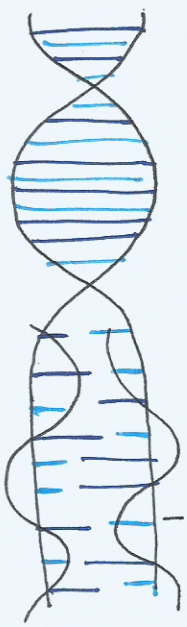
2.7 DNA REPLICATION, TRANSCRIPTION AND TRANSLATION

Semi-conservative replication



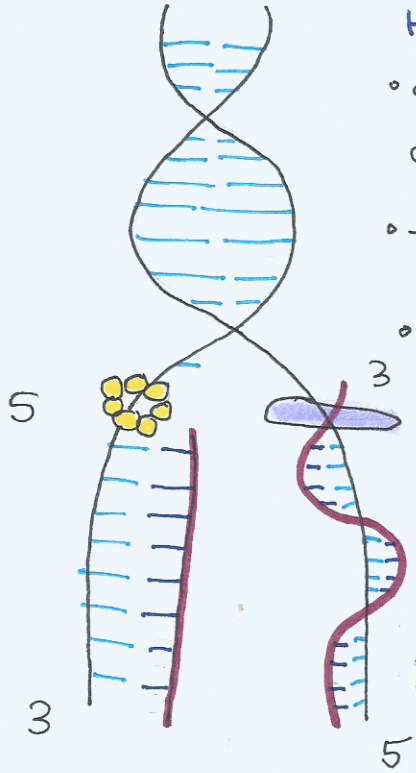
→ cell is ready to divide
→ two strands of the helix separate
→ both the strands serve as templates
→ the nucleotides attach to the strands
→ 2 new DNA molecules are formed
→ one strand is new and one is original
∴ it is called semi-conservative.

The base sequence of the original strand determines the base sequence of the new strand. This is because of complementary base pairing.

- only if the right nucleotides are linked, the structure will be stable.

HELICASE

It is an enzyme that separates the 2 strands of the DNA by breaking the hydrogen bonds. The strands need to be straight as they can't split if they are still in a helix.



Helicase:

- consists of 6 globular polypeptides in a donut shape.
- they assemble with the DNA strand
- the strand passes through the centre and moves along the DNA molecule
- the movement separates the strands and ATP is used for the movement.

■ - helicase ■ - DNA polymerase

~ - new strand

DNA POLYMERASE

- It links neuclotides together to form a new strand, using the original strand as a template.

4 nucleotides are present in the area where the replication is taking place.

Polymerase brings the nucleotides into the positions so that the hydrogen bonds can be formed.

- It gradually moves along the template strand.
- It assembles the new strand with a base sequence complementary to the template strand.
- There are very few mistakes during DNA replication.

TRANSCRIPTION

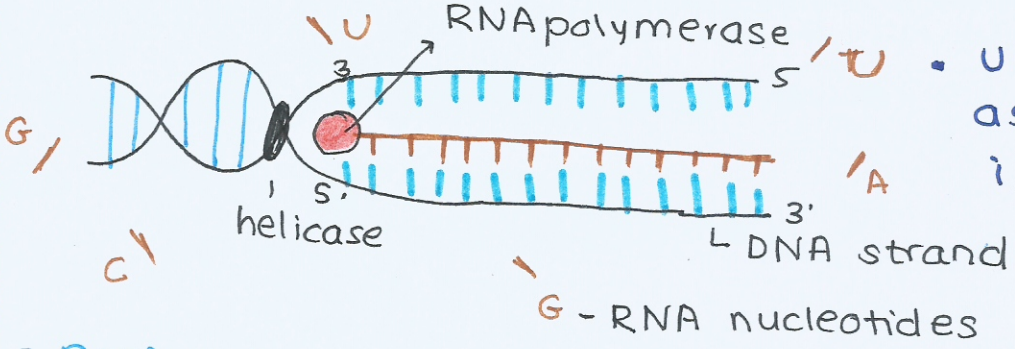
It is the synthesis of mRNA copied from the DNA base sequences by RNA polymerase.

DNA → Transcription ⟶ Translation ⟶ Protein

- RNA polymerase binds to a gene on the DNA strand.

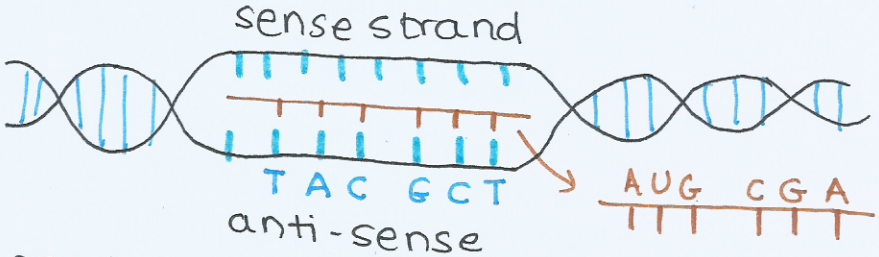
(The DNA strand is already unwinded by Helicase)

- RNA polymerase separates the DNA strands and starts pairing up RNA nucleotides with the DNA strand. (only one → leading strand.)



