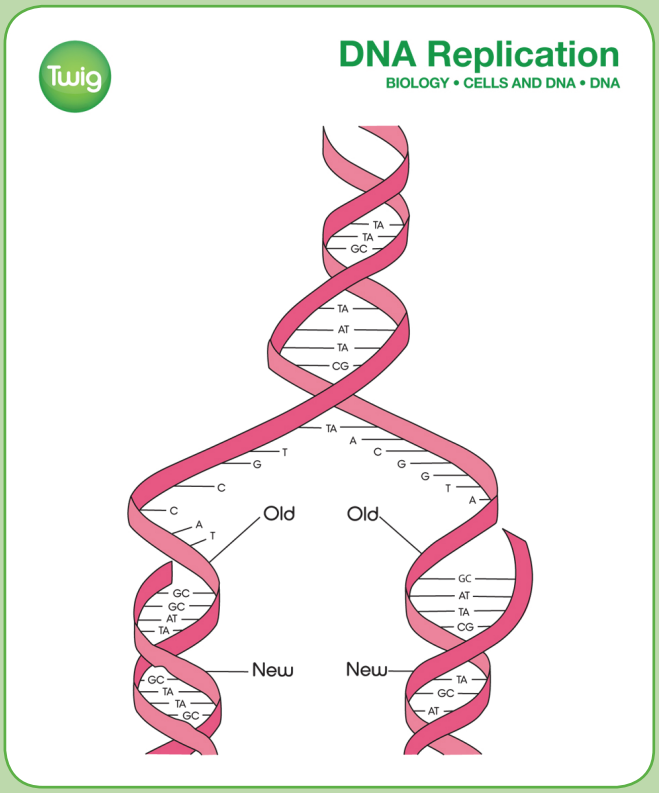
- **Suggested Film**
  - **What Is DNA?**

Extension Question

Q6. Are mistakes ever made when DNA is replicated?

Yes, these mistakes are called mutations. These mutations lead to new genetic sequences, which occasionally code for the production of novel proteins, some of which may be of benefit to the cell or organism which inherits them.

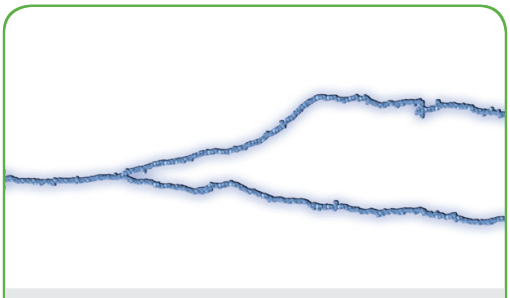
DIAGRAM 02:



• When does DNA replicate?

DNA replicates before cell division, so that the new cells created have copies of all the genes they need to function. Cells divide by mitosis to produce the genetically identical cells needed for processes such as growth, repair and asexual reproduction. Cells divide by meiosis in order to create gametes for sexual reproduction.

- **Suggested Films**
  - **Cell Division: Mitosis**
  - **Cell Division: Meiosis**



DNA replication fork seen under a microscope

• Quizzes

What Is DNA?

Basic

• What is the name of the genetic material in cells?

A – protein
B – DNA
C – amino acid
D – enzymes

• What does DNA code for in the cell?

A – bases
B – ribose
C – phosphate
D – proteins

• Where is DNA found in the cell?

A – cytoplasm
B – membrane
C – nucleus
D – ribosomes

Advanced

• What does DNA stand for?

A – dinucleotide acid
B – deoxynucleotide acid
C – deoxynucleic acid
D – deoxyribonucleic acid

• What is the name of the structures in the nucleus that hold the DNA?

A – genes
B – chromosomes
C – ribosomes
D – proteins

• What are adenine, thymine, cytosine and guanine examples of?

A – amino acids
B – proteins
C – sugars
D – bases

• Which of the following bases pairs with cytosine?

A – guanine
B – adenine
C – cytosine
D – thymine

DNA Makes Protein

Basic

• What are proteins constructed from?

A – enzymes
B – hormones
C – amino acids
D – DNA

• How many bases code for one amino acid?

A – 20
B – 4
C – 3
D – 64

• On what organelles in the cell are the proteins constructed?

A – mitochondrion
B – chloroplast
C – nucleus
D – ribosome

Advanced

• What are proteins constructed from?

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• What is the name of the molecule that carries the genetic instructions from the nucleus to the ribosomes?

A – protein
B – RNA
C – amino acid
D – DNA

• Answers

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