

JURONG WEST SECONDARY SCHOOL
SCIENCE DEPARTMENT
SECONDARY FOUR/FIVE SCIENCE BIOLOGY (5088)
MOLECULAR GENETICS

Learning Outcomes:

- Outline the **relationship** between **genes**, **chromosomes** and **DNA**
- State the **structure of DNA** in terms of the **bases, sugar and phosphate groups** found in each **nucleotide**
- State the rule of **complementary base pairing**
- State that DNA is used to carry the genetic code
- State that **each gene**
 - is a sequence of **nucleotides**, as part of a DNA molecule
 - Controls the production of **one polypeptide**
 - is a unit of inheritance

State that DNA is used to carry the genetic code, which is used to synthesise specific polypeptides (details of transcription and translation are **not** required)

What is DNA?

- **Deoxyribo nucleic acid** (DNA)
- It is a molecule that carries **genetic information**.
- This genetic information is important for all cellular functions, such as cell division and cell differentiation.
- Almost all cells in our body contain DNA inside their nuclei.
- Each DNA molecule consists of **two strands twisted** around each other to form a **double helix**. (Fig. 1)

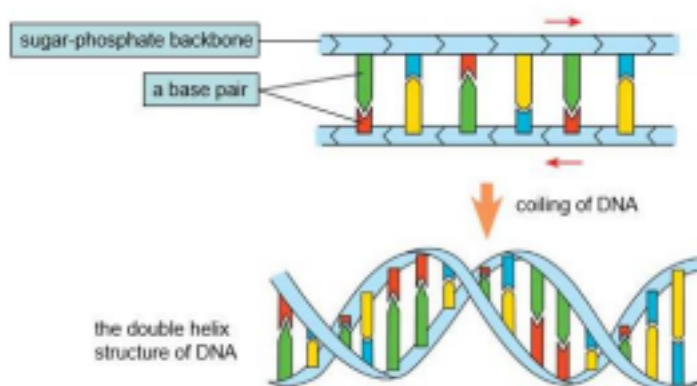
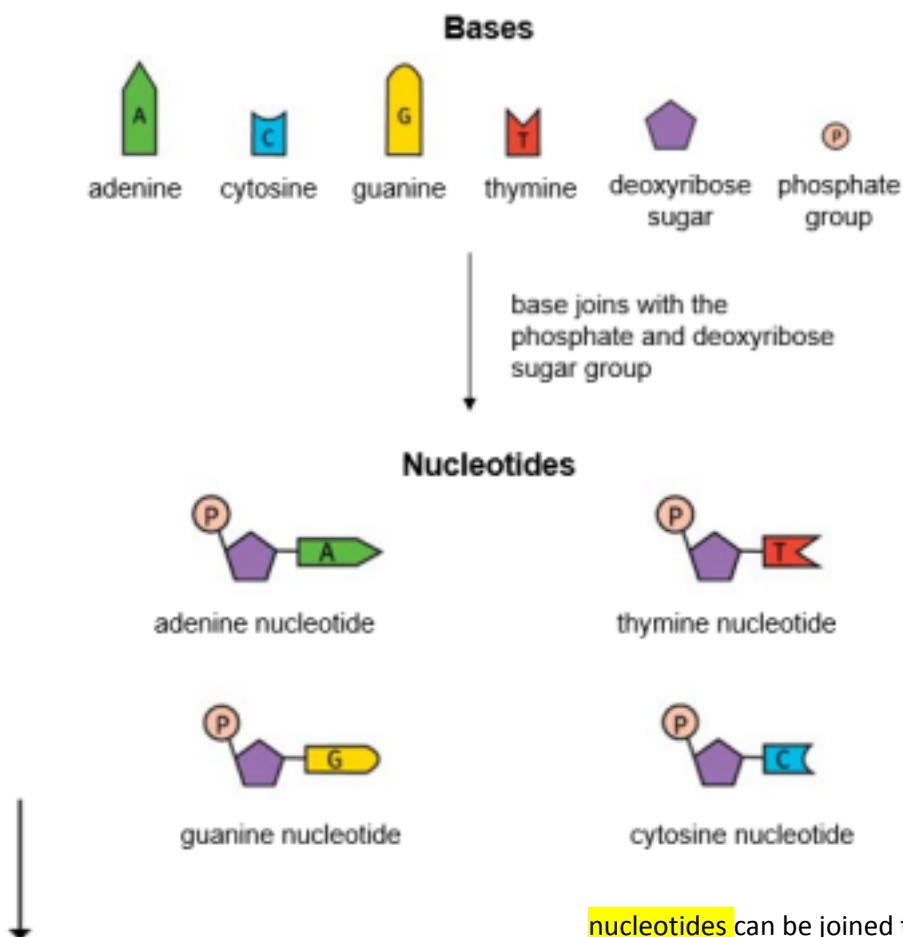


