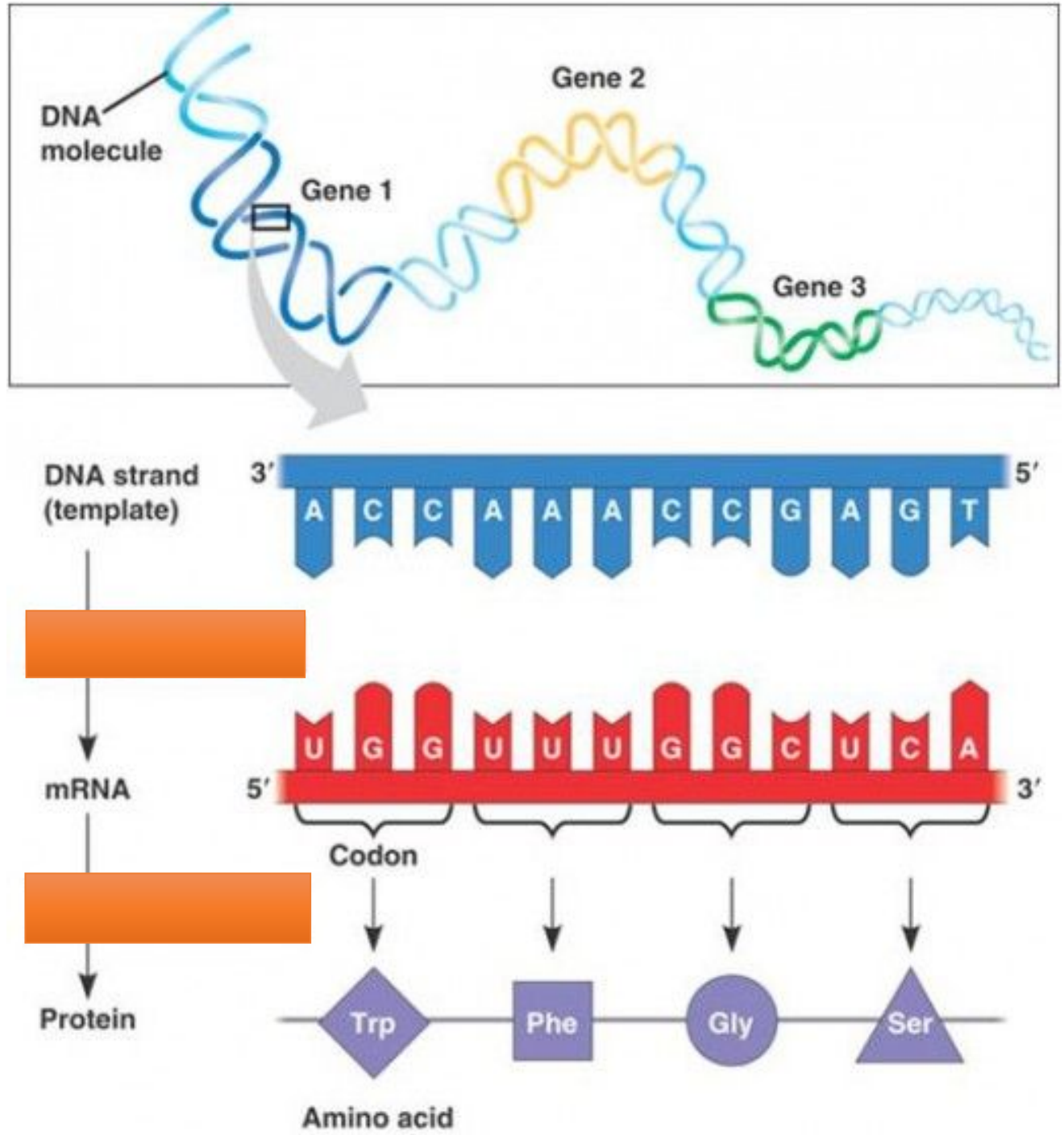

DNA molecule
Gene 1
Gene 2
Gene 3
DNA strand (template)
3′
5′
A C C A A A C C G A G T
mRNA
5′
3′
U G G U U U G G C U C A
Codon
Protein
Trp
Phe
Gly
Ser
Amino acid

