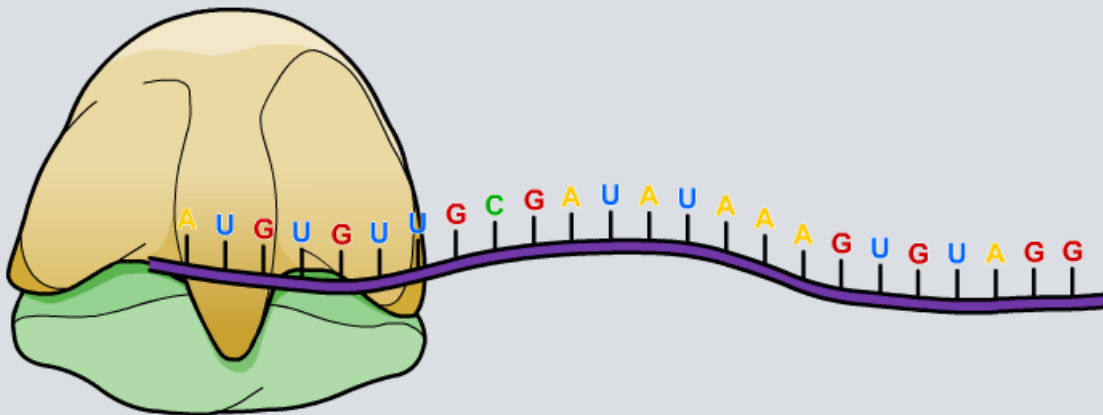
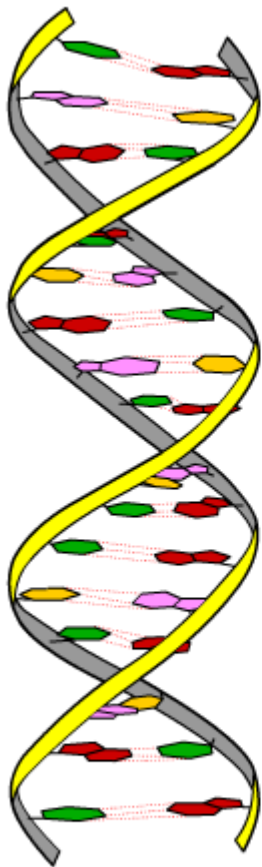


## Transcription and Translation



## DNA and genetics: timeline of discoveries



Click on the dates to find out more about some of the key discoveries relating to DNA and genetics.

1866

1941

1944

1950

1952

1953

1957

1958

1960

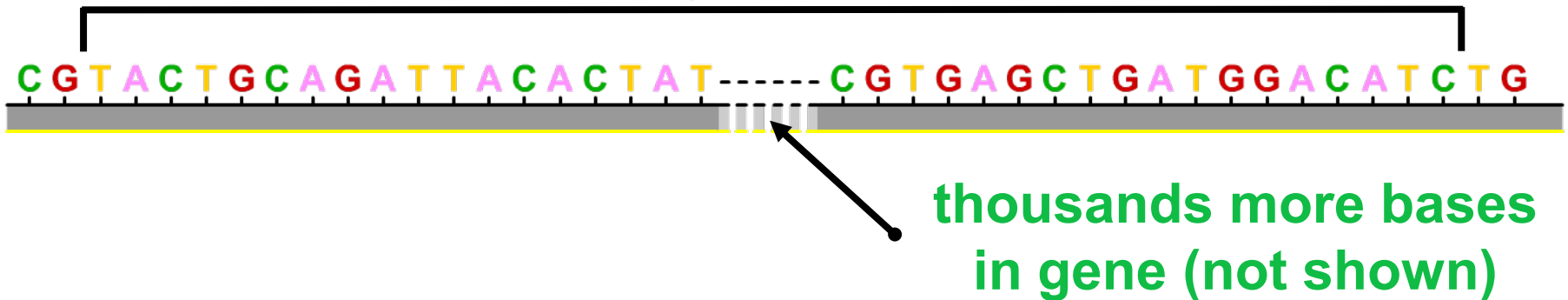
1961



# What is the genetic code?

The **genetic code** of an organism is the sequence of bases along its DNA. It contains thousands of sections called **genes** or **cistrons**. Each gene codes for a specific polypeptide.

**one gene/cistron**



All polypeptides are made from amino acids, so the sequence of bases in a gene must code for amino acids.

The genetic code is almost **universal** – the same sequence of bases codes for the same amino acids in all organisms.

Given that there are four bases in DNA, and these code for 20 amino acids, what is the basis for the genetic code?

