Structure of DNA: GCSE Biology

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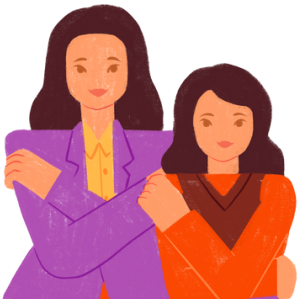
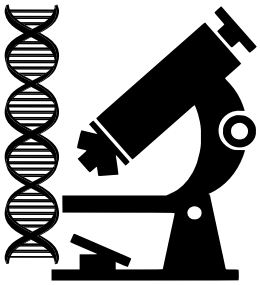
1. Introduction

- In our body, all the **cells know what, when, and how to do.**
- This is because there are **instructions present** inside the **nucleus** of each cell.
- It is called **genetic information** and is stored in the form of **DNA**.
- All forms of life having cells as their basic unit have DNA as their genetic material.
- However, certain viruses use RNA for the same purpose.

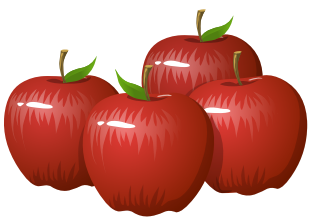
Real-life examples:



Identical features



DNA Fingerprinting



Genetically Modified Food

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2. What is DNA

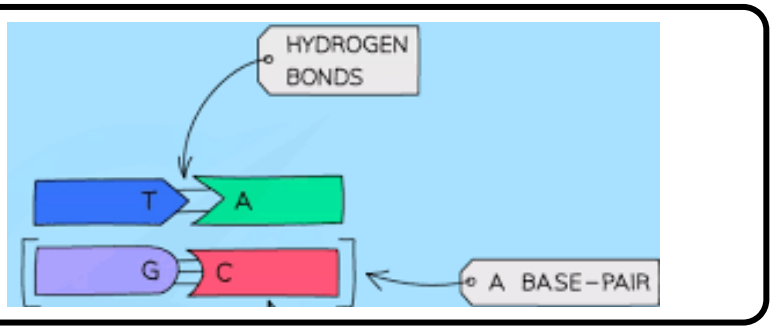
- DNA is an abbreviation for **Deoxyribonucleic Acid**.
- It is the **genetic material** in most organisms.
- It is the **carrier** of the **genetic information** from one generation to another.
- In the **nucleus,** DNA is condensed with proteins and is present in the form of **chromosomes**.

3. Overall Structure of DNA

- A DNA molecule is a **double-stranded** structure.
- Both the **strands spiral around each other**, connected by base pairs in a **double helix** structure.
- The backbone of the strands is made of the **sugars** and **phosphate groups**.
- These two are attached to one of the four bases: **Adenine** (A), **Thymine** (T), **Cytosine** (C), and **Guanine** (G).
- Together, a base, a sugar, and a phosphate group form a **nucleotide.**

4. Double-stranded structure and Hydrogen bonding

- The bases, **A, T, C,** and **G**, are **slightly electrically charged**.
- As opposite charges attract each other, they form **weak attractive forces** known as **hydrogen bonds**.
- Therefore, **Cytosine** forms **three hydrogen bonds** with **Guanine**, and **Adenine** forms **two hydrogen bonds** with **Thymine**.
- These weak hydrogen bonds hold two sugar and phosphate group backbones together, making DNA double-stranded.



