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Nucleic Acids: DNA and RNA; carriers of genetic information

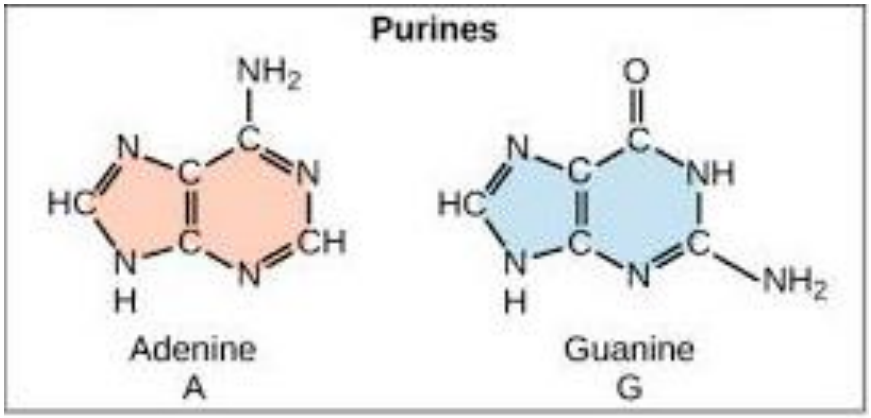
Nucleic Acid Definition

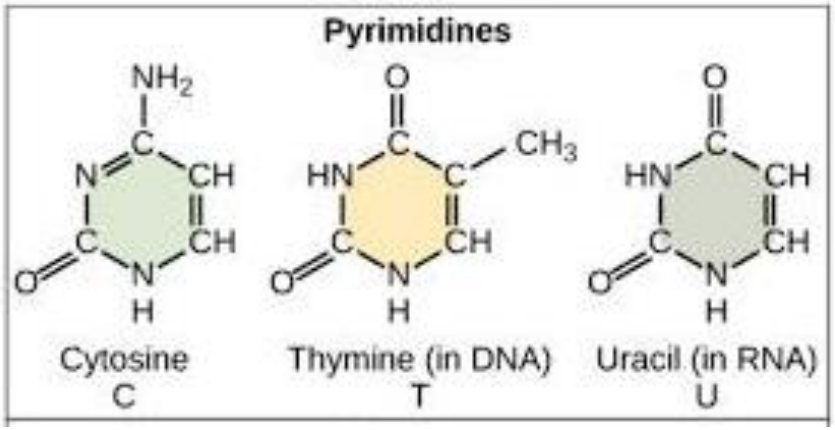
are macromolecule composed of nucleotides, which aid in the **storage of genetic material** and **protein production in the cell**. Two different nucleic acid sequences are usually present in cells such as deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) based on the sugar component present in the molecule.

Properties of nucleic acids are as follows:

- Nucleic acids (DNA and RNA) are long polymers made of repeating units of nucleotides.
- Adenine and guanine are purine bases while cytosine and thymine are pyrimidines .

