

DNA, genes and protein synthesis

Revision notes · The genome, genes and chromosomes, and (Biology only) the structure of DNA, RNA and how a gene is used to make a protein.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

DNA, genes and protein synthesis Spec 3.14-3.18B

The genome, genes and chromosomes Spec 3.14, 3.15

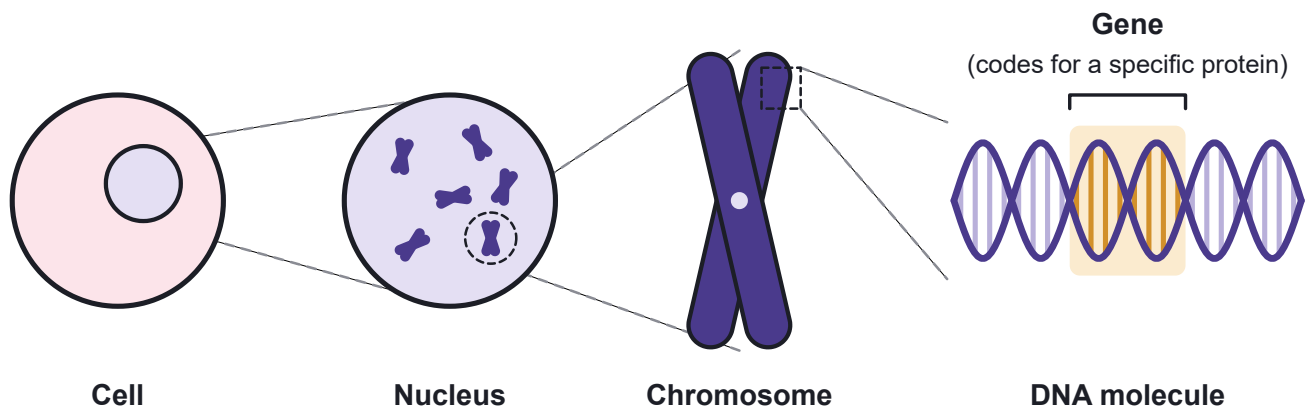
Genome	The entire DNA of an organism.
Gene	A section of a molecule of DNA that codes for a specific protein.
Chromosome	A long molecule of DNA, found in the nucleus, on which genes are located.

The **nucleus** of a cell contains **chromosomes**. Each chromosome is one very long DNA molecule, and many genes are located along it.

The genome includes all of the genes of an organism, as well as the rest of its DNA. A gene is a short section of the DNA. Each gene has a different sequence of bases, so each gene codes for a different protein.

Proteins do most of the work in a cell. Enzymes are proteins, for example. So the genes in a cell decide which proteins it can make, and that helps to decide the characteristics of the organism.

From nucleus to gene	
Structure	What it is
Nucleus	The part of the cell that contains the chromosomes
Chromosome	A long DNA molecule with many genes along it
Gene	A section of DNA that codes for one specific protein
Genome	All of the DNA of the organism



The **nucleus** contains **chromosomes**; each chromosome is a long DNA molecule, and a **gene** is a short section of it.

Exam tip: Use the exact wording. A gene codes for a specific protein, and the genome is the entire DNA, not just the genes.

Common mistake: Genes are located on chromosomes, which are in the nucleus. Do not say that chromosomes are found inside genes.