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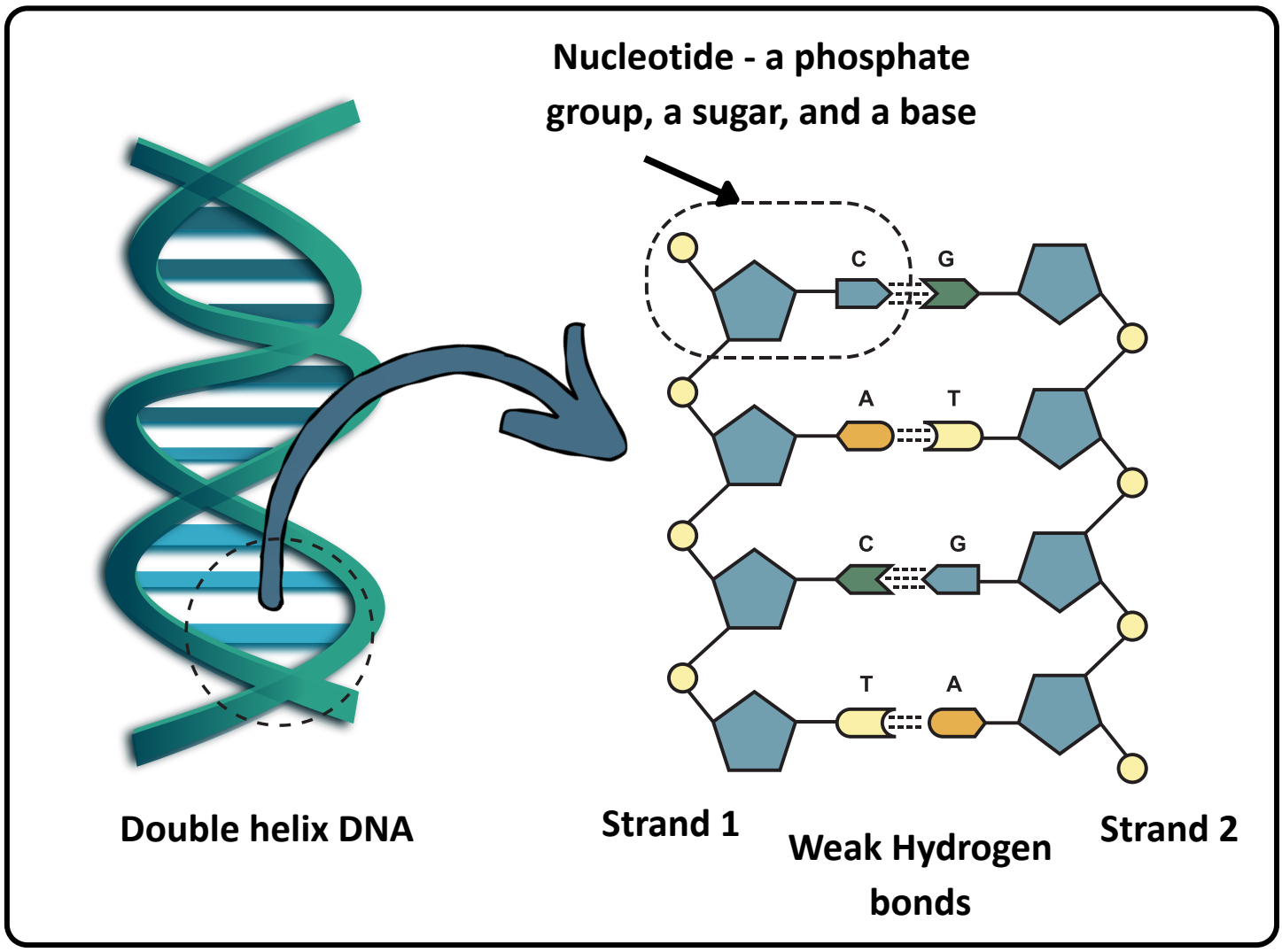

5. Base Pairing and the DNA Code

- DNA has four bases in it.
- Bases form pairs, **A with T**, and **G with C**, known as **complementary base pairs.**
- These four bases come together in **different sequences** in a **three-letter** codon and **encode** for a **protein**.
- These coded instructions are present in **genes**.
- Difference in the order of the bases causes us all to have **different genes**.
- All the individuals have different DNA except for identical twins.
- Scientists can find an individual's identity as parents transfer DNA to their offspring.

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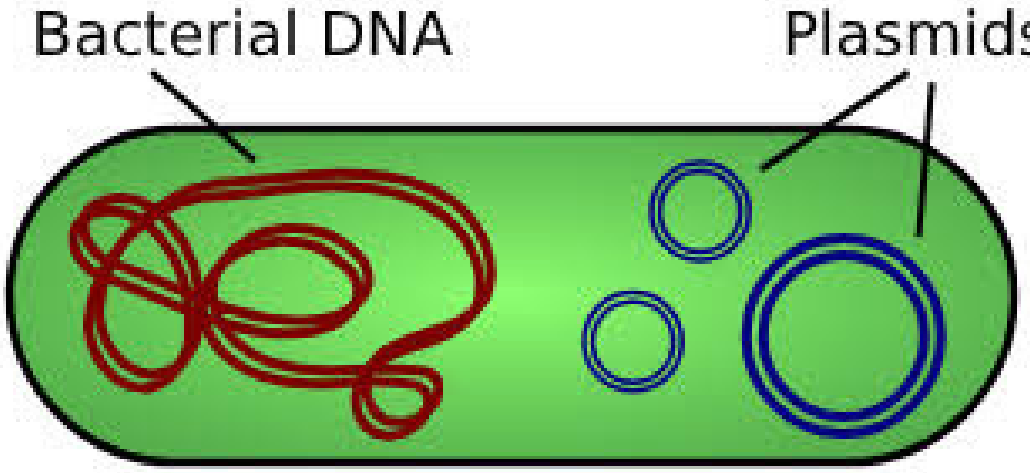
6. Organization of DNA