- If **one** base = one amino acid,  
possible amino acids = **4**



- If **two** bases = one amino acid,  
possible amino acids = **16** ( $4 \times 4$ )



- If **three** bases = one amino acid,  
possible amino acids = **64** ( $4 \times 4 \times 4$ )



The existence of a three-base (**triplet**) code was confirmed by experiments by Francis Crick and his colleagues in 1961. The triplet code is **degenerate**, which means that each amino acid is coded for by more than one triplet.



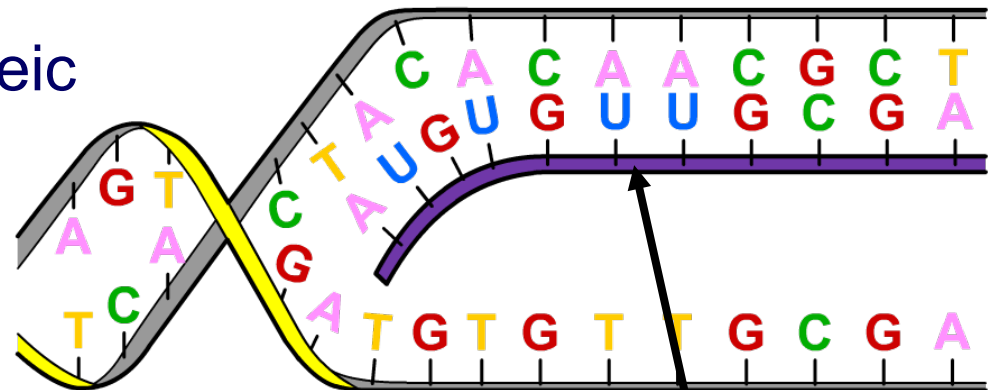
# What is mRNA?

When a polypeptide is required, the triplet code of its gene is converted into a molecule of **messenger RNA (mRNA)**.

This process is called **transcription** and is the first stage of **protein synthesis**.

Like DNA, mRNA is a nucleic acid, but it differs in that:

- it is single stranded, not double stranded
- it contains ribose instead of deoxyribose
- it contains uracil instead of thymine.



**mRNA strand  
during  
transcription**

During transcription, the mRNA is built up by complementary base pairing, using the DNA as a template. The DNA's base triplets are converted into mRNA **codons**.

What are the codons in the mRNA transcribed from this sequence of DNA base triplets?

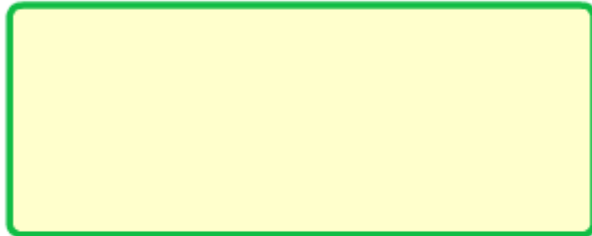
DNA	T	A	C	G	C	A	G	A	T	T	A	C
mRNA	A	U	G	C	G	U	C	U	A	A	U	G

The genetic code is **non-overlapping**: each base is only part of one triplet/codon, and each triplet/codon codes for just one amino acid.

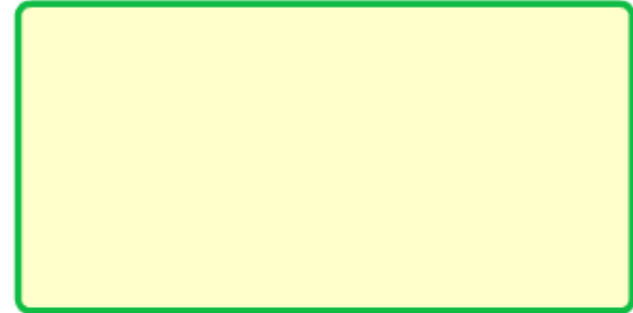


What is the genetic code?