Fig. 1

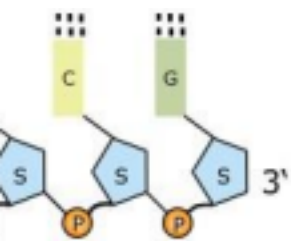
- A small segment of DNA **carries gene** that stores **genetic information** to make a **single polypeptide**.
- Polypeptides are used to make **proteins**.
- Proteins are used to **determine the characteristics of an organism**.

Basic Unit of DNA (Fig. 2)

- The basic unit of DNA is a **nucleotide**.
- Each nucleotide is made of
 - a sugar called **deoxyribose**;
 - a **phosphate** group; and
 - a **nitrogen-containing base**.
- all joined together
- The **four** bases of nitrogen-containing bases are
 - **Adenine** (A)
 - **Thymine** (T)
 - **Cytosine** (C)
 - **Guanine** (G)



nucleotides can be joined together to form long chains called **POLYNUCLEOTIDES**



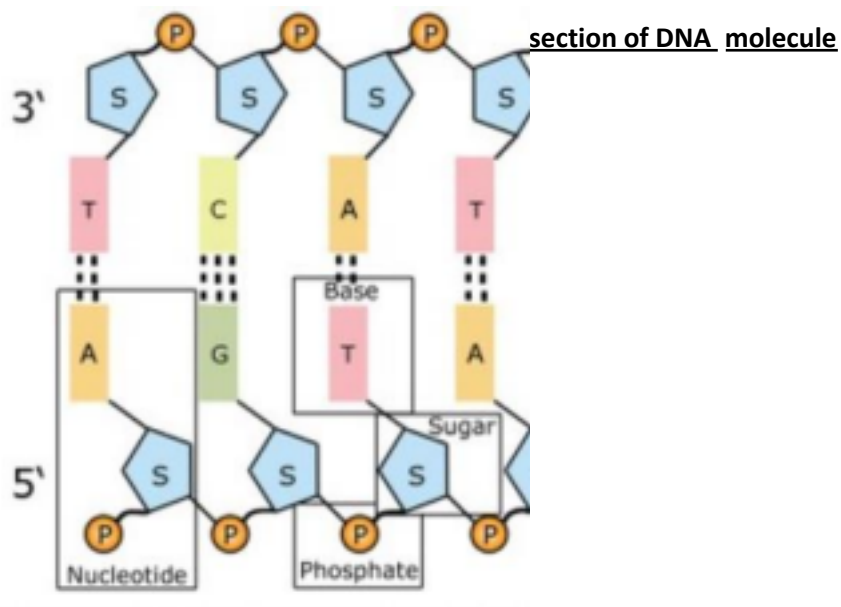
polynucleotides

Fig. 2

<https://www2.le.ac.uk/projects/vgec/highereducation/topics/dna-genes-chromosomes>



polynucleotides can be joined together to form long chains called DNA MOLECULES.



- The **double helix** of the complete DNA molecule resembles a spiral staircase, with two **sugar phosphate backbones** and the paired bases in the centre of the helix.

Rule of **Complementary Base Pairing** (Fig. 3)

- The bases of one strand form bonds with bases of the other strand according to the **rule of complementary base pairing**.
- **Adenine always bonds with Thymine.**

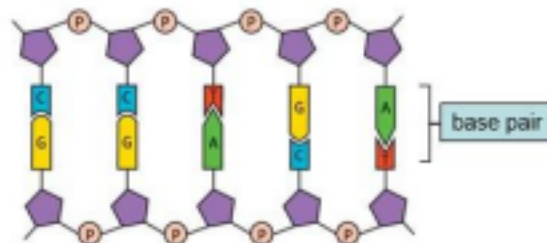
- **Cytosine always bonds with Guanine.**

• Bases that bond with each other are known as Complementary Base Pairs. • In the DNA molecule, the ratios of adenine to thymine (A:T) and cytosine to guanine (C:G) are **1:1**.