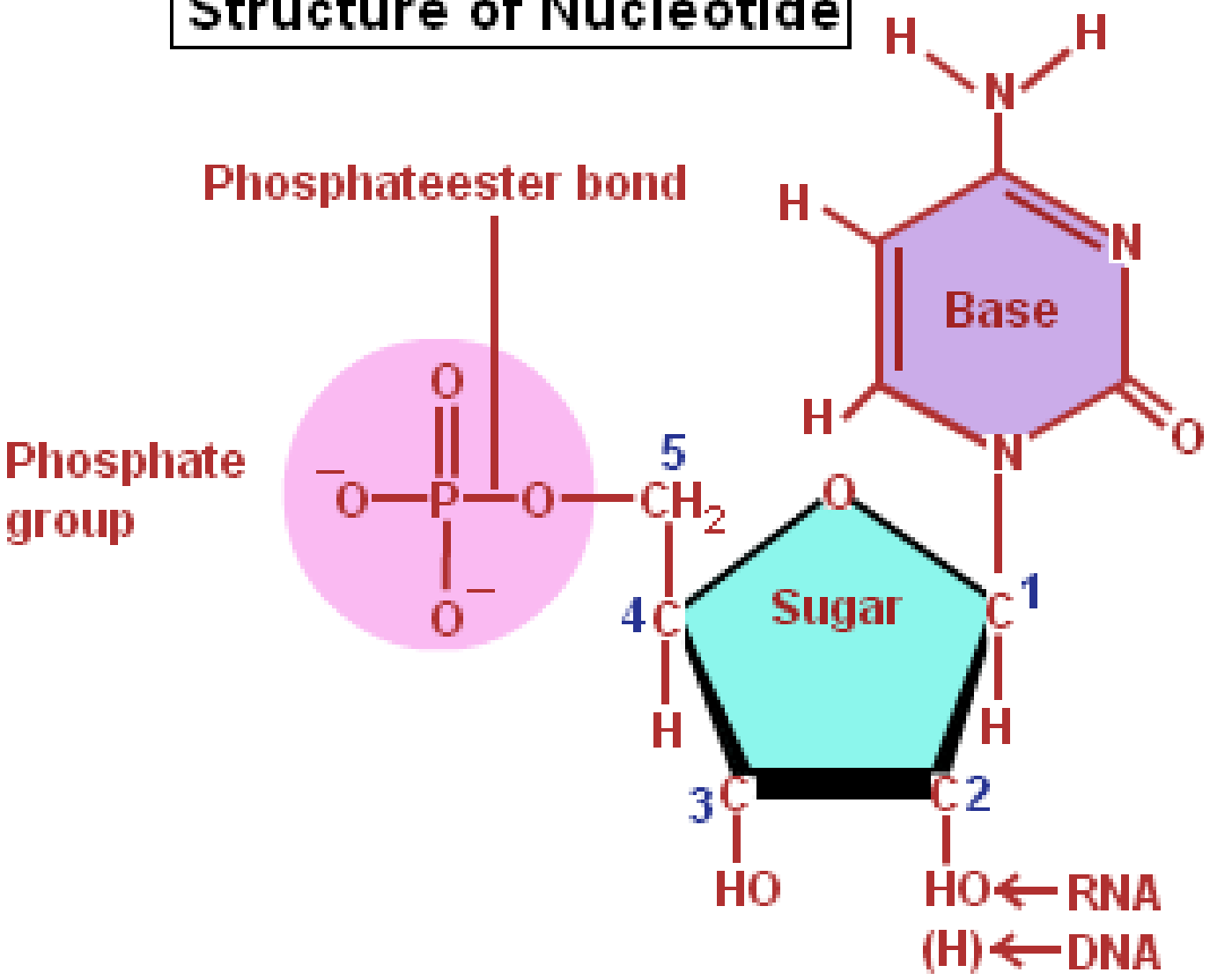
They are linked by a phosphate group on the 5th position of sugar residue becomes linked to 3' hydroxyl group of the proceeding sugar molecule.





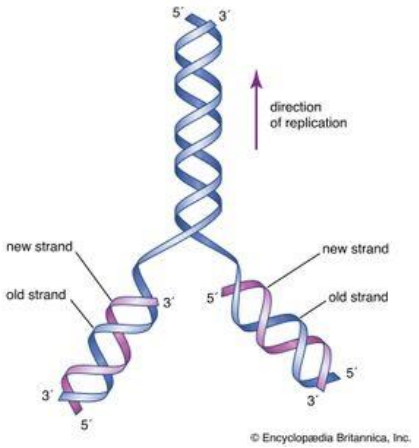
Nucleotides

Structure of Nucleotide



Deoxyribonucleic Acid (DNA)

Chemically, DNA is composed of a **pentose sugar**, **phosphoric acid** and some **cyclic bases** containing nitrogen. The sugar moiety present in DNA molecules is β-D-2-deoxyribose. The cyclic bases that have nitrogen in them are adenine (A), guanine (G), cytosine(C) and thymine (T). These bases and their arrangement in the molecules of DNA play an important role in the storage of information from one generation to the next one. DNA has a double-strand helical structure in which the strands are complementary to each other