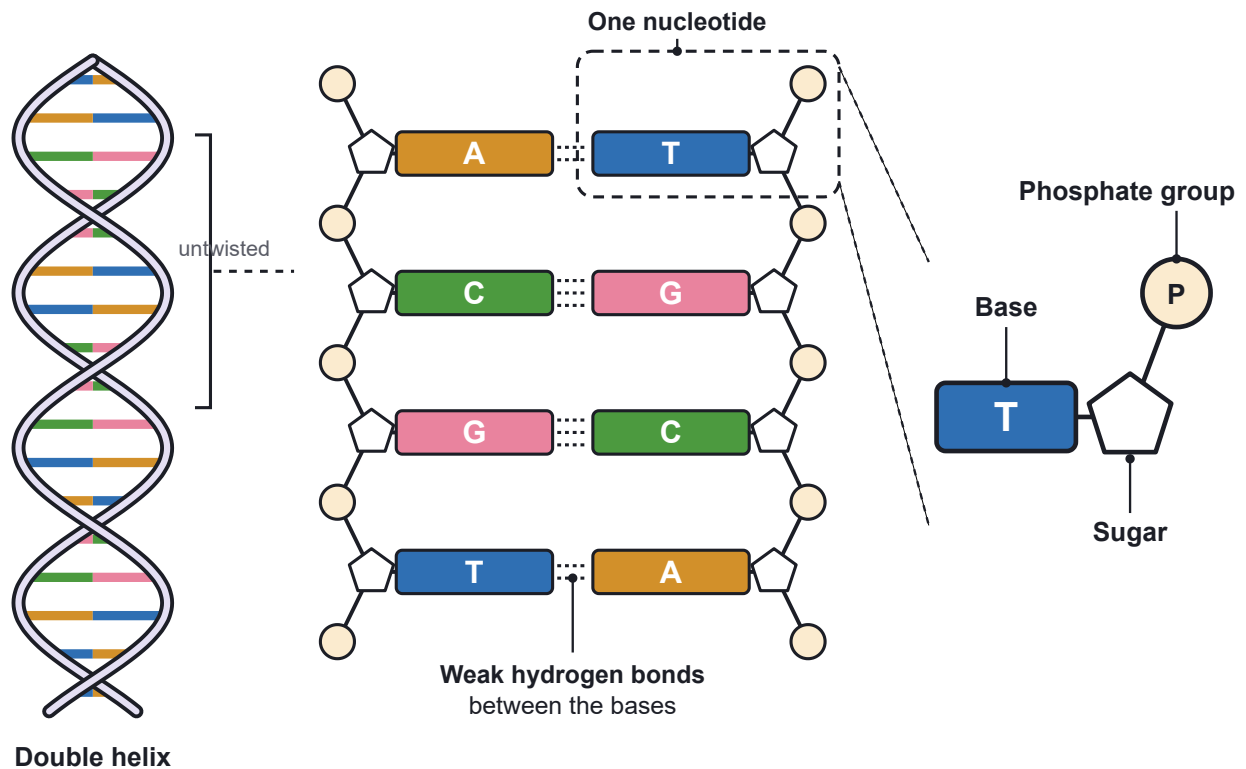
The structure of DNA Spec 3.16B Biology only

A DNA molecule is made of **two strands** coiled to form a **double helix**. Each strand is a chain of small units called nucleotides.

The two strands are linked by a series of **paired bases**. There are four bases, and each one only pairs with one other.

The four bases and how they pair	
Base	Pairs with
Adenine (A)	Thymine (T)
Thymine (T)	Adenine (A)
Cytosine (C)	Guanine (G)
Guanine (G)	Cytosine (C)

Because A always pairs with T and C always pairs with G, the base sequence on one strand tells you the sequence on the other. If one strand reads A T G C, the other strand reads T A C G.



DNA is a double helix of two strands; the bases pair **A with T** and **C with G**.

Exam tip: Write the pairs as A with T and C with G. If you are asked for the complementary strand, swap each base for its partner.

Common mistake: A does not pair with C or G. In DNA there is no uracil; that base is only in RNA.

RNA and protein synthesis Spec 3.17B, 3.18B Biology only

DNA stays in the nucleus, but proteins are made at ribosomes in the cytoplasm. A different molecule, RNA, carries the instructions from the gene to the ribosome.

DNA and RNA		
	DNA	RNA
Number of strands	Two (double helix)	One (single stranded)
Base that pairs with adenine	Thymine (T)	Uracil (U)
Bases present	A, T, C, G	A, U, C, G

A **codon** is a sequence of three bases on mRNA. Each codon codes for one amino acid. An **anticodon** is a sequence of three bases on a tRNA molecule that is complementary to a codon.

Stage 1: transcription (in the nucleus)

1. The two DNA strands separate along the gene.
2. A single strand of **mRNA** (messenger RNA) is made as a copy of the gene, by pairing complementary bases. A pairs with U, T pairs with A, C pairs with G and G pairs with C.
3. The mRNA leaves the nucleus through a pore and goes to a ribosome in the cytoplasm.

Stage 2: translation (at a ribosome)

1. The mRNA attaches to a **ribosome**.

2. **tRNA** (transfer RNA) molecules bring amino acids to the ribosome. Each tRNA carries one specific amino acid.
3. The anticodon of each tRNA pairs with the matching codon on the mRNA.
4. The amino acids are joined together in the order set by the codons, making a chain called a polypeptide. The polypeptide folds up to form a protein.

