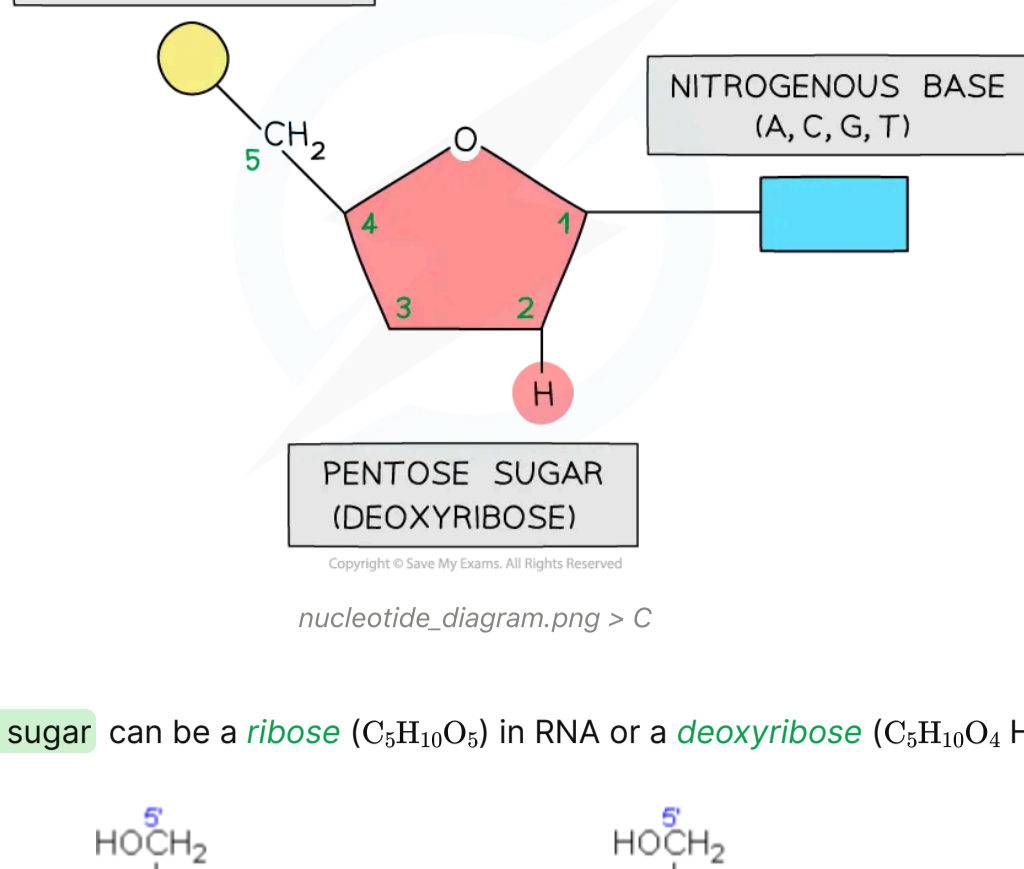


3.1.5 - DNA structure

Specification

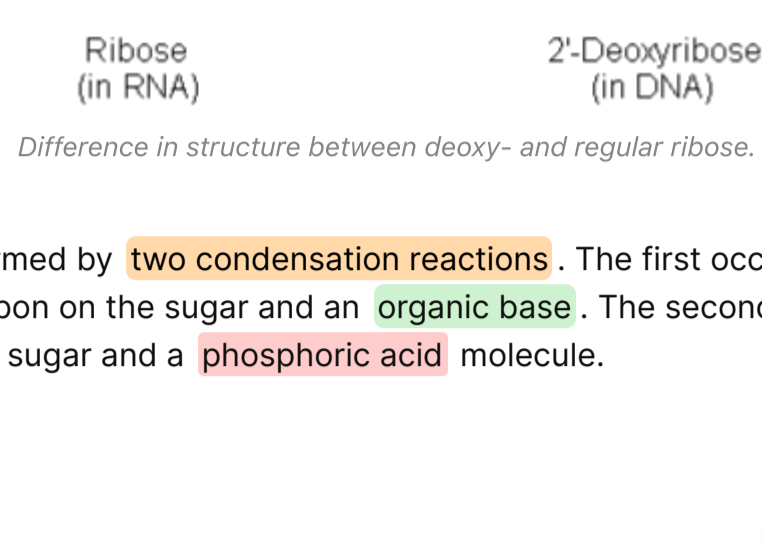
Nucleotides

Nucleotides are made up of a **phosphate**, a **pentose sugar**, and an **organic nitrogenous base**. **DNA** and **RNA** are **polynucleotides**.