The translation and transcription

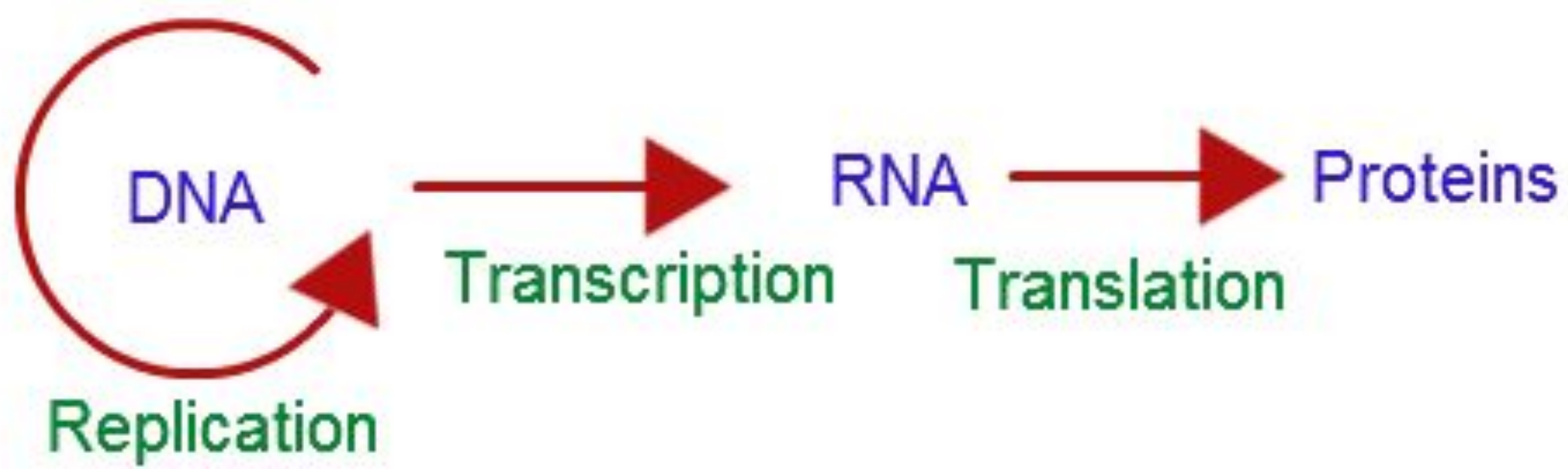
Learning objectives

- Specifies the translation and transcription

Success criteria

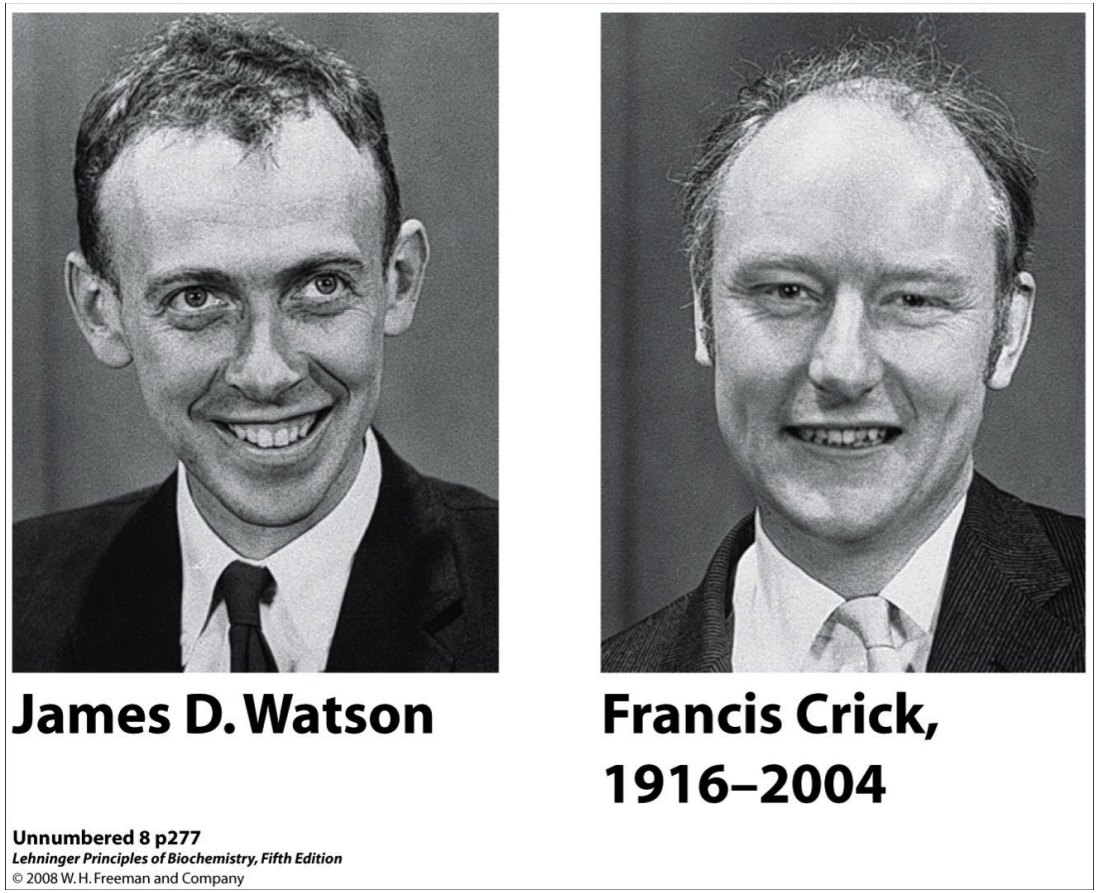
- Knows the definition of transcription and translation terms
- Defines the terms of transcription and translation
- Describes the processes of transcription and translation
- Using the table of the genetic code table can identify amino acids

