

CAIE Biology A-level

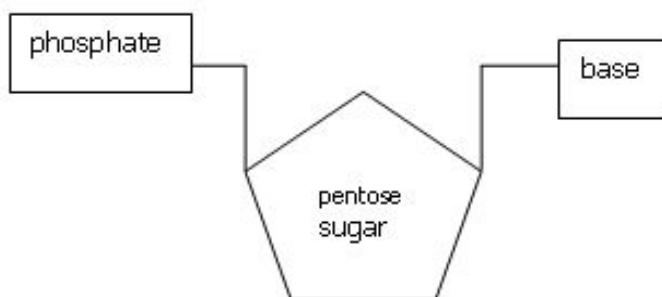
Topic 6: Nucleic acids and protein synthesis

Notes

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DNA and Protein Synthesis



Both **DNA** and **RNA** carry information. DNA holds genetic information, whereas RNA then transfers this genetic information from DNA to **ribosomes** made of RNA and proteins. Both deoxyribonucleic and ribonucleic acid are **polymers of nucleotides**. **Nucleotides** consist of **pentose**

which is a 5 carbon sugar, a nitrogen containing **organic base** and a **phosphate group**:

- The components of a **DNA** nucleotide are **deoxyribose, a phosphate group and one of the organic bases adenine, cytosine, guanine or thymine**. Adenine and guanine both have double ring structure and are classified as **purine** bases.
- The components of an **RNA** nucleotide are **ribose, a phosphate group and one of the organic bases adenine, cytosine, guanine or uracil**. Thymine, uracil and cytosine all have single ring structure and are classified as **pyrimidines**.
- Nucleotides join together by **phosphodiester bonds** formed in **condensation reactions**.

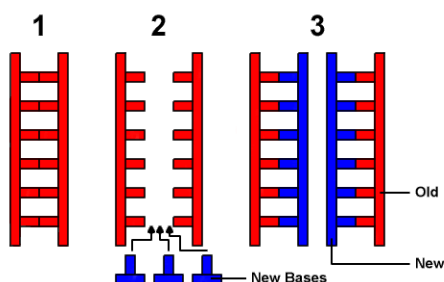
A DNA molecule is a **double helix** composed of two polynucleotides joined together by a **hydrogen bonds** between complementary bases whereas **RNA is a relatively short polynucleotide chain**. Purine bases always bind to pyrimidine bases.

DNA replication

The **semi-conservative replication** of DNA ensures genetic continuity between generations of cells meaning that genetic information is passed on from one generation from the next. DNA replication occurs during interphase.

The steps of semi-conservative replication of DNA are as following:

- The **double helix unwinds** and the **hydrogen bonds between the complementary bases break** using **DNA helicase** thus separating the two strands of DNA



- One of the strands is used as the **template** and **complementary base pairing occurs** between the template strand and **free nucleotides**
- Adjacent nucleotides are joined by **phosphodiester bonds** formed in condensation reactions using **DNA polymerase**

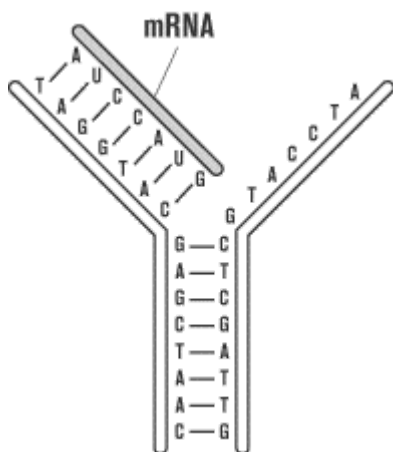


Protein synthesis

Proteins are polypeptide chains, coded for by a gene. There are two stages of **protein synthesis: transcription and translation**. **Transcription** which occurs in the nucleus and involves **DNA and mRNA** and **translation** which involves **mRNA, tRNA and ribosomes**. During transcription, DNA strand is transcribed into mRNA and translation is the process during which the amino acids are assembled together to form a polypeptide chain/protein.

Transcription:

During transcription, a molecule of mRNA is made in the nucleus:

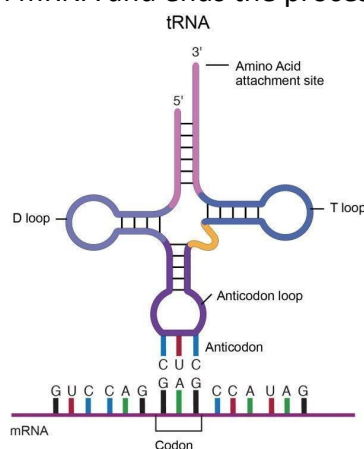


- The **hydrogen bonds** between the complementary bases break and the **DNA uncoils**, separating the two strands
- One of the DNA strands is used as a **template** to make the mRNA molecule, the template is called the **antisense strand**
 - **Free nucleotides** bind to the exposed bases via **complementary base pairing**, and adjacent nucleotides are joined by phosphodiester bonds, forming a molecule of mRNA
 - mRNA then moves out of the nucleus through a **pore** and attaches to a **ribosome** in the cytoplasm which is the site of next stage of protein synthesis called **translation**

Translation:

During translation amino acids join together to form a polypeptide chain:

- **mRNA** attaches to a ribosome. **Transfer RNA** is a type of RNA. It has an anticodon on one end and an amino acid bonded to the other, which it carries to the ribosome.
- The **anticodon of the tRNA** binds itself to the first codon on the mRNA by **complementary base pairing**
- Another tRNA molecule binds to the second codon of the mRNA. The amino acids attached to the tRNA molecules join by a **peptide bond** and then **tRNA molecules detach** themselves from the amino acids, leaving them behind
- This process is repeated thus leading to the formation of a **polypeptide chain** until a **stop codon** is reached on mRNA and ends the process of protein synthesis



Gene mutations

A gene mutation occurs when the **base sequence of DNA is altered**. If the DNA sequence is altered, this change is replicated in the mRNA chain and thus can result in an **altered polypeptide chain**. Gene mutations are caused by **mutagenic agents** such as chemicals and ionising radiation.