codon



amino acid



A C G U

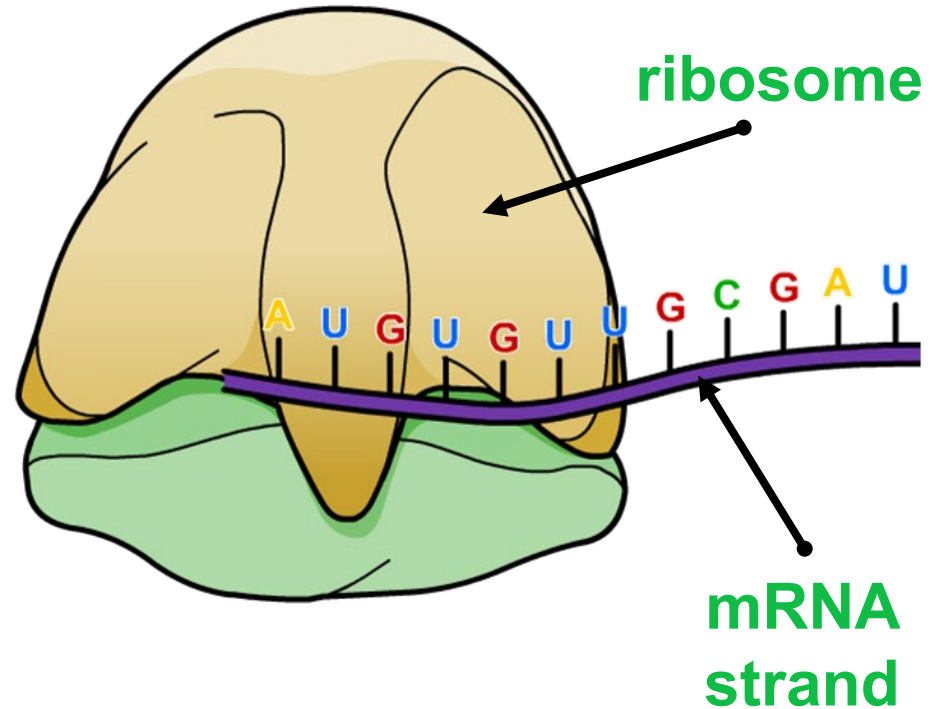
by amino acid



# What is translation?

Once a molecule of mRNA has been transcribed, it moves out of the nucleus via a nuclear pore.

In the cytoplasm, the mRNA combines with a **ribosome** – the cellular structure on which the polypeptide chain will be built in a process called **translation**.



How are the correct amino acids transported to the ribosome, and how are they linked together in the correct order?



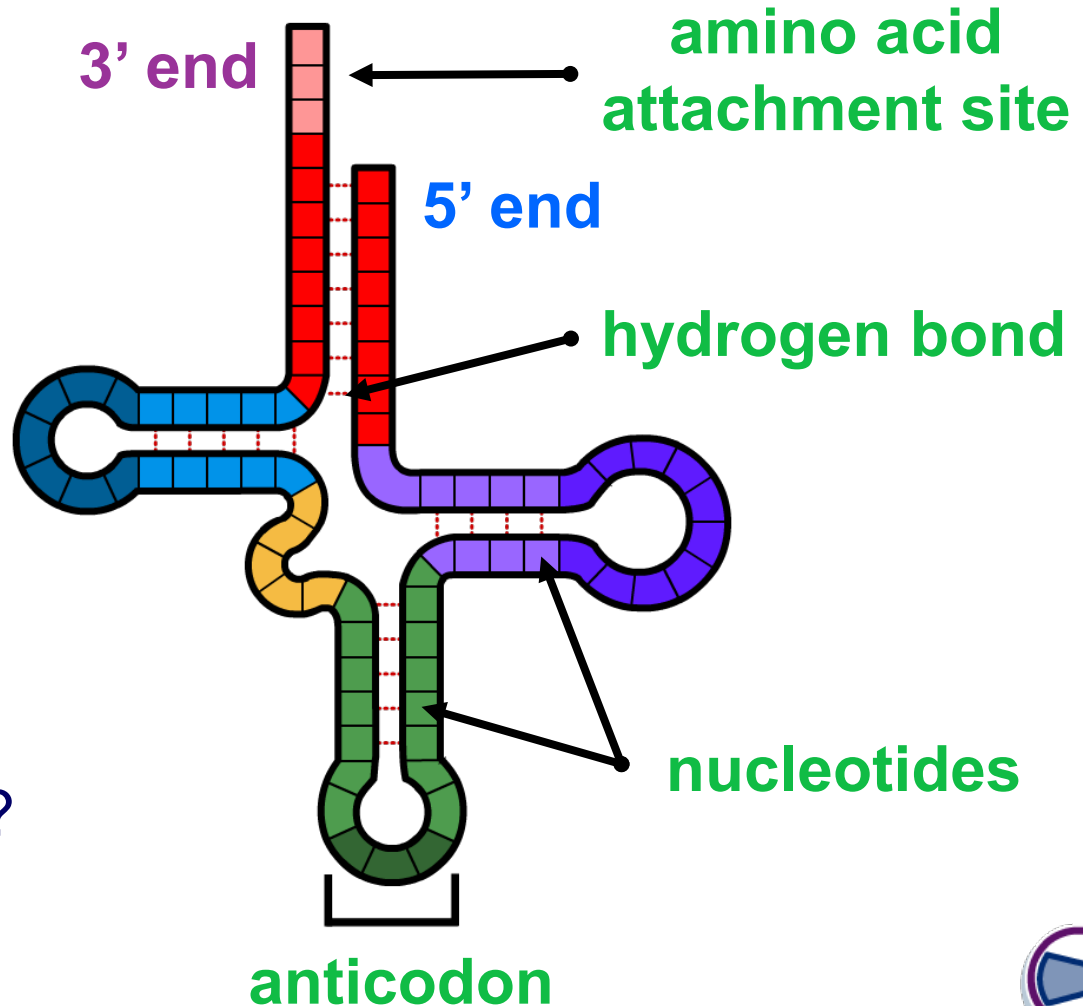
# What is tRNA?