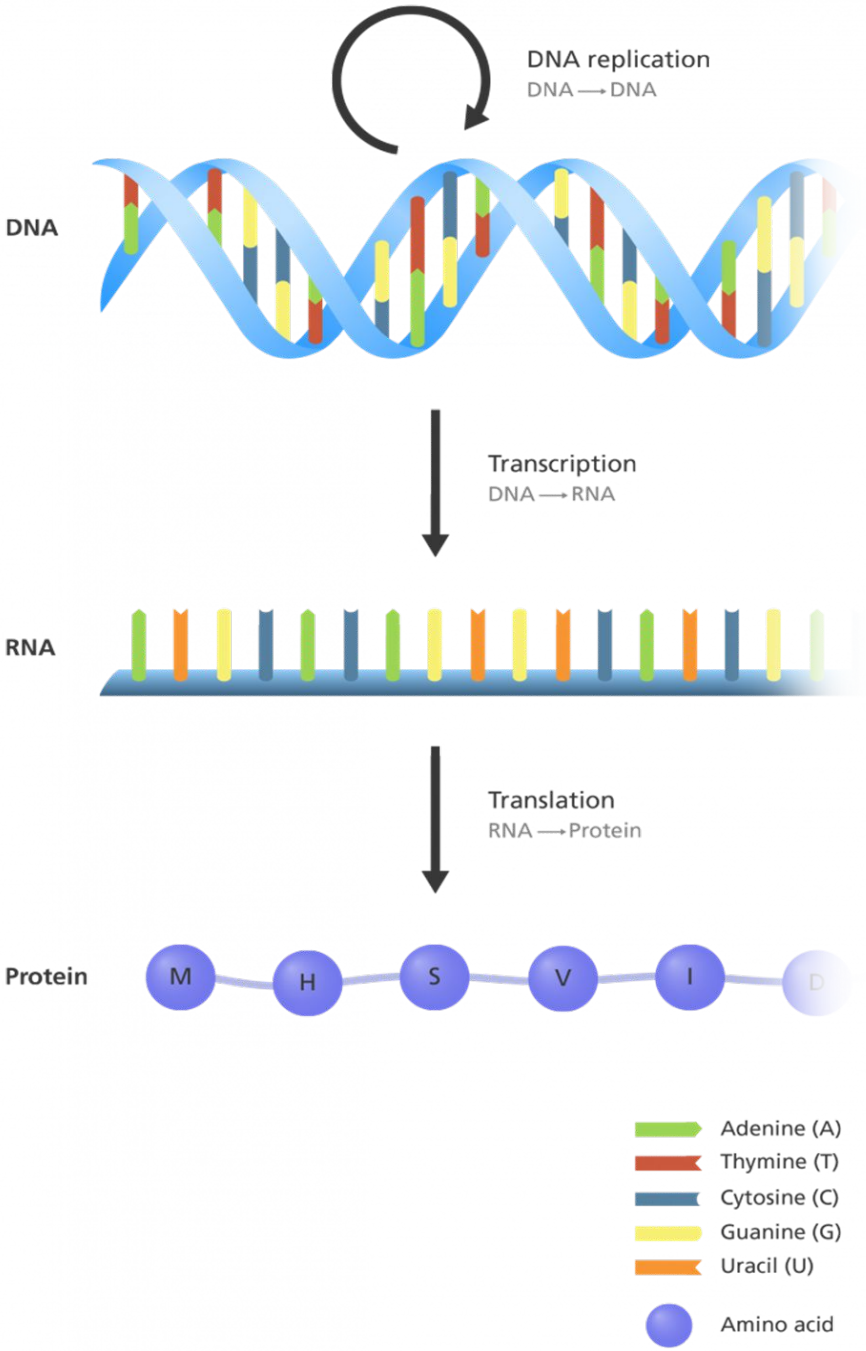
Central dogma of modern biology



Central dogma of modern biology

The Central Dogma. This states that once ‘information’ has passed into protein it cannot get out again. In more detail, the transfer of information from nucleic acid to nucleic acid, or from nucleic acid to protein may be possible, but transfer from protein to protein, or from protein to nucleic acid is impossible. Information means here the precise determination of sequence, either of bases in the nucleic acid or of amino acid residues in the protein.





The central dogma of molecular biology explains the flow of genetic information, from **DNA to RNA**, to make a functional product, a **protein**.

The central dogma suggests that **DNA contains the information needed to make all of our proteins**, and that **RNA is a messenger that carries this information** to the ribosomes.

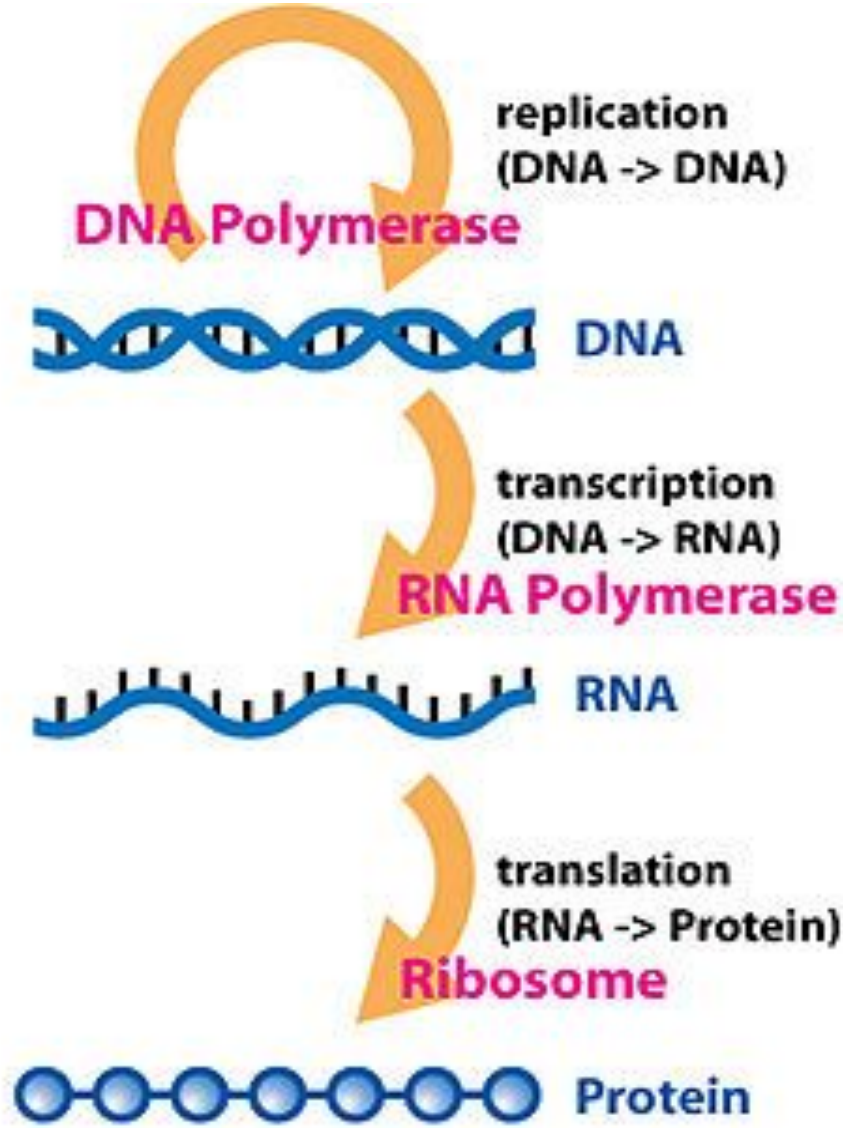
The ribosomes serve as factories in the cell where the information is **'translated'** from a code into the **functional product**.

The central dogma states that the pattern of information that occurs most frequently in our cells is:

- From existing DNA to make new DNA (DNA replication)
- From DNA to make new RNA (**transcription**)
- From RNA to make new proteins (**translation**).