The double stranded model of the DNA was structured as:-

- The **double helix model** consists of two strands wound around a central axis with the bases stacked inside.
- The order of the strand is in **opposite directions** ,i.e., from 5'to3‘ direction in one and 3'to5'direction in the other.
- The bases stacked in the center of the helix as they inter act with each other through **weak hydrogen bonds**

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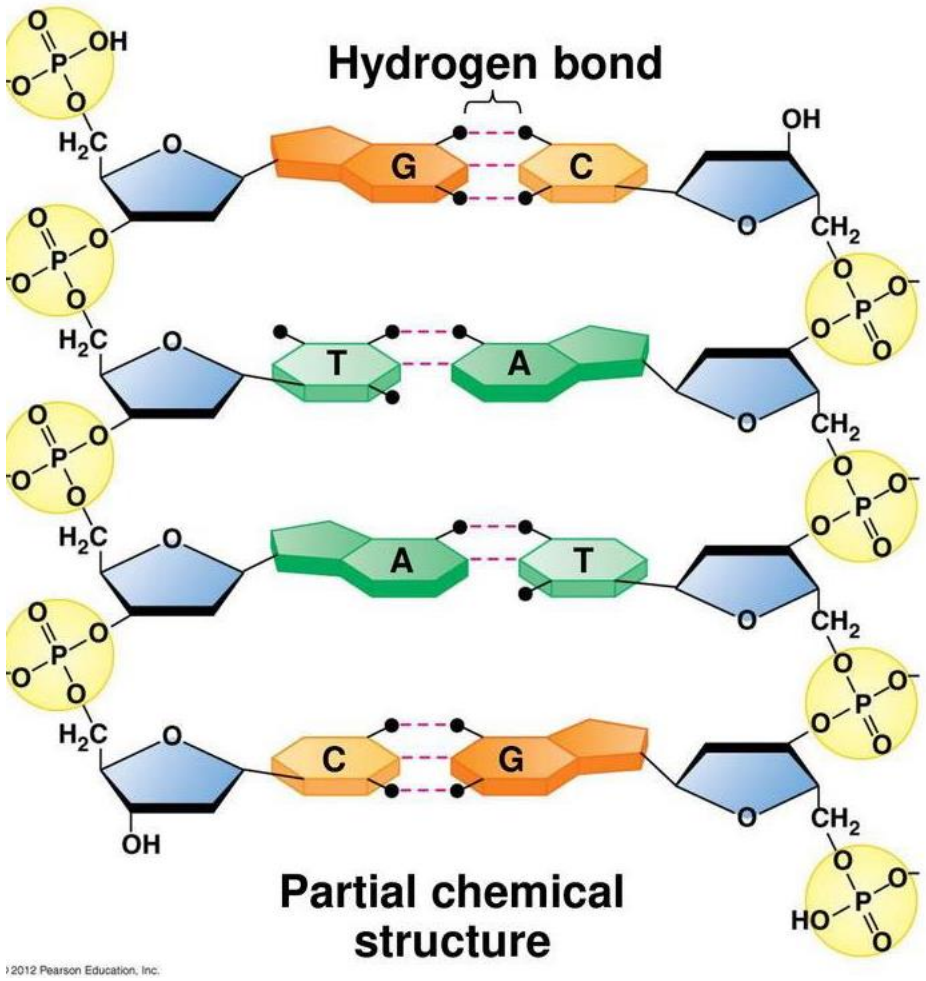
Hydrogen bond
G
C
T
A
A
T
C
G
OH
OH
HO
CH_2
H_2C
O
P
Partial chemical structure
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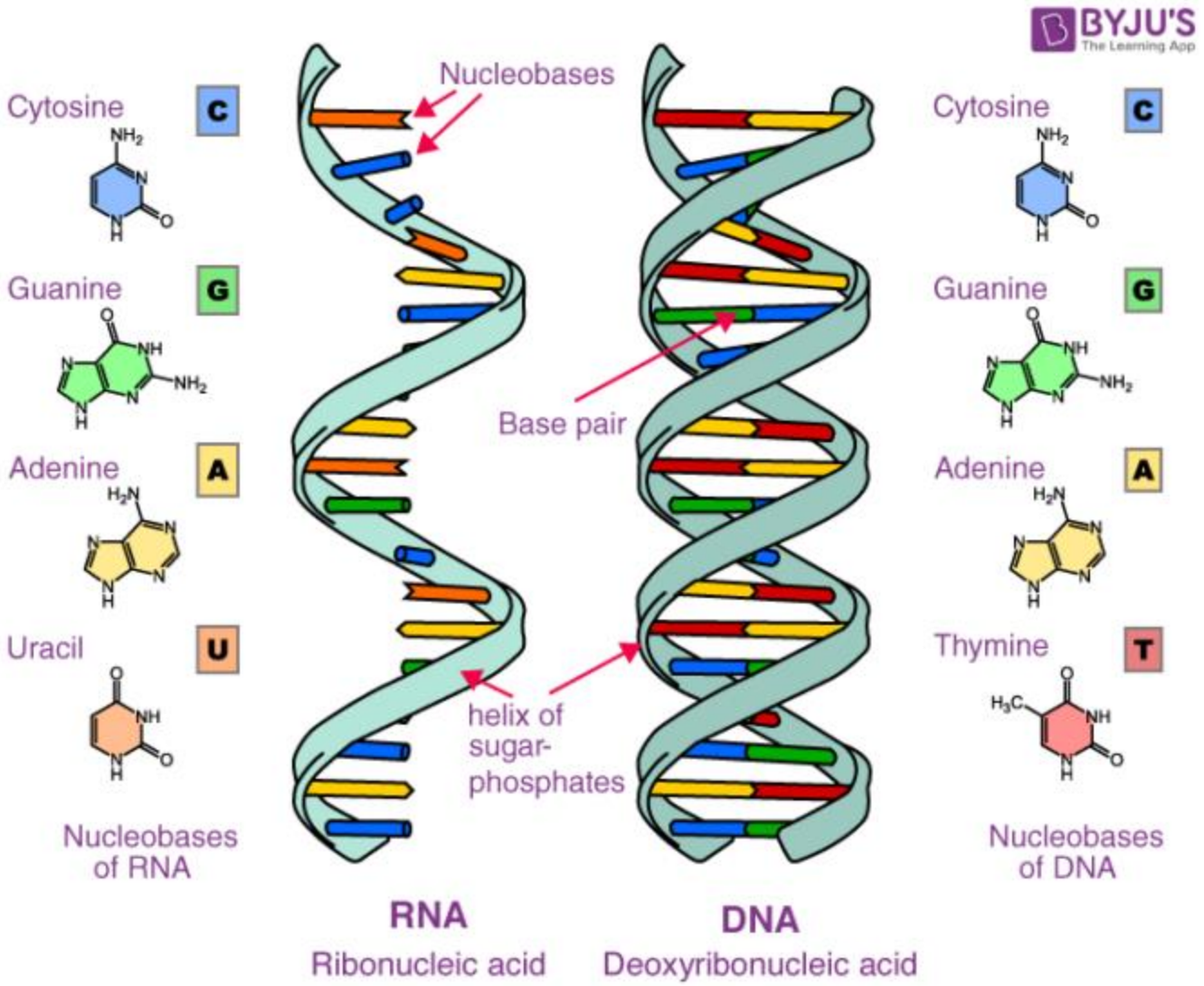