In the cytoplasm, amino acids become attached to **transfer RNA (tRNA)** molecules. Each tRNA is specific for one amino acid.

Each tRNA molecule has a sequence of three bases called an **anticodon**. These are complementary to codons on the mRNA molecule.

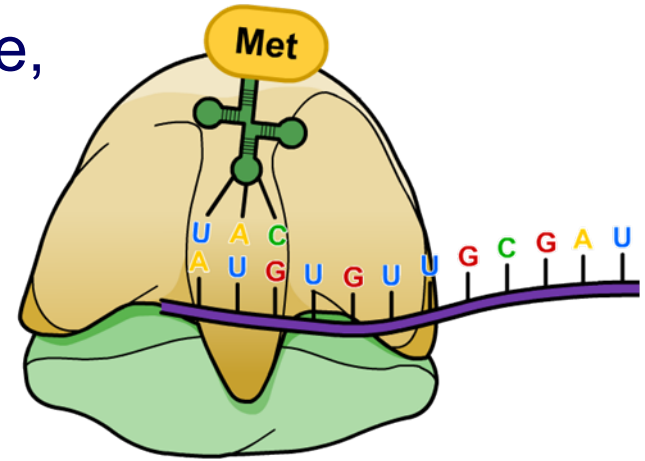
What is the anticodon for the codon **AUG**?

**UAC**



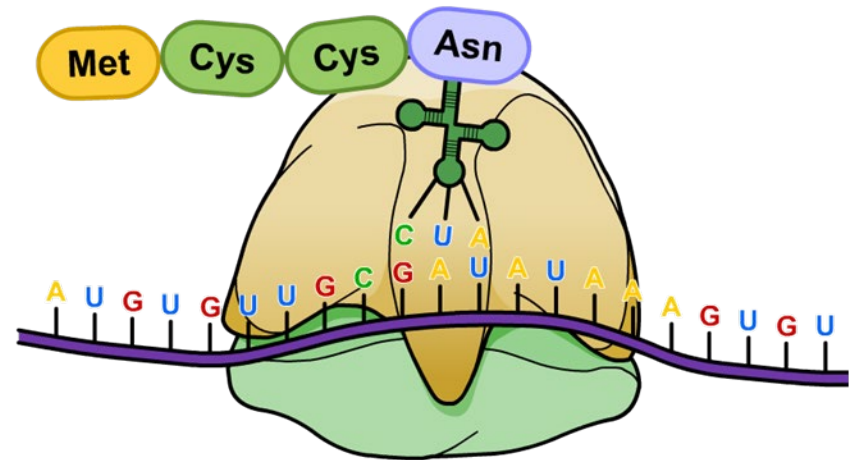
# What happens during translation?

tRNA molecules attach to the ribosome, and their anticodons pair up with the appropriate codons on the mRNA.



The amino acids transported by the tRNA link together, and the tRNA molecules then return to the cytoplasm.

The ribosome moves along the mRNA, and amino acids continue to join together until all the codons have been translated and the polypeptide is complete.



## What is the order of stages in protein synthesis?

- 1 completed polypeptide chain dissociates from ribosome
- 2 anticodons on tRNA molecules pair up with codons on mRNA
- 3 amino acids start to be joined by peptide bonds
- 4 amino acids transported to ribosome by tRNA molecules
- 5 DNA unwinds, exposing base triplet code of gene
- 6 ribosome moves along mRNA until all amino acids linked
- 7 mRNA is built up, using exposed DNA strand as template
- 8 mRNA moves into cytoplasm and combines with ribosome



# From DNA to amino acids