- A-T and G-C makeup **100%** of the DNA molecule.

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What are GENES?

- A DNA molecule contains **many genes** along its length.
- A gene is a small segment of DNA which carries **genetic information**. It controls the formation of a **polypeptide** which eventually form a **protein**. The proteins are used to determine the **characteristics of an organism**.
- The genetic information stored by a gene is known as the genetic code. (Fig. 4)

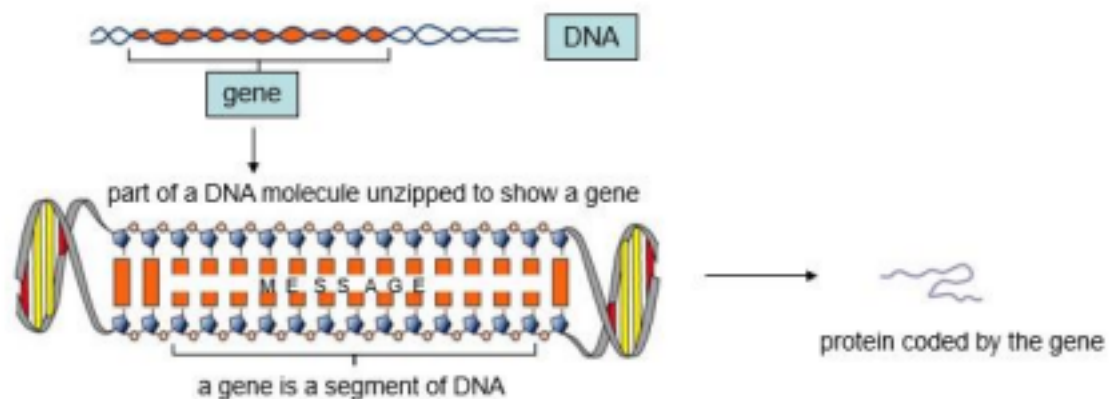


Fig. 4

Structure of a Gene

- Each gene consists of two polynucleotide chains. One of the chains determines the type of protein made. This chain is called the template.
- The template is made up of a sequence of nucleotide bases.
- The sequence of nucleotide bases can vary.
 - This results in many different genes.
 - Many different proteins that codes for different characteristics can then be produced.
- Three sequential bases code for one amino acid. This is known as the triplet code or CODON. (Fig. 5)