- Since DNA is a **polymer** (a long chain of nucleotides joined together), it cannot simply fit inside a cell.
- Therefore, a long molecule of **DNA is wrapped around proteins**, named as histones, to make **chromatin**.
- The chromatin coils numerous times to form a **chromosome.**
- In **prokaryotes**, for example, bacteria, DNA lies **freely in the cytoplasm**.
- However, in **eukaryotes**, like plants and animals, DNA is present **enclosed in the nucleus.**

7. Organization of DNA in Prokaryotic Cells

- In prokaryotic cells, DNA is found **free** in the **cytoplasm**.
- It is in the form of one **circular** DNA molecule, **chromosomal DNA**.
- There is no association of DNA with histone proteins.
- Other than this, **plasmids** are also found in these cells.
- These are **small, circular DNAs** that carry extra genes.



Prokaryotic Cell

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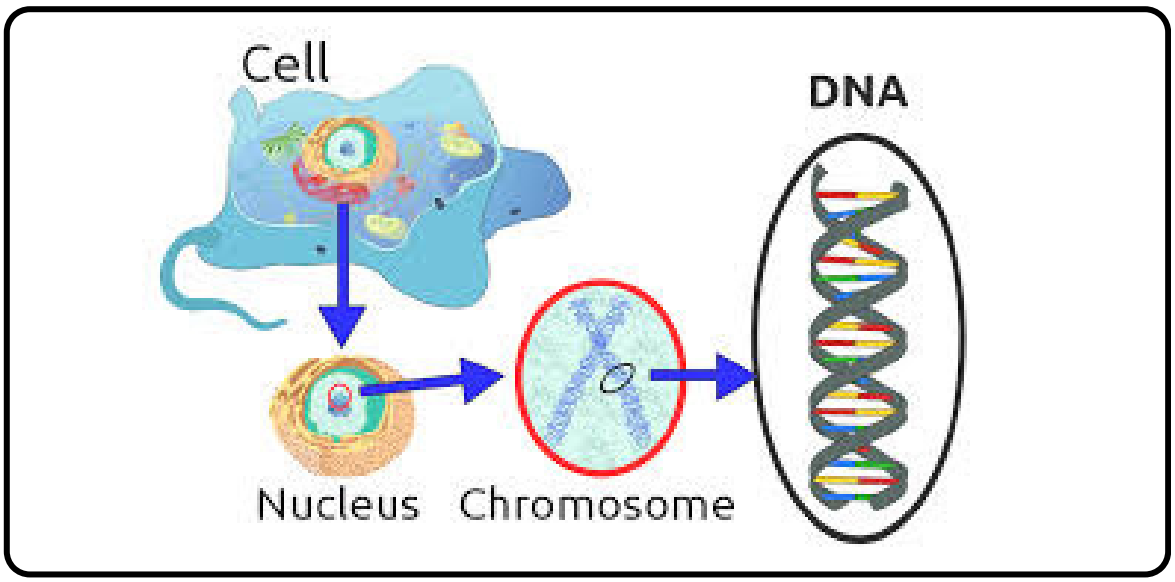
7. Organization of DNA in Eukaryotic Cells

- In eukaryotic cells, DNA is present inside the **nucleus**.
- Unlike prokaryotes, its **shape** is **linear**.
- It is condensed with histone proteins to form **chromatin**.
- Other than nuclear DNA, mitochondria and chloroplasts have their own DNA.



Features	Prokaryotic Cells	Eukaryotic Cells
Present in	Cytoplasm	Nucleus
Shape	Circular	Linear
Histone proteins	Absent	Present
Other DNAs	Plasmids	Mitochondrial & Chloroplast DNA

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7. FAQs

1. **What is DNA?**
DNA (Deoxyribonucleic Acid) is the genetic material found in cells.

2. **What is the shape of DNA?**
The shape of DNA is a double helix, which looks like a twisted ladder.

3. **What is a nucleotide?**
A nucleotide is the basic building block of DNA. Each nucleotide has: a deoxyribose sugar, one nitrogen base, and a phosphate group.

4. **How are the two DNA strands held together?**
Weak hydrogen bonds hold two DNA strands together.

5. **What are the four bases found in DNA?**
Four bases found in DNA are Adenine (A), Thymine (T), Guanine (G), Cytosine (C).

6. **What is complementary base pairing?**
The specific base pairing between Adenine and Thymine, and Guanine and Cytosine is known as complementary base pairing.

7. **What is gene?**
A gene is a short section of DNA that codes for a specific protein.

8. **How many chromosomes do human cells have?**
Human cells have 23 pairs of chromosomes, that is, 46 in total.