- U binds with A as there is no T in RNA.

- RNA polymerase forms covalent bonds between the RNA nucleotides. A RNA polymer is formed.
- It gets separated from the DNA strand and detaches. The double helix of the DNA forms again.



The product of transcription is a RNA strand with a base sequence complementary to the DNA strand.

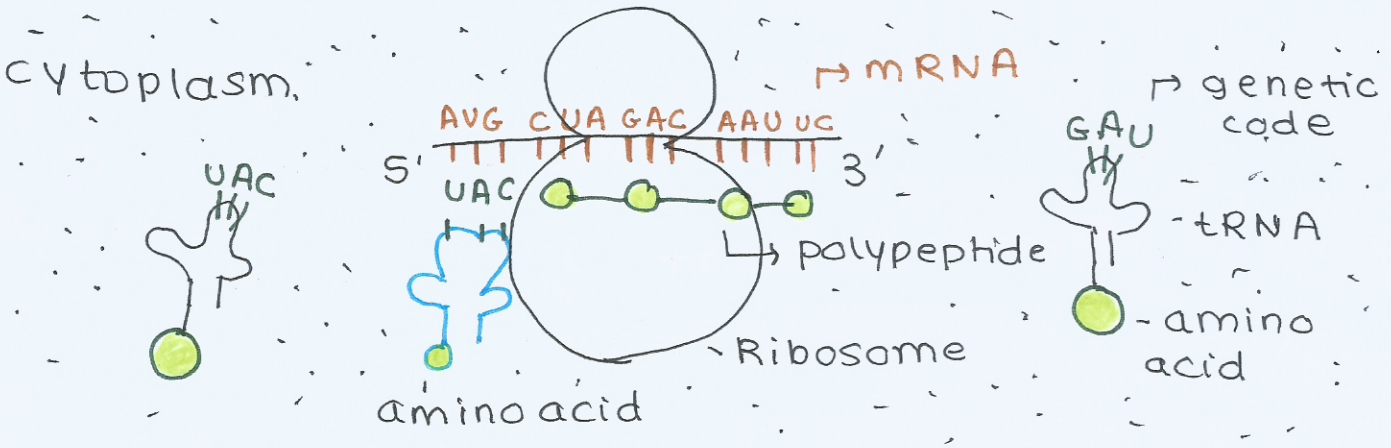
Sense strand: The strand that is identical to the RNA sequence (T instead of U).

Antisense strand: The DNA strand that gets transcribed and it is **complimentary to the RNA sequence** and the sense strand as well.

The RNA strand that is formed is the **messenger RNA strand (mRNA)**.

TRANSLATION

It is the process where the genetic information on the **mRNA** is translated into a polypeptide chain on a **ribosome**.



- The ribosomes bind to the **mRNA** and move in a **5'3' direction**.
- The genetic code present on the **tRNA** align with the base sequence on the **mRNA** strand. There is **complementary base pairing** (AUG-UAC).
- Each tRNA molecule binds with a specific amino acid with the used energy from **ATP**. Only a specific amino acid will bind with a specific **tRNA**. This is determined by the genetic code on the **tRNA**.
- The ribosome helps forms the bonds between the amino acids to make a polypeptide chain.
- After the code is translated, the **polypeptide chain is detached** and the **protein** is formed.

Central dogma of protein synthesis:

DNA —transcription→ mRNA —translation→ Proteins.

→ mRNA transcribes the DNA antisense strand. The mRNA is translated by tRNA on ribosomes to form proteins.

MESSENGER RNA AND GENETIC CODE

RNA that carries the information to synthesize a protein is called messenger RNA or mRNA.

▷ Only certain genes are transcribed and only certain mRNAs are present in the cytoplasm for translation.

CODONS & ANTICODONS

A sequence of 3 bases on the mRNA is called a codon.

• Each codon is responsible for coding a certain type of amino acid.

The order of codons determines the order of amino acids in the polypeptide chain.

codon ← GUU → valine → amino acid.

Why are only 3 bases used?

→ 4 different bases and 20 amino acids

△ 1 base cannot code one amino acid.

△ 2 bases code 16 amino acids but not 20.

∴ 3 bases are used.

Anticodons:

tRNA molecules have anticodons of 3 bases.

↓

these anticodons bind with the codons on mRNA (complimentary).

↓

they carry the amino acid corresponding to the codon.

The process of translation goes on until it reaches a stop codon.

The polypeptide is released after the completion.