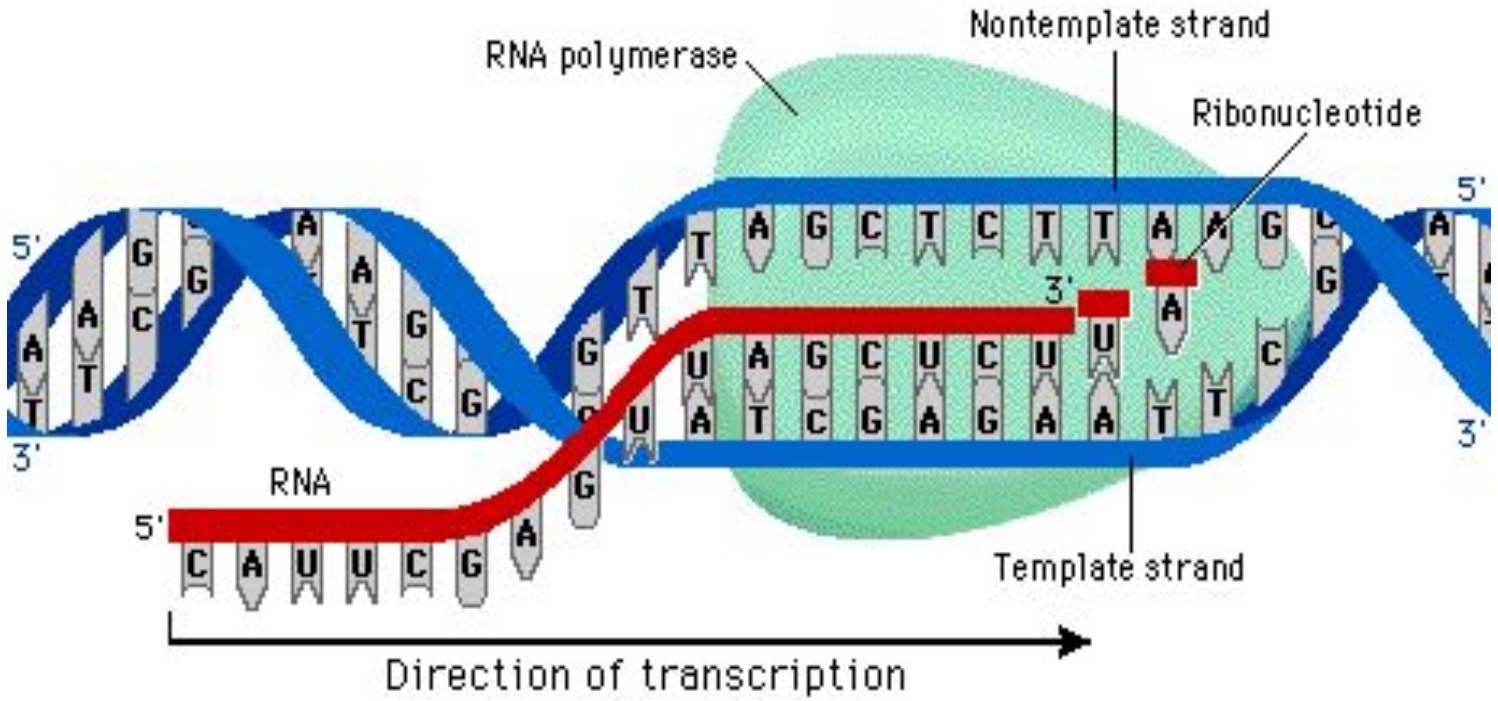
Protein synthesis

- The first stage is called **transcription**.
- The next stage of protein synthesis is called **translation.**



Transcription

Transcription is the process by which the information in a strand of **DNA** is **copied** into a new molecule of **messenger RNA** (mRNA).



Transcription

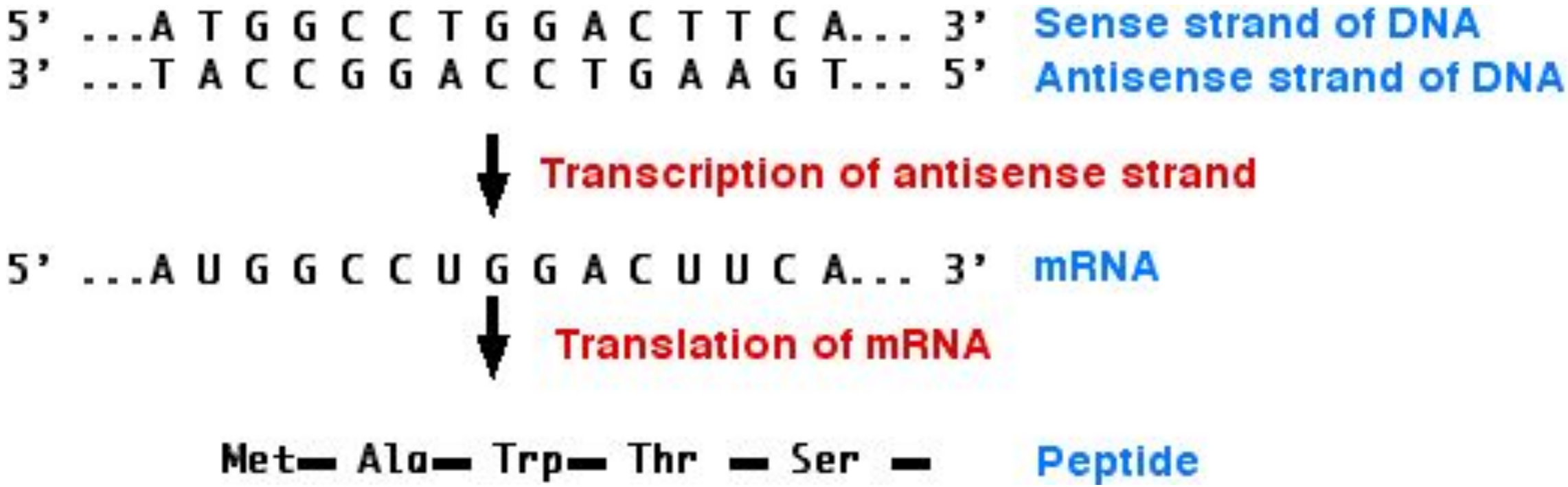
In the nucleus, a complementary **copy of the code** from a gene is made by building a molecule of a different type of nucleic acid, called **messenger RNA (mRNA),** using one strand (the **sense strand**) as a template. Three **RNA nucleotides are joined together** by the enzyme **RNA polymerase**. This process copies the DNA code onto an mRNA molecule.

