TB6 – Nucleic Acids

Nucleic acids are large biopolymers which carry the genetic information within organisms. They are **polynucleotides** – polymers made from **nucleotides**. Nucleic acids can be divided into two groups, called **DNA** and **RNA**.

DNA AND RNA

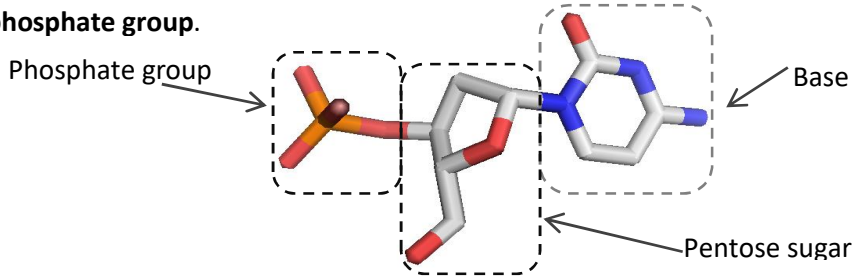
Deoxyribonucleic acid, DNA, is well known as the holder of genetic information, but there is an equally important nucleic acid called a **ribonucleic acid**, RNA, too.

DNA is the information manual to build and maintain all organisms. But the DNA code is only useful if it can be translated into other molecules, which do much of the work in cells and organisms. This is where RNA comes in. RNA helps to transfer the genetic code in DNA to amino acids and proteins using a **ribosome**. DNA is first transcribed into RNA which can be read by ribosomes (this RNA carries the instructions from the DNA to the ribosome, so it's called messenger RNA). Ribosomes are **molecular machines** which are **complexes of RNA and proteins**. These ribosomes will convert the genetic code and synthesise proteins by joining up amino acids. The ribosome reads the code along the messenger RNA, and matches this up to the correct amino acids. This process is repeated until the whole gene is translated to the protein it code for.

DNA and RNA are both made from monomers called nucleotides. There are different types of nucleotides, but they all have the same general structure.

NUCLEOTIDES

Nucleotides are monomers which have 3 distinct components: A **nitrogenous base**, a **deoxyribose sugar**, and a **phosphate group**.



Together the phosphate group and **pentose sugar** make up the **sugar-phosphate backbone**. This part is the same in each of the nucleotides. When nucleotides combine to form polymers such as DNA, they do so through **phosphodiester bonds** between adjacent sugar and phosphate groups. We call this the sugar-phosphate backbone, because this is the outer part of the helix which gives the overall DNA molecule its classic structure, just like our own backbones.

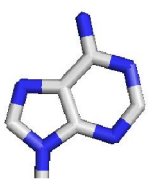
NUCLEOTIDES: DNA VS RNA

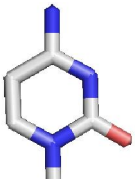
Deoxyribonucleic acid	Ribonucleic acid
Phosphate group	Phosphate group
Pentose sugar: Deoxyribose	Pentose sugar: Ribose
Nitrogenous base: ACGT	Nitrogenous base: ACGU

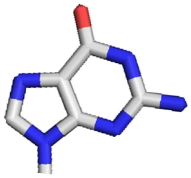
Produced by Adam Stubbs at Newcastle University as part of a summer outreach project.

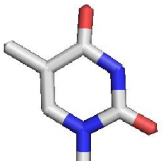
The nucleotides in DNA and RNA are different.

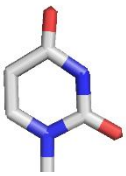
They both contain the same phosphate groups, and both contain a pentose (5-carbon ring) sugar. However, DNA uses a sugar called **deoxyribose**, and RNA uses **ribose**. The difference between them is that deoxyribose lacks an -OH group on the ribose. These sugars give the two different nucleic acids their respective names. Lastly are the bases, DNA uses adenine, cytosine, guanine, and thymine. In RNA, thymine is replaced by the base **uracil**.


Adenine


Cytosine


Guanine

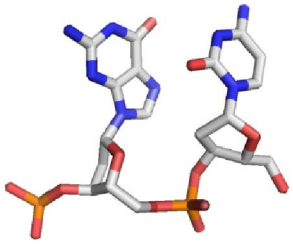

Thymine


Uracil

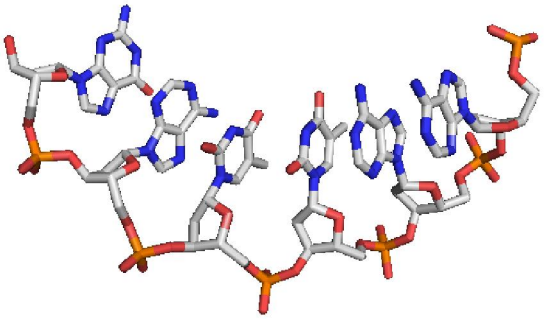
The 5 nucleotide bases. Note that the hydrogen atoms are not included.

POLYNUCLEOTIDES

When two nucleotides combine, they form a **dinucleotide**. When many nucleotides are combined, they form a **polynucleotide**, such as the individual **strands** in DNA. The nucleotide units polymerise and join through strong **covalent** bonds formed by **condensation reactions**. The condensation reaction between two nucleotides produces a **phosphodiester bond**. The sugar-phosphate backbone is visible in the polynucleotide below.

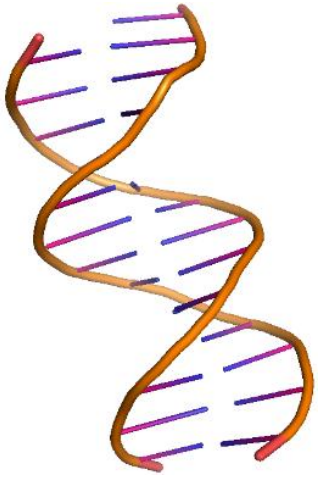

Dinucleotide 4rdu_dinucleotide

Each strand can be considered as polymer chain with various bases attached.

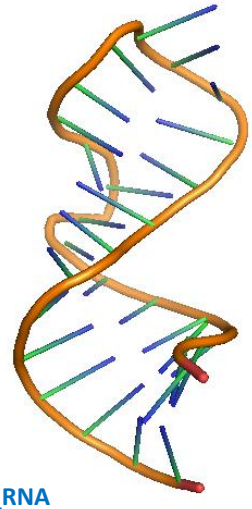

Polynucleotide 4rdu_polynucleotide

MOLECULAR NUCLEIC ACIDS

DNA polynucleotides arrange in a **double helix** structure, with two DNA strands combining through a process of complementary base pairing. See the DNA Structure and Base Pairing sheet TA7 for more information.


4rdu_Double_Helices

RNA doesn't usually exist in a double-stranded helix. Instead it tends to exist as **short single strands**, which can fold to base pair with itself.


5nqi_RNA