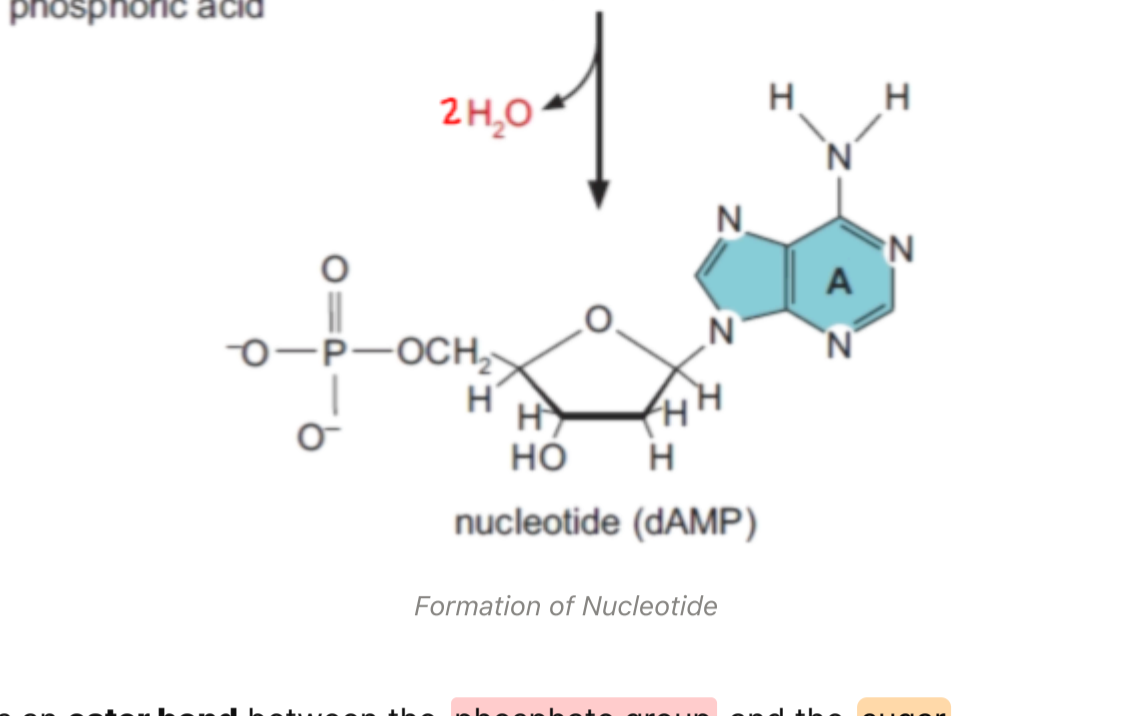


nucleotide_diagram.png > C

The **pentose sugar** can be a **ribose** ($C_5H_{10}O_5$) in RNA or a **deoxyribose** ($C_5H_{10}O_4$ H-2') in DNA.