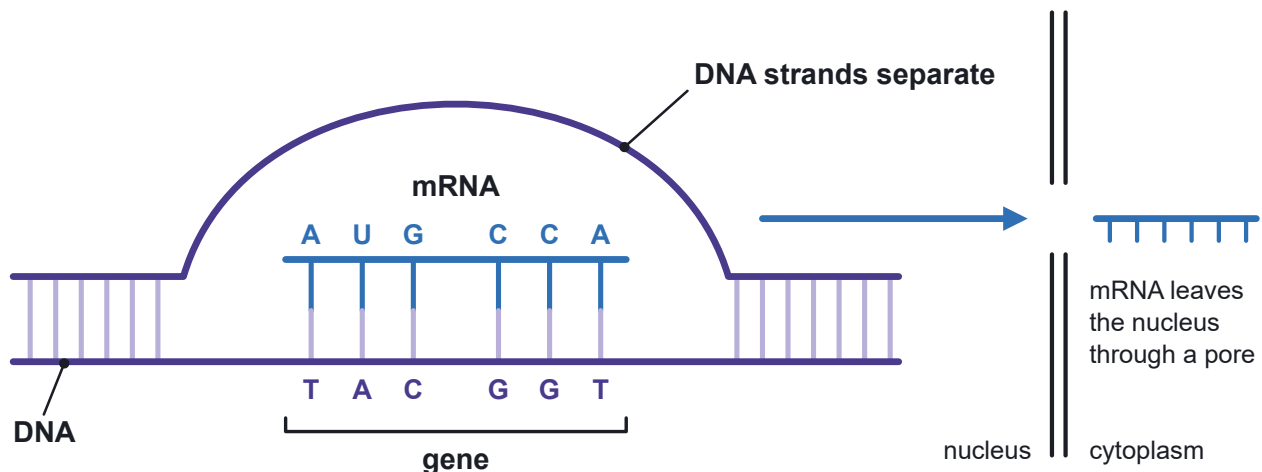
Transcription and translation of a short gene

The DNA template strand reads T A C G G T. Give the mRNA codons and the tRNA anticodons.

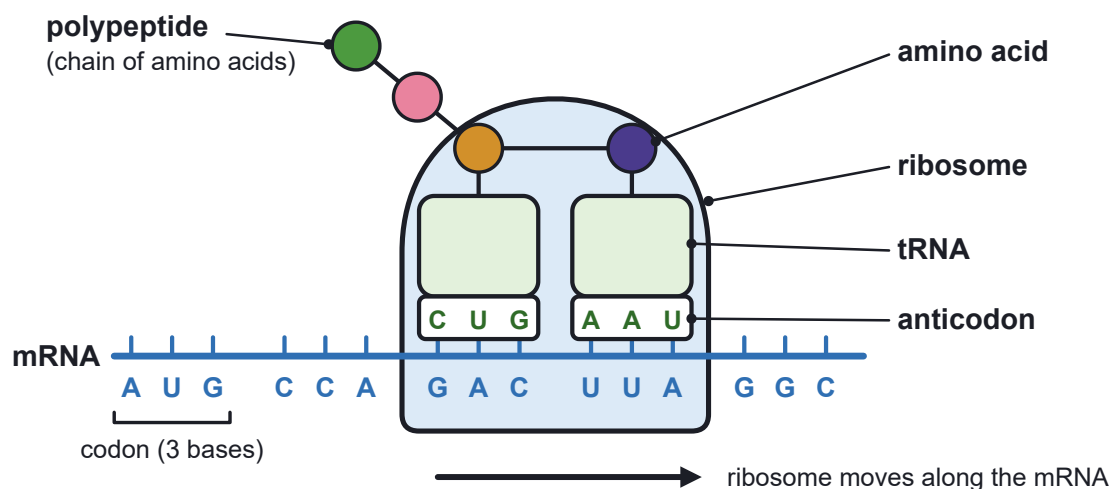
1. Transcription: pair each DNA base with its RNA partner. T gives A, A gives U, C gives G, and so on.
mRNA = A U G C C A.
2. Codons: AUG and CCA.
3. Translation: each anticodon is complementary to its codon. AUG pairs with UAC and CCA pairs with GGU.

Answer: mRNA codons AUG CCA; tRNA anticodons UAC and GGU.

1 Transcription (in the nucleus)



2 Translation (at a ribosome in the cytoplasm)



Transcription makes mRNA from a gene in the nucleus; **translation** at a ribosome joins amino acids in the order set by the codons.

Common mistake: Do not mix up the two stages. Transcription makes mRNA from DNA in the nucleus. Translation makes a polypeptide from mRNA at a ribosome.

Exam tip: Codons are on mRNA. Anticodons are on tRNA. Name the molecule when you use either word.

Quick check

1. What is a gene?
2. What is the genome?
3. **Biology only** Which base pairs with adenine in DNA?
4. **Biology only** Which base is in RNA instead of thymine?
5. **Biology only** Where are amino acids joined together to make a polypeptide?

Quick check answers

DNA, genes and protein synthesis

1. A section of a molecule of DNA that codes for a specific protein.
2. The entire DNA of an organism.
3. Thymine.
4. Uracil (U).
5. At a ribosome (translation).