The last triplet transcribed onto mRNA is one of the DNA triplets coding for ‘stop’ - **ATT, ATC** or **ACT**

Transcription

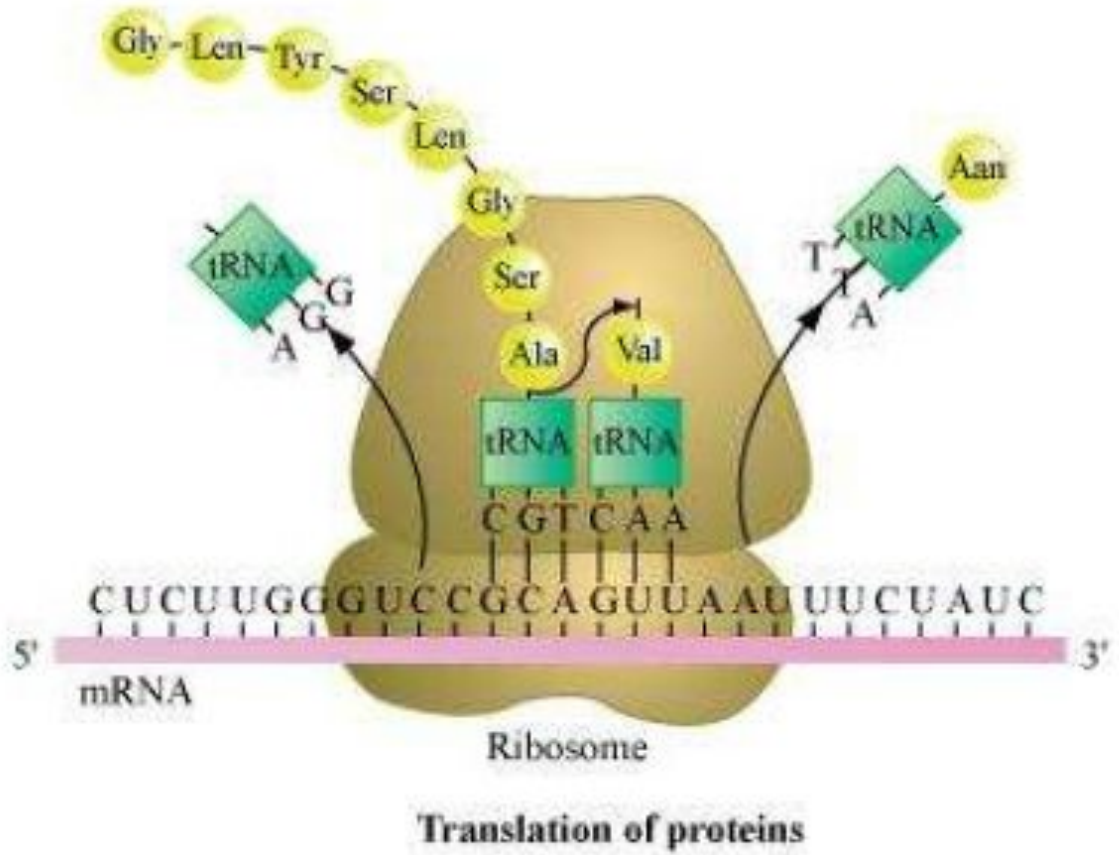
DNA safely and **stably stores genetic material** in the nuclei of cells as a reference, or template. Meanwhile, **mRNA** is comparable to a **copy** from a reference book because it carries the **same information** as DNA but is not used for long-term storage and can freely exit the nucleus. Although the **mRNA** contains the **same information**, it is not an identical copy of the DNA segment, because its sequence is complementary to the DNA template.

Transcription is carried out by an **enzyme called RNA polymerase** and a number of accessory proteins called transcription factors.


5' ...A T G G C C T G G A C T T C A... 3'
Sense strand of DNA
3' ...T A C C G G A C C T G A A G T... 5'
Antisense strand of DNA
Transcription of antisense strand
5' ...A U G G C C U G G A C U U C A... 3'
mRNA
Translation of mRNA
Met Ala Trp Thr Ser
Peptide

Translation

Translation is the process by which a **protein is synthesized** from the information contained in a molecule of messenger RNA (mRNA).



Translation of proteins

Translation

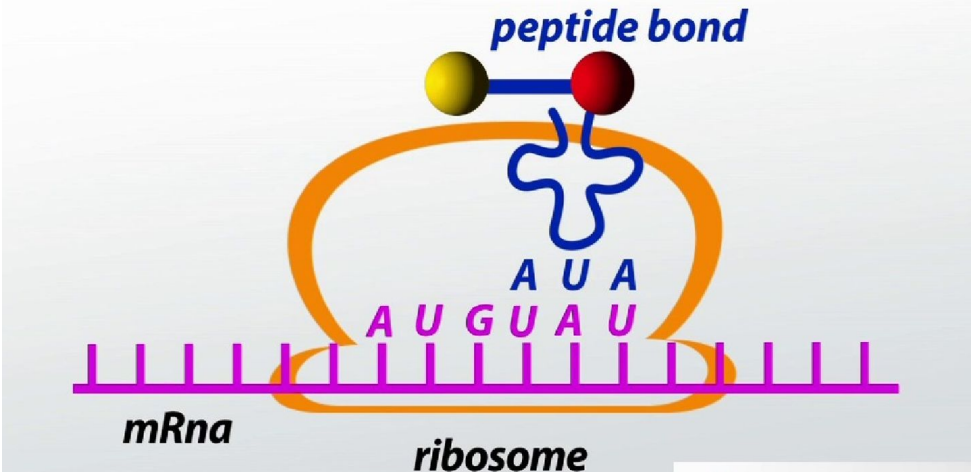
Protein synthesis is called **translation** because this is when the **DNA code is translated into an amino acid sequence.** The mRNA **leaves** the nucleus and **attaches** to a **ribosome** in the cytoplasm.

The triplet of bases (an **anticodon**) of each **tRNA** links up with a **complementary** triplet (a codon) on the **mRNA** molecule.

The **amino acids are linked together** as the **polypeptide molecule** is made.