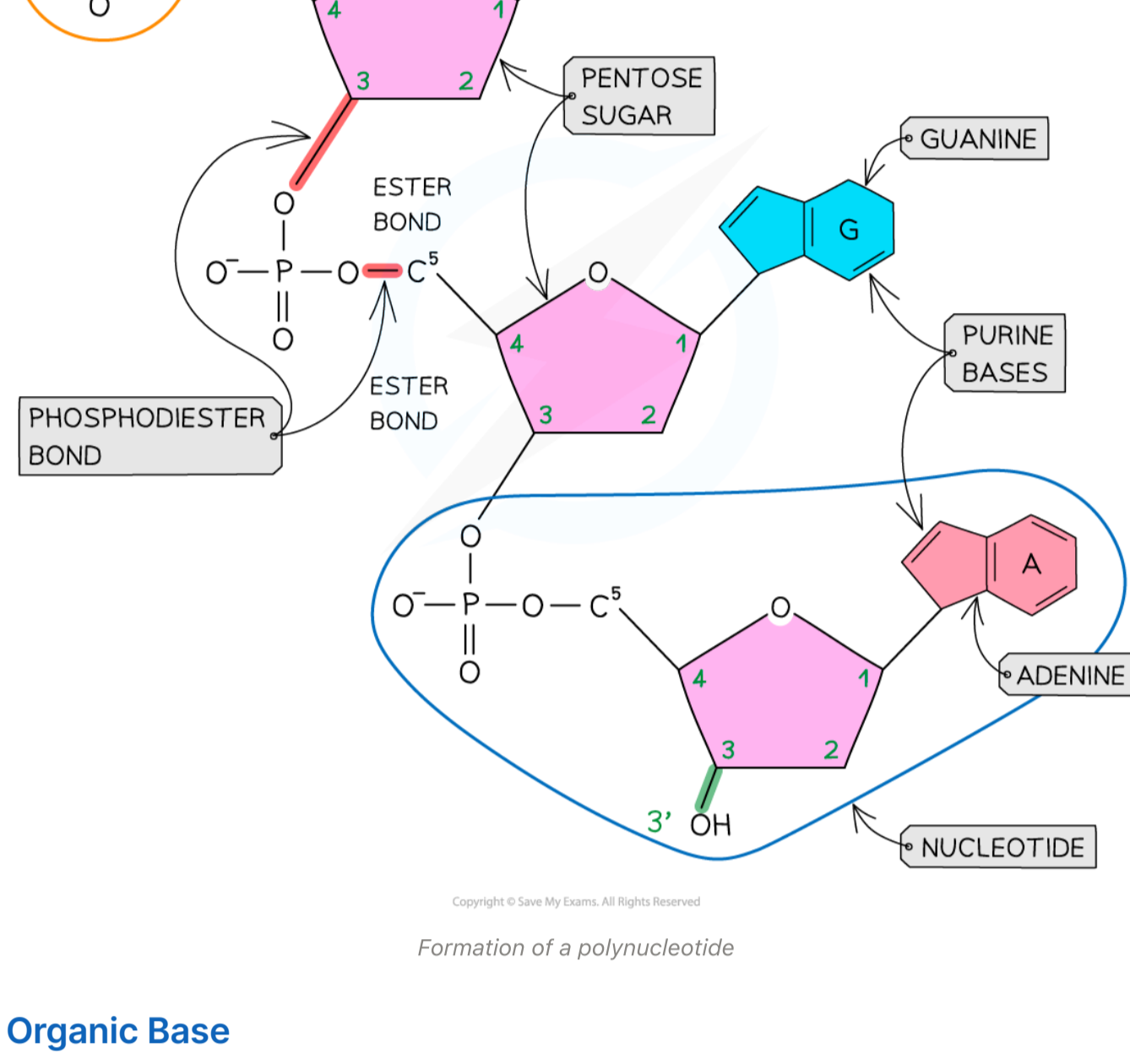
A **nucleotide** is formed by **two condensation reactions**. The first occurs between the **OH** on the 1st carbon on the sugar and an **organic base**. The second, between the **OH** on the 5th C of the sugar and a **phosphoric acid** molecule.



There is an **ester bond** between the **phosphate group** and the **sugar**.

There is a **glycosidic bond** between the **base** and the **sugar**.

Polynucleotides are also formed by condensation reactions between multiple nucleotide monomers. The **phosphate group** of one nucleotides forms a **phosphodiester bond** to the **pentose sugar** of another nucleotide.

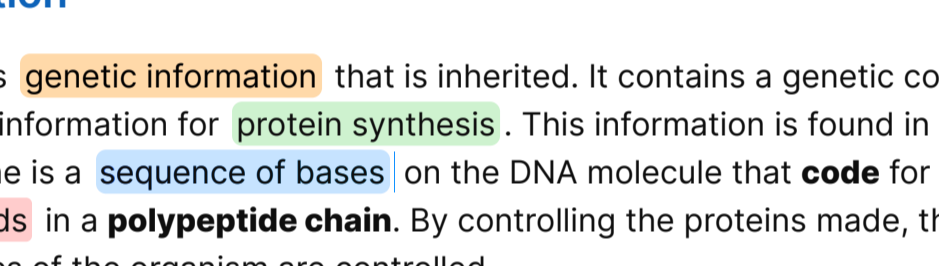


Organic Base

There are 5 types of organic bases that occur in DNA/RNA:

- **Pyrimidines** :
 - 0
 - Thymine
 - Only found in DNA
 - (Uracil)
 - Only found in RNA
 - Replaces thymine
- **Purines** :
 - Adenine
 - Guanine

The **pyrimidines** have a **simple (benzene) ring structure**. The **purines** have a **double ring structure**.