BYJU'S
The Learning App
Cytosine
C
Guanine
G
Adenine
A
Uracil
U
Nucleobases of RNA
Nucleobases
Base pair
helix of sugar-phosphates
RNA
Ribonucleic acid
DNA
Deoxyribonucleic acid
Cytosine
C
Guanine
G
Adenine
A
Thymine
T
Nucleobases of DNA

Ribonucleic Acid (RNA)

The RNA molecule is also composed of phosphoric acid, a pentose sugar and some cyclic bases containing nitrogen. RNA has β-D-ribose in it as the sugar moiety. The heterocyclic bases present in RNA are adenine (A), guanine (G), cytosine(C) and uracil (U). In RNA the fourth base is different from that of DNA. The RNA generally consists of a **single strand** which sometimes folds back; that results in a double helix structure. There are three types of RNA molecules, each having a specific function:

- **messenger RNA (m-RNA)**
- **ribosomal RNA (r-RNA)**
- **transfer RNA (t-RNA)**

There are several different types of RNA, each having different functions in the cell. The structure of **RNA is similar to DNA** with a few small exceptions. For one thing, unlike DNA, most types of RNA, including

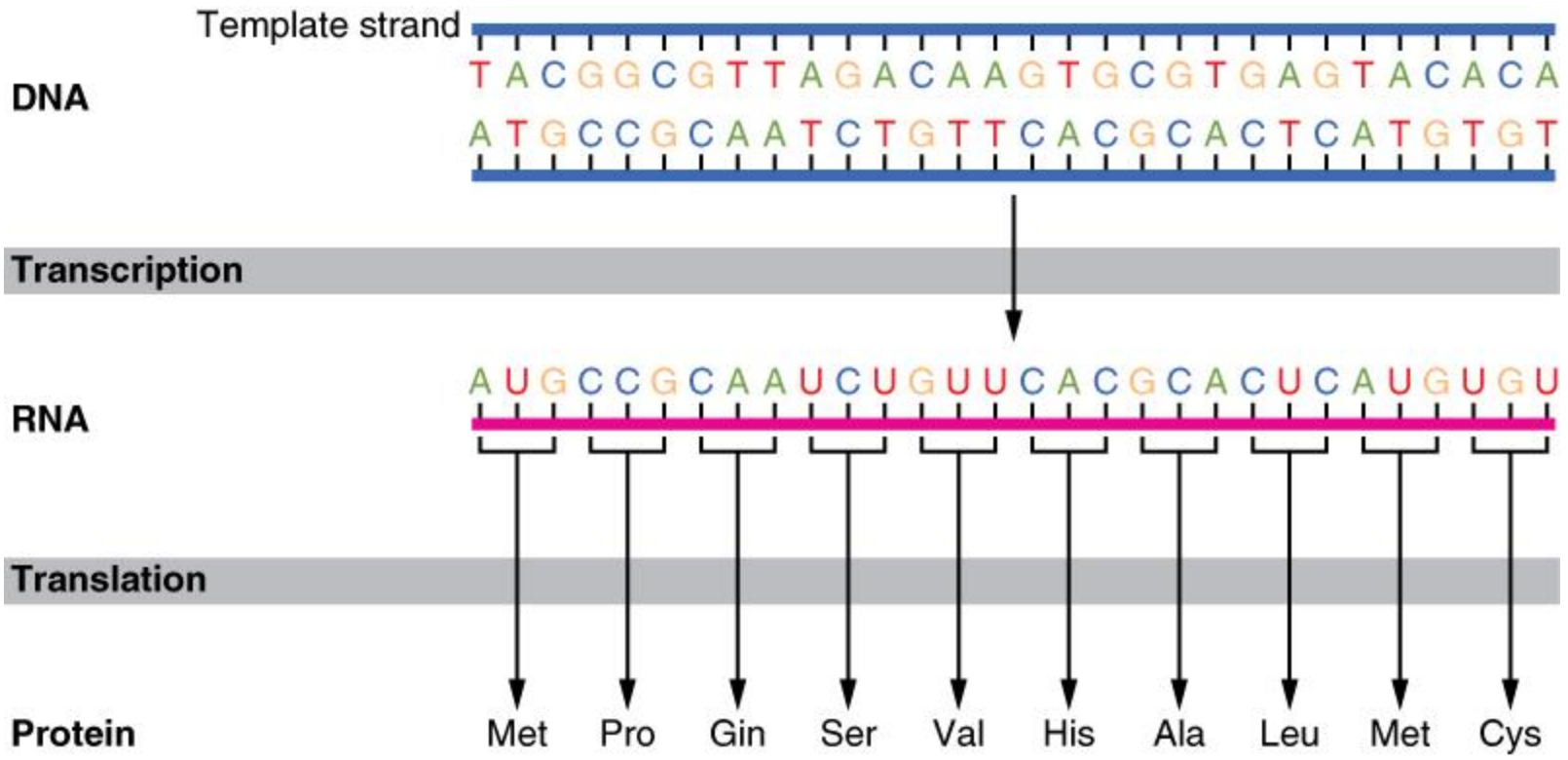
- **mRNA**, are single-stranded and contain no complementary strand.
- Second, the ribose sugar in RNA **(r-RNA)**contains an additional oxygen atom compared with DNA.
- The other major requirement for protein synthesis is the translator molecules that physically "read" the mRNA codons. **Transfer RNA (tRNA)** is a type of RNA that carries the appropriate corresponding amino acids to the ribosome, and attaches each new amino acid to the last, building the polypeptide chain one-by-one. This sequence of three bases on the tRNA molecule is called an **anticodon**