Translation

During translation, an **mRNA sequence** is **read** using the **genetic code**, which is a set of rules that defines how an mRNA sequence is to be translated into the **20-letter code of amino acids**, which are the **building blocks of proteins**.



Translation

The **genetic code** is a set of **three-letter combinations of nucleotides** called **codons**, each of which corresponds with a specific amino acid or stop signal.

Translation occurs in a structure called the **ribosome**, which is a factory for the **synthesis of proteins**.

Translation of an mRNA molecule by the ribosome occurs in three stages:

- **initiation,**
- **elongation,**
- **termination.**

Transcription vs. Translation Review

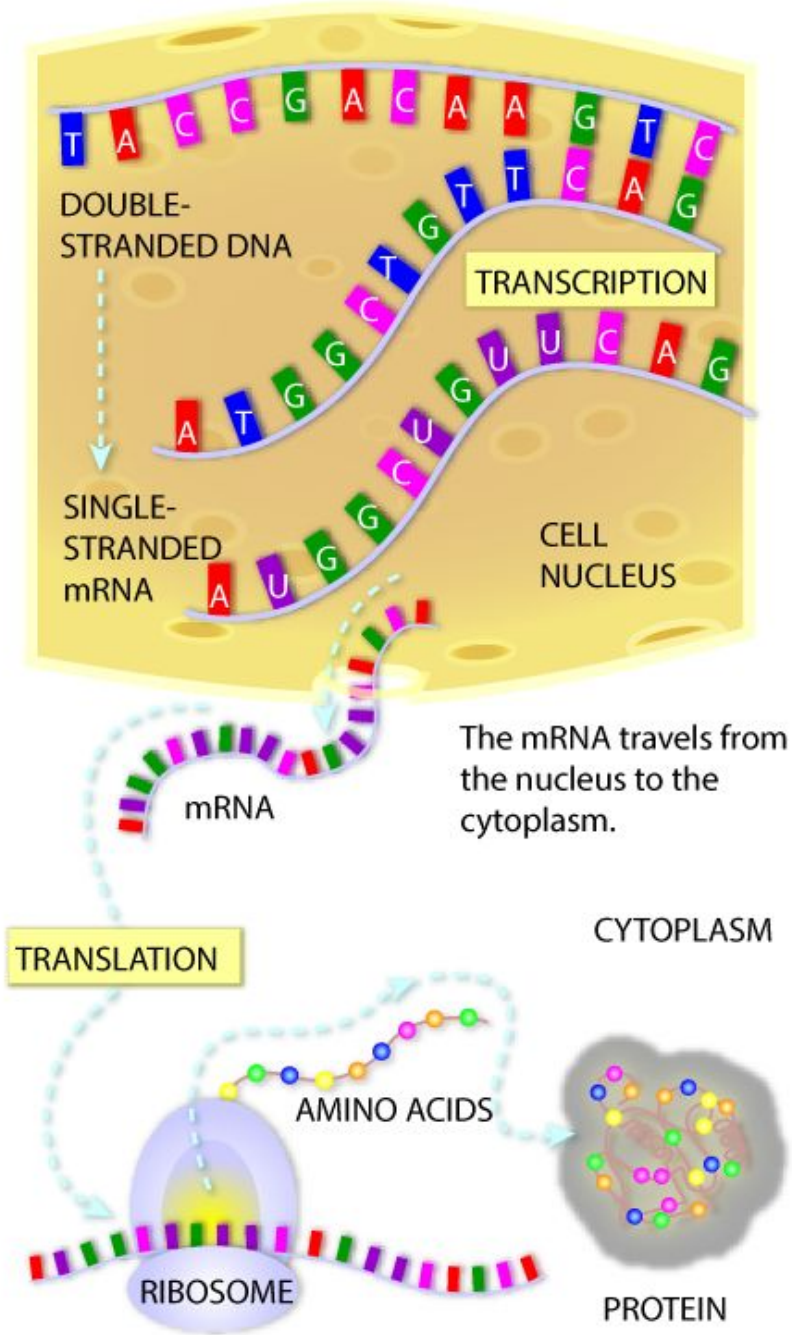
Transcription

- Process by which genetic information encoded in DNA is copied onto messenger RNA
- Occurs in the nucleus
- DNA → mRNA

Translation

- Process by which information encoded in mRNA is used to assemble a protein at a ribosome
- Occurs on a Ribosome
- mRNA → protein

TRANSCRIPTION: In the nucleus, the cell's machinery copies the gene sequence into messenger RNA (mRNA), a molecule that is similar to DNA. Like DNA, mRNA has four nucleotide bases - but in mRNA, the base uracil (U) replaces thymine (T).