Structural differences between the bases

DNA - Deoxyribonucleic Acid

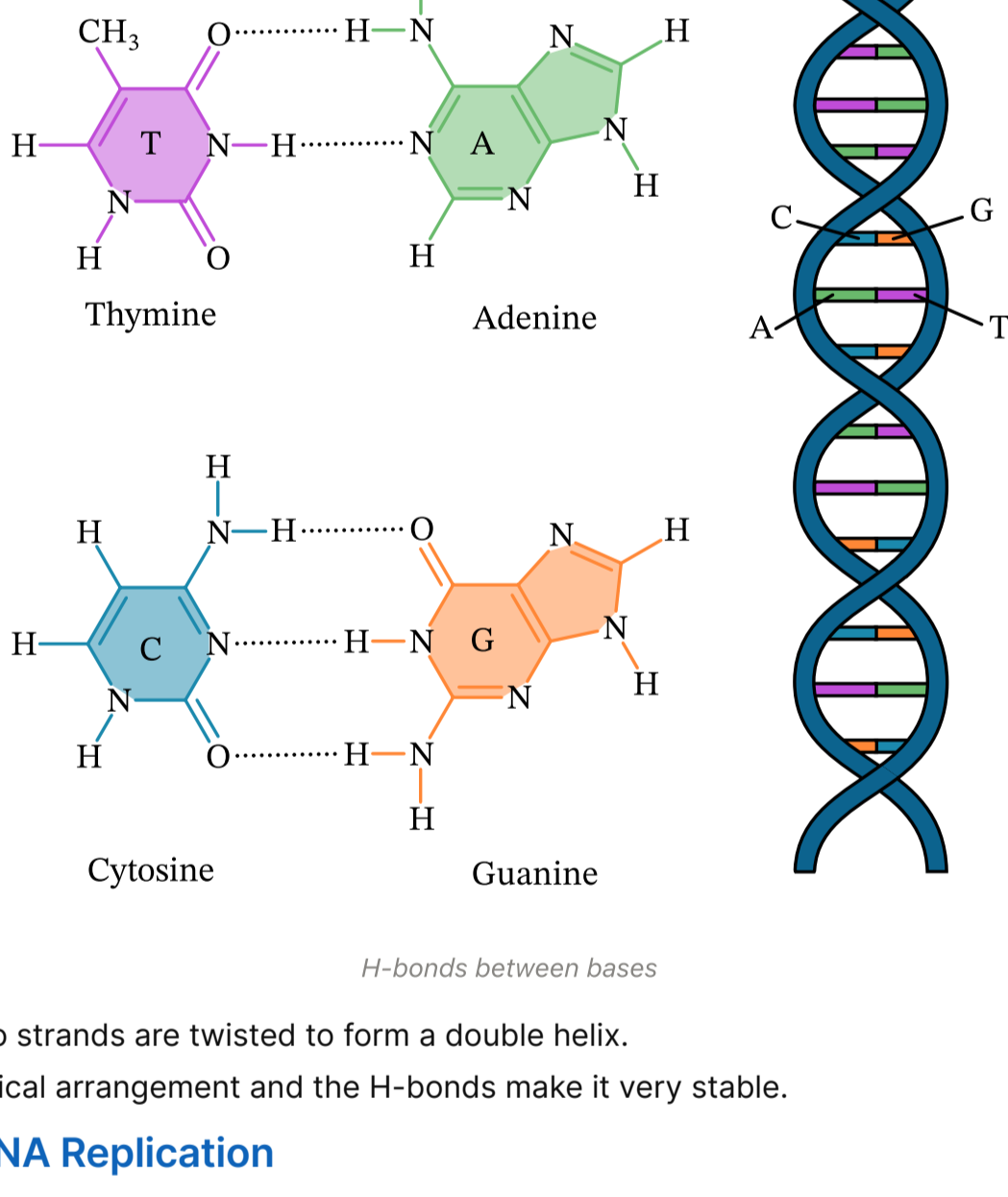
DNA function

DNA provides **genetic information** that is inherited. It contains a genetic code which provides the information for **protein synthesis**. This information is found in the form of **genes**. A gene is a **sequence of bases** on the DNA molecule that **code** for a **sequence of amino acids** in a **polypeptide chain**. By controlling the proteins made, the characteristics of the organism are controlled.

