Experience Day Biomedical Sciences

Pre-discussion

Literature round
Discuss which sources everyone used.

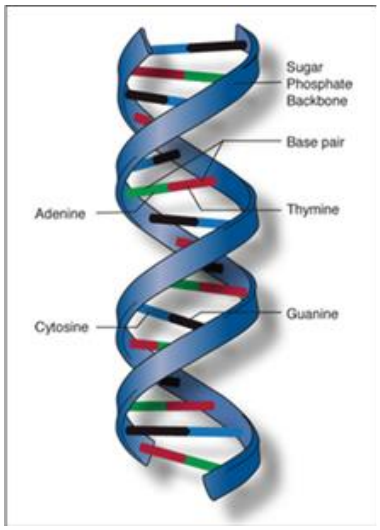
Problem statement
What is DNA and how is it replicated?

Learning goals
1. What is DNA?
    a. What is the structure of DNA?
2. How is DNA replicated?
3. What is RNA?
    a. What are the types of RNA?
    b. What is the structure of RNA?
4. How is RNA transcribed from DNA?
5. What are the differences between DNA and RNA?

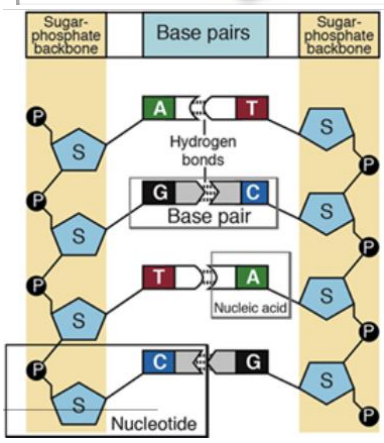
Post discussion: answers to the learning goals

1. What is DNA?

DNA is the information molecule. It stores instructions for making other large molecules, called proteins. These instructions are stored inside each of your cells, distributed among 46 long structures called chromosomes. These chromosomes are made up of thousands of shorter segments of DNA, called genes. Each gene stores the directions for making protein fragments, whole proteins, or multiple specific proteins.



What is the structure of DNA?
DNA is a made from **nucleotides**: a combination of a phosphate group, a sugar molecule and a nitrogen group (also known as the nucleobases). In DNA, two strands of nucleotides are held together by hydrogen bonds between the nitrogenous bases and are intertwined, forming a so-called **double helix**.

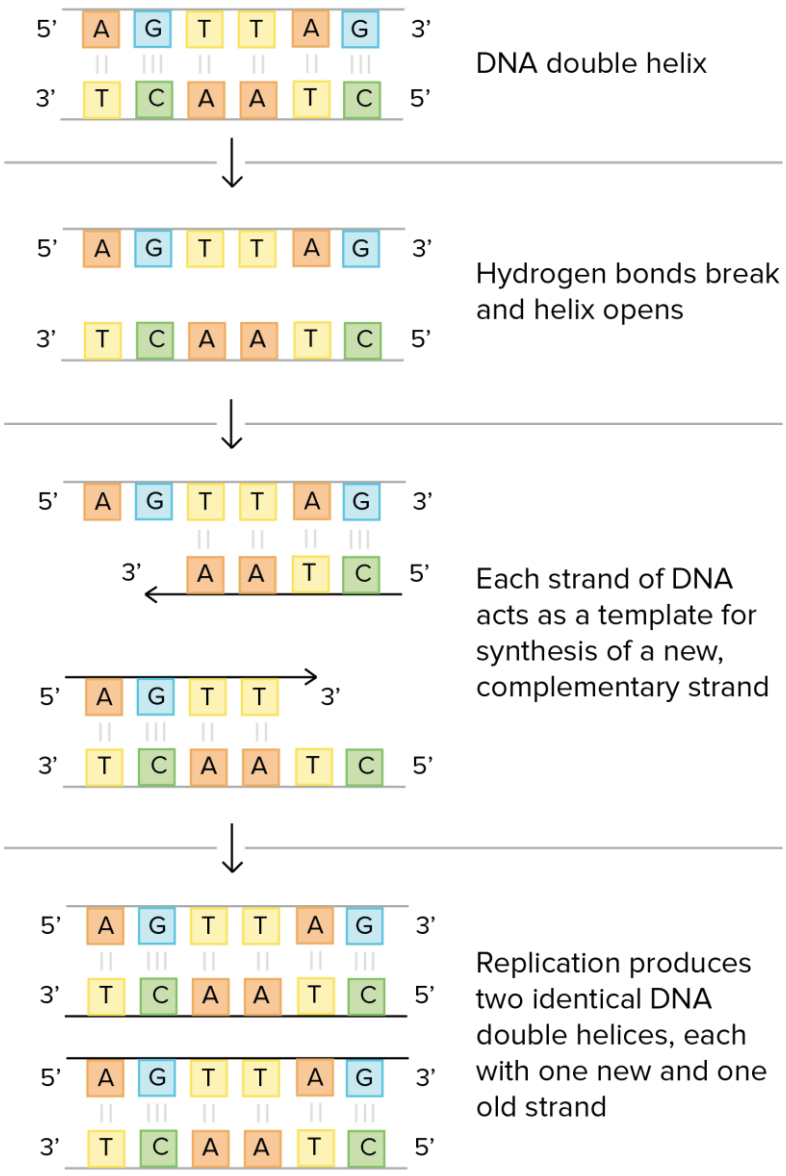


There are in total four nucleobases: **adenine, cytosine, thymine and guanine**. The combination of the nucleobases to form the connection between the strands of nucleotides, is set and always the same; A and T, C and G. A and G are purines which means they are made of two carbon nitrogen rings. C, T and U are pyrimidines which means they are made of a single carbon nitrogen ring. There are equal amounts of purines and pyrimidines found in the DNA.