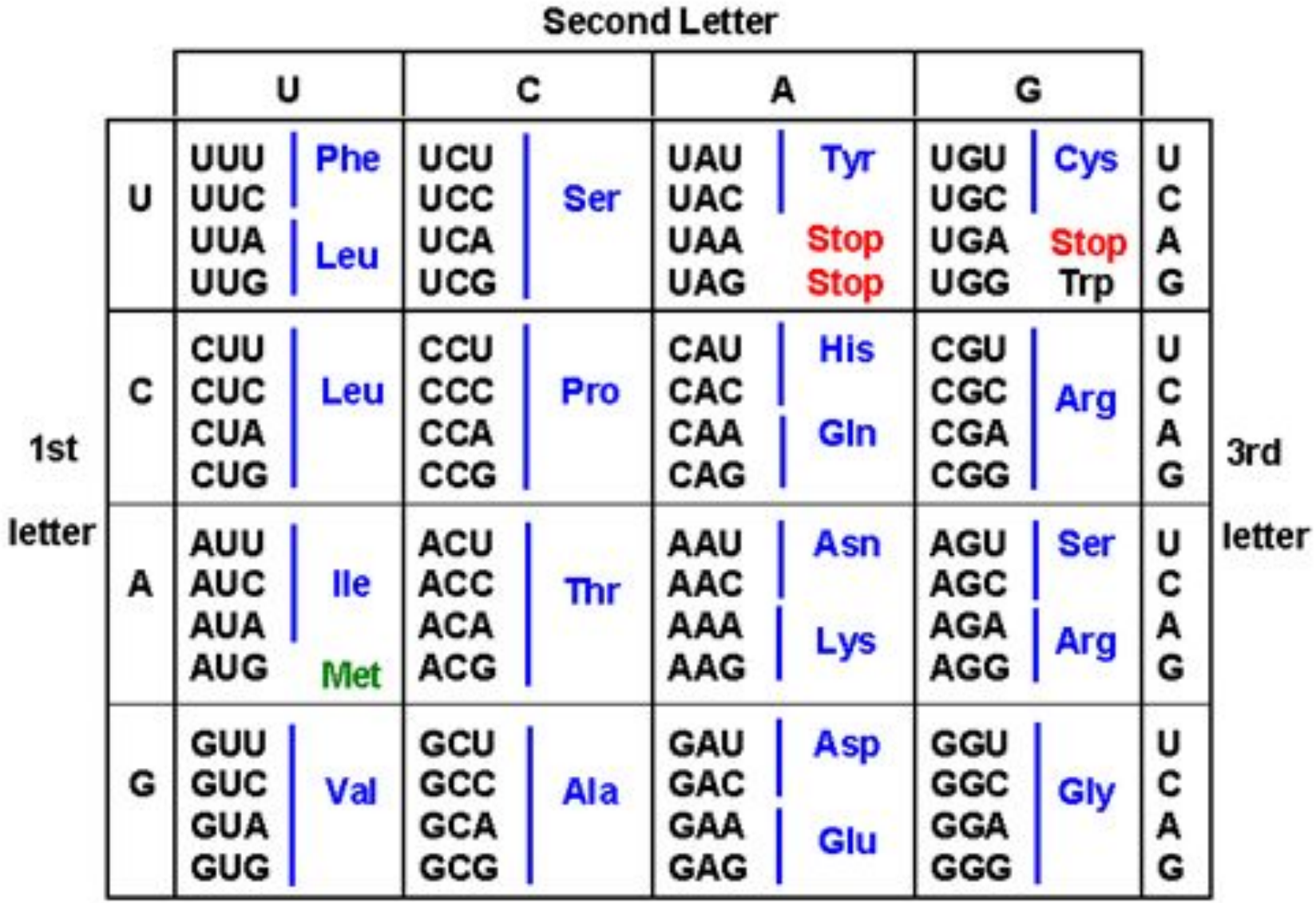


TRANSLATION: The protein-making machinery, called the ribosome, reads the mRNA sequence and translates it into the amino acid sequence of the protein. The ribosome starts at the sequence AUG, then reads three nucleotides at a time. Each three-nucleotide codon specifies a particular amino acid. The "stop" codons (UAA, UAG and UGA) tell the ribosome that the protein is complete.

The triplet code

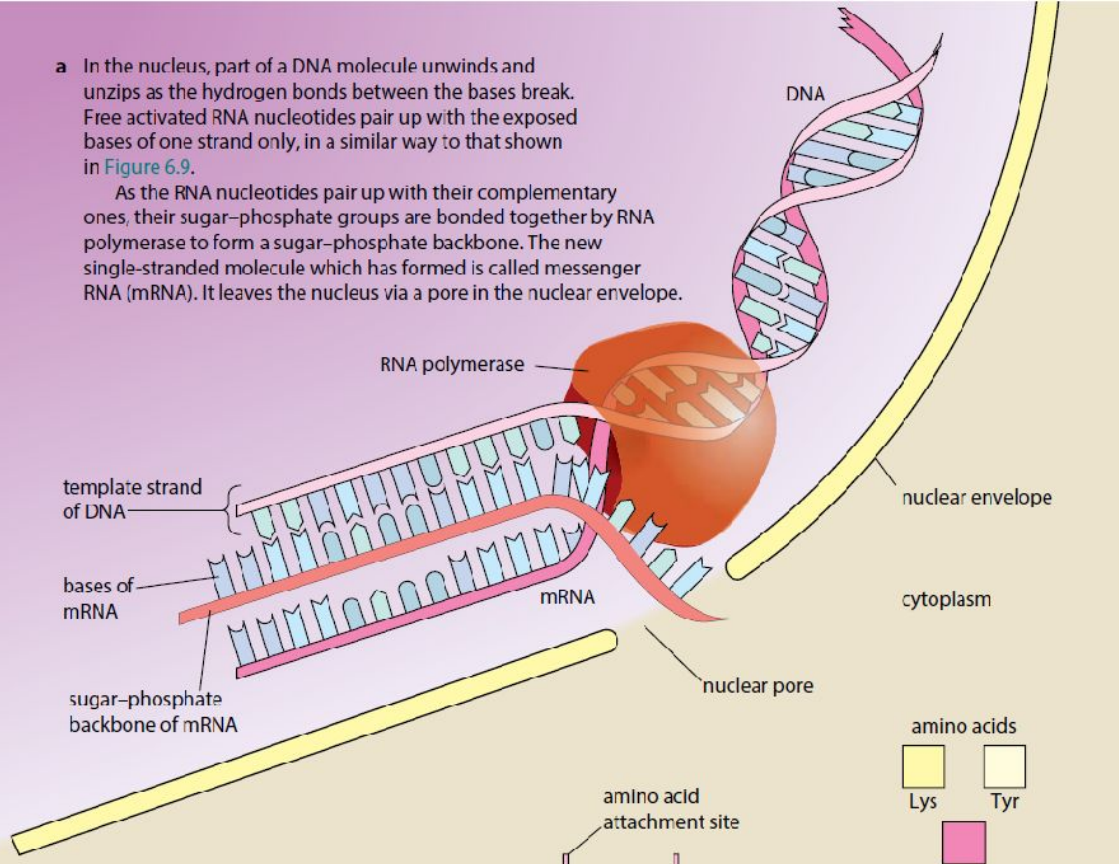
The code is a three-letter, or **triplet**, **code**. Each sequence of t**hree bases stands** for **one amino acid**. The sequence is always read in the same direction and from only one of the two strands of the DNA molecule (the so-called **sense strand**). In this case, assume that this is the lower strand in the diagram. The complementary strand is referred to as the **anti-sense strand**.