The Functions of Nucleic Acids

Nucleic acids are responsible

- for the **transmission of inherent** characters from parent to offspring.
- They are responsible for the **synthesis of protein** in our body
- DNA fingerprinting is a method used by **forensic experts** to determine paternity. It is also used for the identification of criminals.
- It has also played a major role in studies regarding biological evolution and genetic

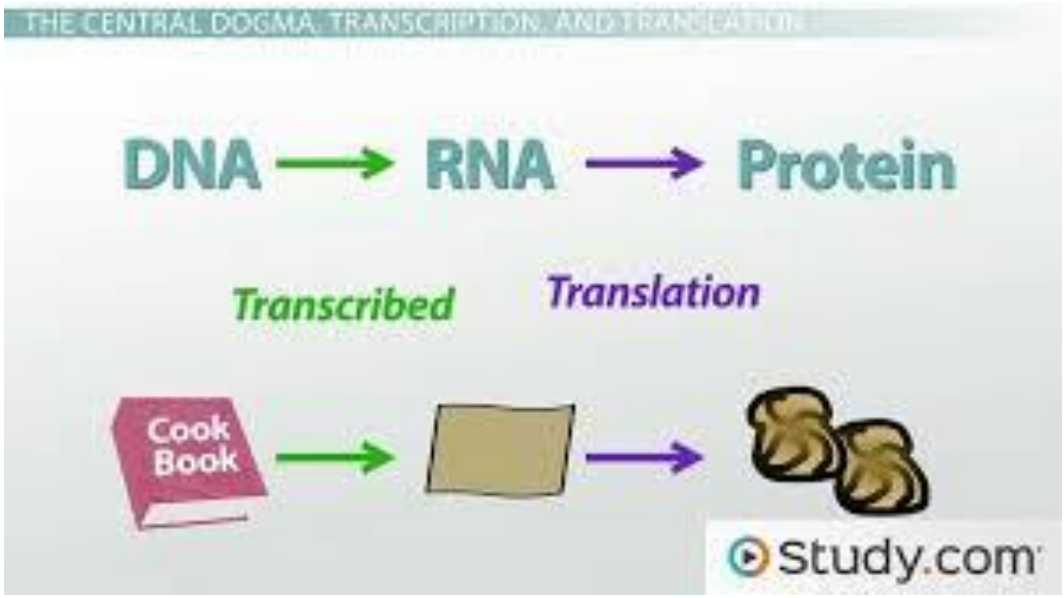
Protein Synthesis



Proteins are composed of **amino acids**–there are **20** different amino acids

- Different **proteins** are made by **combining** these 20 amino acids in different combinations