The bond between A and T is made of two hydrogen bonds (=non-covalent bonds), whereas the bond between G and C consists of three hydrogen bonds. The bond between A and T therefore is easier to break.

DNA is **antiparallel** and **complimentary**. The side on which the phosphate group 'extends' is indicated by 3', the side on which the pentose sugar groups 'extends' is the 5' ending.

2. How is DNA replicated?



Leading strand: template strand of the DNA double helix that is oriented so that the replication fork moves along it in the 3' to 5' direction.

Lagging strand: the strand of the template DNA double helix that is oriented so that the replication form moves along it in a 5' to 3' manner, creating Okazaki fragments.

Replication fork: the point at which the two strands of DNA are separated to allow replication of each strand.

Helicase: opens up the DNA at the replication fork.

Primers: singular small strand of RNA that is added to the leading strand, which allows DNA polymerase to add new nucleotides.

DNA ligase: seals the gaps between DNA fragments.

Binding sites: a region of a nucleotide sequence where an RNA or DNA single-stranded primer binds to start replication.

3. What is RNA?

Ribonucleic acid is a nucleic acid present in all living cells that has structural similarities to DNA. RNA carries out a broad range of functions, from translating genetic information into the molecular machines and structures of the cell to regulating the activity of genes during development, cellular differentiation, and changing environments.

What are the types or RNA?

Three main types of RNA are involved in protein synthesis:

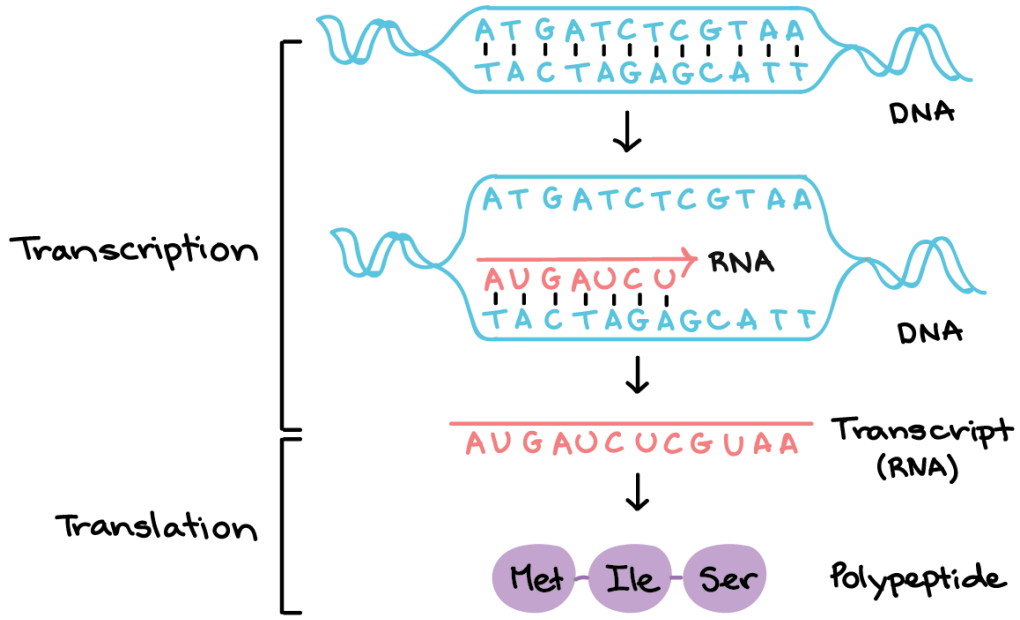
1. Messenger RNA (mRNA)
    a. Carries complementary genetic code copied, from DNA during transcription, in the form of triplets of nucleotides called codons.
2. Transfer RNA (tRNA)
    a. An essential component of translation, where their main function is the transfer of amino acids during protein synthesis.
3. Ribosomal RNA (rRNA)
    a. Forms ribosomes, which are essential in protein synthesis.

Another type is micro RNA, which are small non-coding RNAs useful in gene silencing.

What is the structure of RNA?

It is made up of nucleotides, which are ribose sugars attached to nitrogenous bases and phosphate groups. The nitrogenous bases include adenine, guanine, uracil, and cytosine. RNA mostly exists in the single-stranded form, but there are special RNA viruses that are double-stranded.

4. How is RNA transcribed from DNA?



RNA polymerase: uses a single-stranded DNA template to synthesize a complementary strand of RNA.

Initiation: RNA polymerase binds to a sequence of DNA and separates the strands, providing the single-stranded template needed for transcription.

Elongation: the addition of nucleotides to the mRNA strand by RNA polymerase.

Termination: terminators signal that the RNA transcript is complete and cause the transcript to be released from the RNA polymerase.

5. What are the differences between DNA and RNA?

There are a couple of major structural differences between DNA and RNA. First of all, RNA is single stranded, in contrast to the double strand of DNA. RNA also is much shorter than DNA. RNA sometimes forms a secondary double helix, but only intermittently. Third, RNA contains ribose sugar molecules, whereas the sugar in DNA is deoxyribose, which contains one less hydroxyl group than RNA's ribose. RNA's extra hydroxyl group proves useful in the process of converting genetic code into mRNA's that can be made into proteins, whilst the deoxyribose sugar gives DNA more stability. Fourth, RNA doesn't contain thymine bases, replacing them with uracil bases (U), which pair to adenine (A).

RNA	**DNA**
Single-stranded	Double-stranded
Short	Long
Ribose sugar molecule	Deoxyribose sugar molecule
Uracil instead of thymine	Thymine base