Genetic Code Table



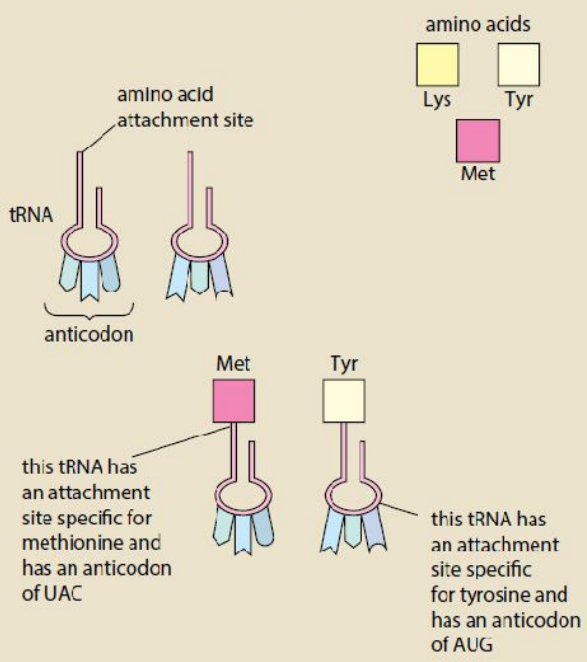
a In the nucleus, part of a DNA molecule unwinds and unzips as the hydrogen bonds between the bases break. Free activated RNA nucleotides pair up with the exposed bases of one strand only, in a similar way to that shown in Figure 6.9.

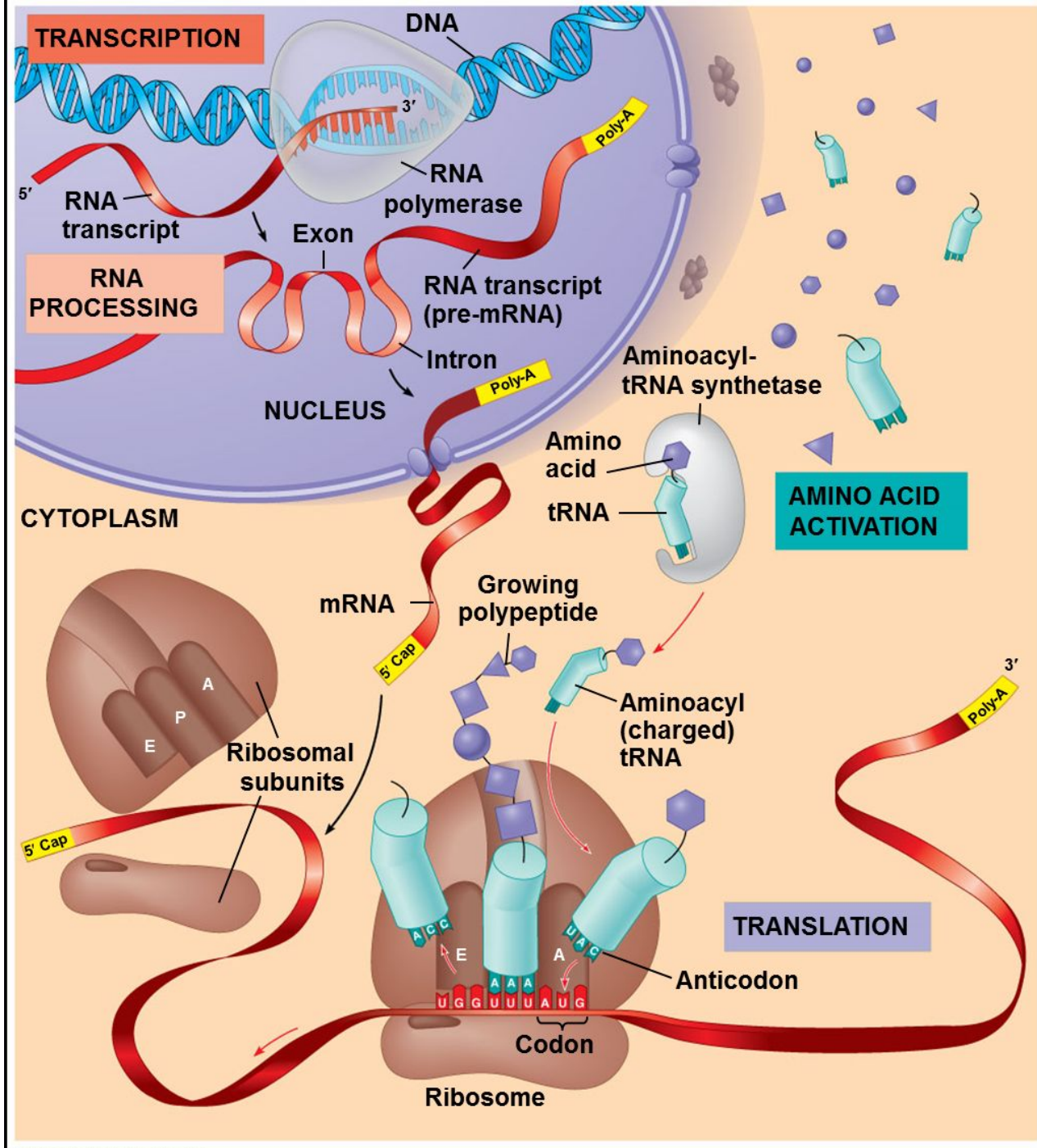
As the RNA nucleotides pair up with their complementary ones, their sugar–phosphate groups are bonded together by RNA polymerase to form a sugar–phosphate backbone. The new single-stranded molecule which has formed is called messenger RNA (mRNA). It leaves the nucleus via a pore in the nuclear envelope.



b In the cytoplasm, there are free amino acids and transfer RNA (tRNA) molecules. At one end of each tRNA molecule is a site to which an amino acid can bind. At the other end are three unpaired bases. The base triplet is called an anticodon. Figure 6.14b gives more detail.

Each tRNA molecule bonds with a particular amino acid, under the control of a specific enzyme and with energy from ATP.





Success criteria

- Knows the definition of transcription and translation terms
- Defines the terms of transcription and translation
- Describes the processes of transcription and translation
- Using the table of the genetic code table can identify amino acids