Proteins are manufactured (made) by the **ribosomes**



Making a Protein

Step 1: Transcription

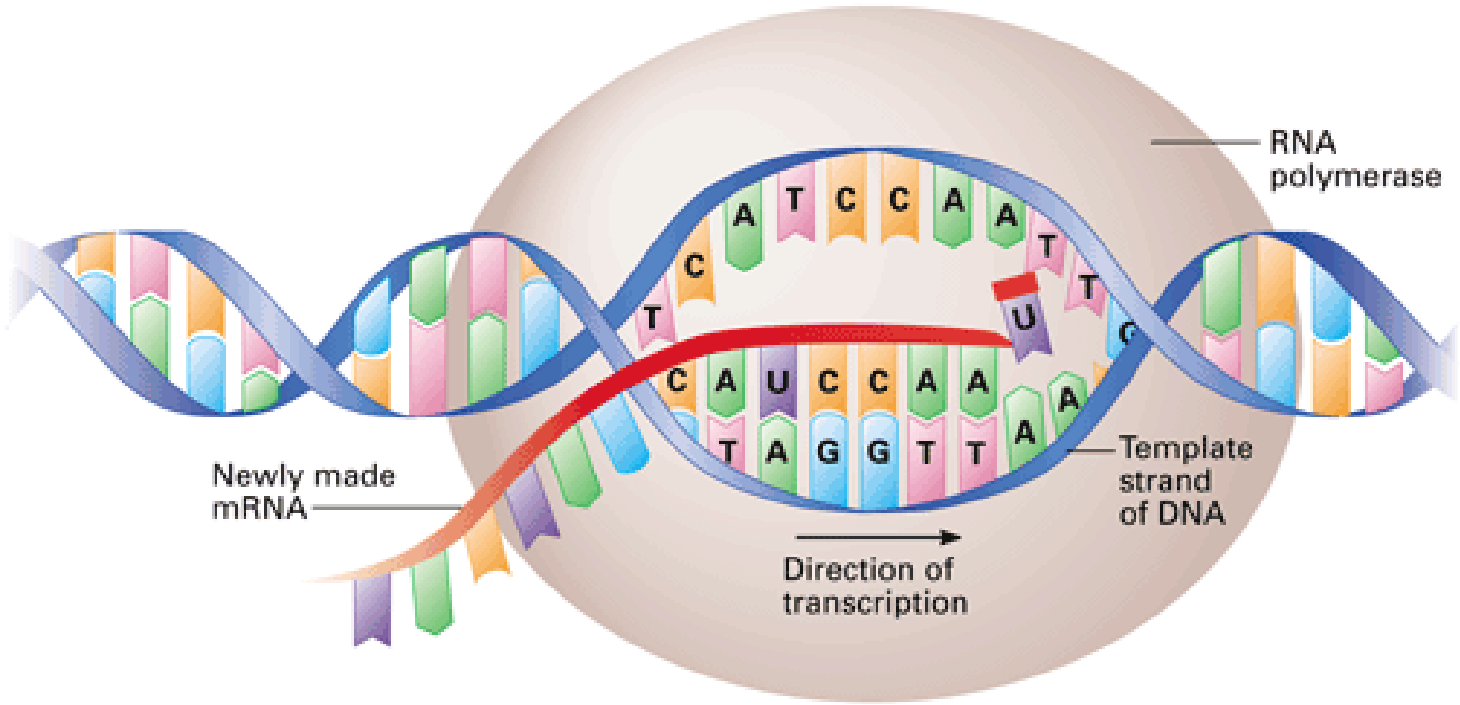
- **First Step : Copying** of genetic information from **DNA** to **RNA** called **Transcription**

Why ? DNA has the **genetic code** for the **protein** that needs to be made, but proteins are made by the ribosomes, ribosomes are outside the **nucleus** in the **cytoplasm**.

DNA is too **large** to leave the nucleus (**double** stranded), but RNA **can leave** the nucleus (**single** stranded)

DNA is housed within the **nucleus**, and protein synthesis takes place in the **cytoplasm**, thus there must be some sort of intermediate messenger that leaves the nucleus and manages protein synthesis. This intermediate messenger is **messenger RNA (mRNA)**, a single-stranded nucleic acid that carries a copy of the genetic code for a single gene out of the nucleus and into the cytoplasm where it is used to produce proteins.