DNA structure

- DNA is a **polymer of deoxyribonucleotides**.
- In each chain a bond is formed between **C'3** of the **pentose** on **one nucleotide** and the **phosphate group** of the **next nucleotide**.
- DNA is **double stranded**, so it consists of **2 polynucleotide chains**.
- Each chain has a **5' end** and a **3' end**. This refers to the **carbon** on the **pentose** that is **closest** to the **end of the chain**.
- The chains are **anti-parallel**:
 - 5' 3'
 - ||
 - 3' 5'
- The **bases** always pair up as thymine (A and T, C and G), forming **weak H-bonds** (2 H-bonds between A and T, and 3 H-bonds between C and G).
- This is known as **complementary base pairing**.

DNA Structure



- The two strands are twisted to form a double helix.
- The helical arrangement and the H-bonds make it very stable.

3.1.5.2 DNA Replication

DNA replication is called **semi-conservative replication** because half of the molecule (one strand) is used to make one completely new strand. DNA replication **occurs in the nucleus** of **eukaryotic cells** and in the **cytoplasm** of **prokaryotic cells**.

Besides the old DNA molecule, other molecules are needed for its replication:

- **DNA helicase** - the enzyme that **unwinds the double helix**
- **DNA polymerase** - the enzyme that **joins the new nucleotides**
- A **supply of free nucleotides** with **each of the four bases**.

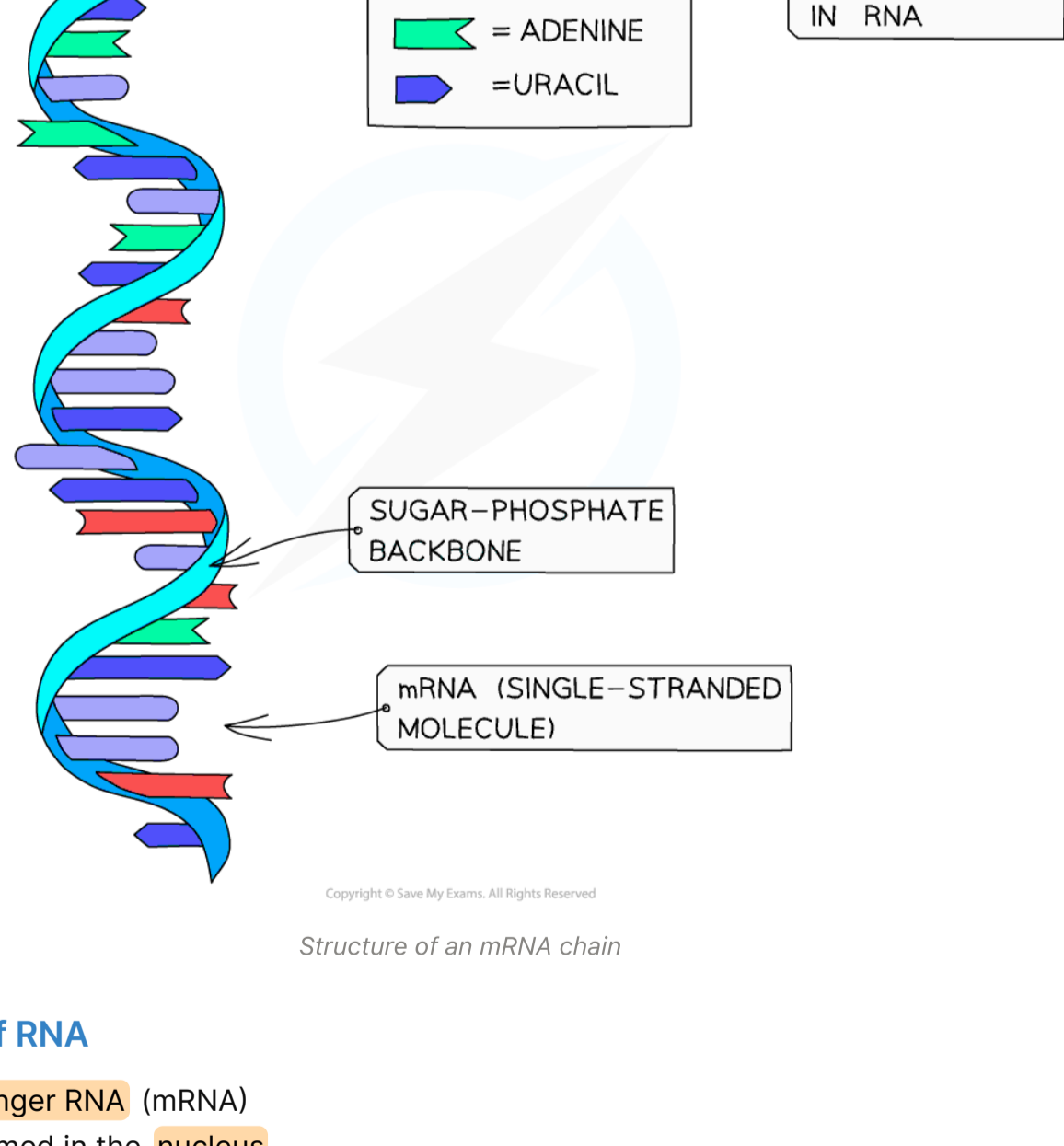
The stages in DNA replication that you need to learn are:

1. **DNA helicase** **unwinds the DNA double helix** starting **from one end**, breaking the **weak hydrogen bonds** between bases.
2. Each old strand acts as a **template** for the synthesis of a new strand.
3. **Free nucleotides** with complementary bases **form hydrogen bonds** with those **bases exposed** on the **template strands** (**adenine with thymine, and guanine with cytosine**).
4. **DNA polymerase** catalyses the **condensation reaction** between the **pentose** and the **phosphate** of each new nucleotide.
5. The process continues along the **entire DNA molecule** until **two new double strands** are completed.

RNA - Ribonucleic Acid

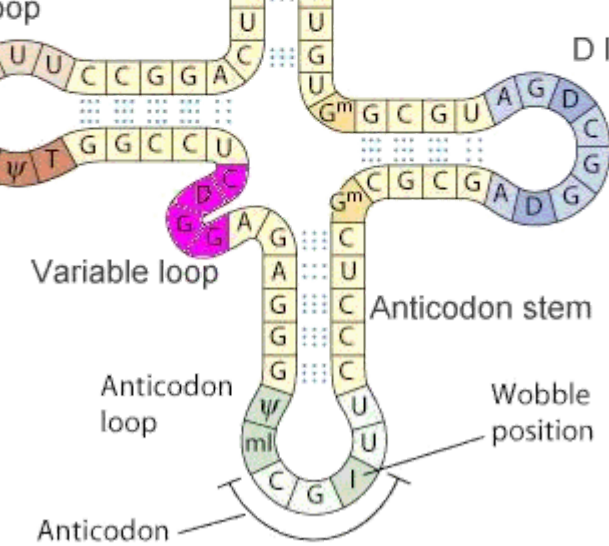
RNA structure

There are **4 different bases** that can occur in RNA - Adenine and Guanine (**purines**), and uracil and cytosine (**pyrimidines**). The **pentose sugar** in the nucleotide is a **ribose**. It's polymerised to form a **single polynucleotide chain** (**single stranded**).



3 types of RNA

1. **Messenger RNA** (mRNA)
 - Formed in the **nucleus**.
 - **Single chain** twisted into a **helix**.
 - **Length** and **base sequence varies**.
 - **Carries instructions from DNA** to ribosomes.
 - **Short life**, degradation after used by ribosome for translation.
2. **Ribosomal RNA** (rRNA)
 - Made in the **nucleolus**.
 - Forms over **half the mass of ribosomes** (on which proteins are made).
3. **Transfer RNA** (tRNA)
 - **Single chain** folded into a **clover shape**.
 - Many **different types** of tRNA.
 - Structure always similar but the **3 bases** on the anticodon **varies**.
 - **Picks up amino acids** and takes them **to the ribosome**.
 - Found in the **cytoplasm**.



Structure of a tRNA(Ala) molecule