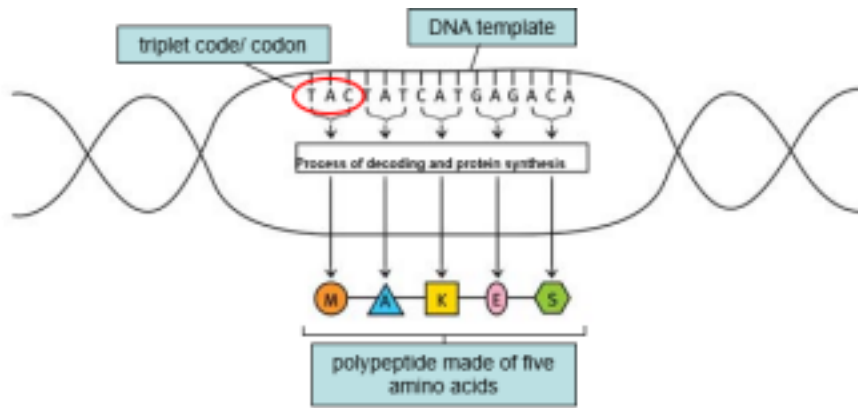


Fig. 5

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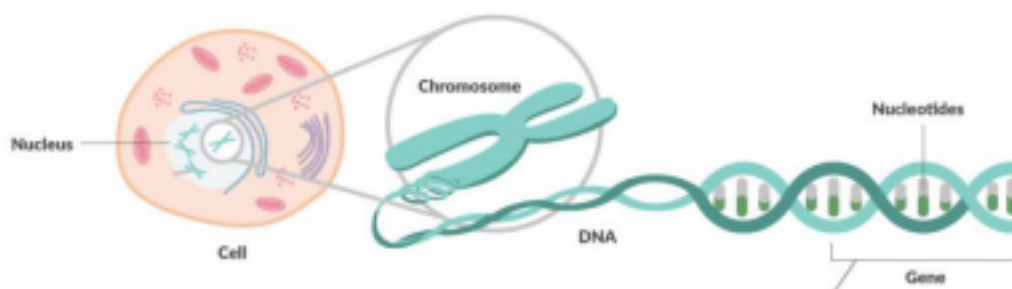
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Outline the relationship between genes, chromosomes and Deoxyribonucleic Acid (DNA).

(The first sentence has been done for you.)

Chromosomes are made up of DNA. Each DNA molecule consists of two anti-parallel strands twisted around each other to form a double helix. The DNA molecule is wrapped around proteins to form a single chromatin thread. During cell division, the chromatin thread condenses to form chromosomes in the cell nucleus. A DNA molecule carries many genes along its length. A gene is a sequence of DNA nucleotides which codes for the production of one polypeptide. These polypeptides are used to produce proteins, which are responsible for determining the characteristics of an organism.





State the structure of DNA in terms of the bases, sugar and phosphate groups found in each nucleotide.

(The first sentence has been done for you.)

The basic unit of DNA is called a nucleotide.

A nucleotide is made up of a deoxyribose sugar, a phosphate group and a nitrogen-containing base (adenine, cytosine, guanine or thymine).

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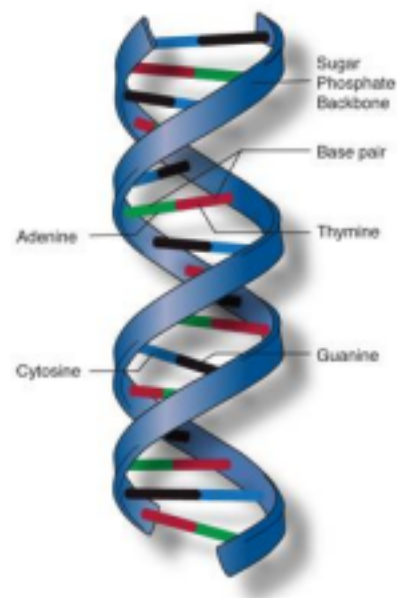
Based on the rule of complementary base pairing, adenine (A) always bonds with thymine (T) and guanine (G) always bonds with cytosine (C).

The two strands are held together by hydrogen bonds between the base pairs. The sugar phosphate backbone is formed as the deoxyribose sugar of one nucleotide bonds to the phosphate group of another nucleotide.

DNA is made up of two anti-parallel strands twisted around each other to form a double helix.

Describe how genes production of

1. A gene is a sequence of nucleotides which information needed to synthesise a
2. One DNA strand in the gene will be used to produce a complementary mRNA strand.
3. A set of three bases in the mRNA (codon) will specify an amino acid during translation by ribosome.
4. When the amino acids are assembled in sequence, a specific polypeptide is produced.
5. One or more polypeptide chains may fold together to form a protein.



control the proteins.

carries genetic polypeptide.

for transcription



Humans and chimpanzees share a surprising 98.8 percent of their DNA. As a result, we share many similar features, such as expressive faces, big toes and hands that can grasp. We also show similar behaviours, and like us chimps laugh when playing, hug to show affection and are able to walk upright.

How can we be so similar--and yet so different?

Chimpanzees and Humans only have a difference of 1.2% in the DNA. DNA molecule carries genetic information in the form of genes. **Genes** are sequence of DNA nucleotides that **code for the production of a single polypeptide**, that eventually forms a **protein** that **determines the characteristic of an organism**. The protein that determines the characteristics **depend on the sequence of DNA nucleotide bases** in the gene. While Humans and Chimpanzees may have the **same genes** (e.g. gene to produce big toe), the **difference in order of the nucleotide bases** causes the **characteristics** of the toe to be **different**.