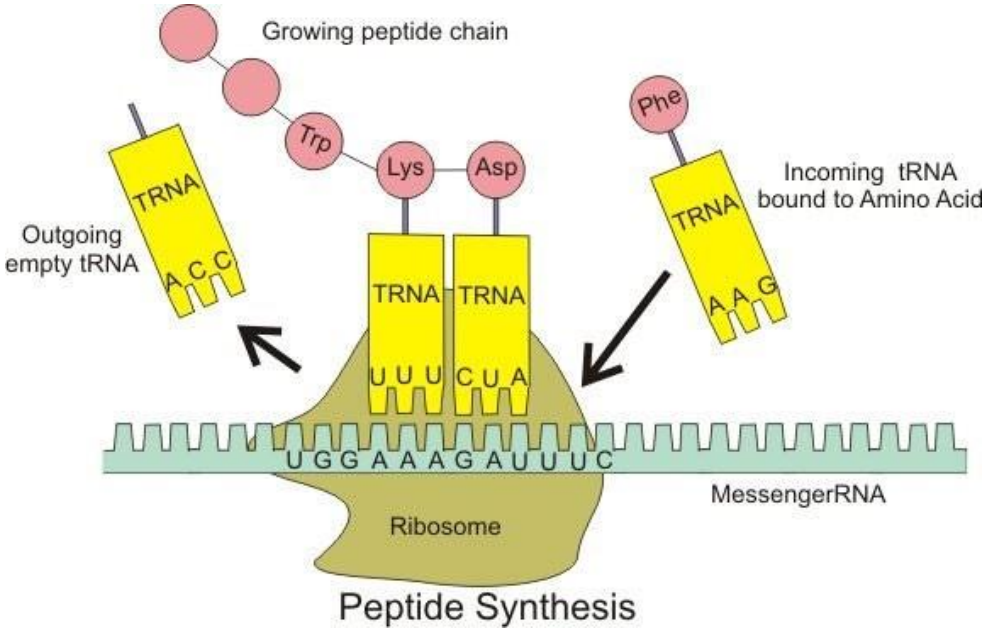
Part of DNA temporarily **unzips** and is used as a **template** to assemble **complementary** nucleotides into **messenger RNA**(mRNA). mRNA then goes through the **pores** of the nucleus with the DNA **code** and attaches to the **ribosome**



Making a Protein Translation

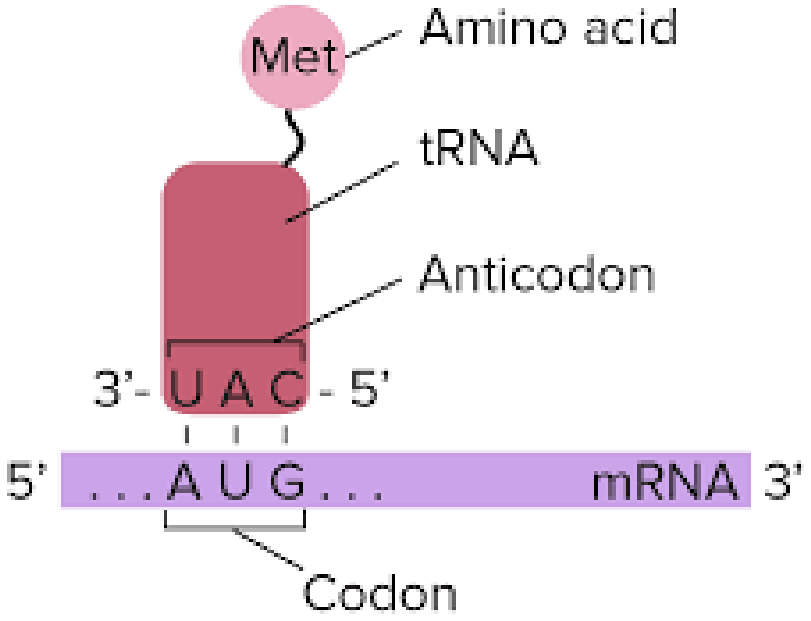
- **Second Step :Decoding** of mRNA into a **protein** is called **Translation**.
- **Transfer RNA** (tRNA) carries **amino acids** from the cytoplasm to the **ribosome**

These amino acids come from the **food we eat**. Proteins we eat are broken down into individual **amino acids** and then simply **rearranged** into new **proteins** according to the needs and directions of our **DNA**.



A series of **three** adjacent **bases** in an mRNA molecule codes for a specific amino acid called a **codon**.

- Each **Translation** has 3 nucleotides that are **complementary** to the **codon** in mRNA.
- Each **tRNA** codes for a **different** amino acid.
- mRNA carrying the **DNA instructions** and tRNA carrying **amino acids** meet in the **ribosomes**




Thank you