Be a ribosome!

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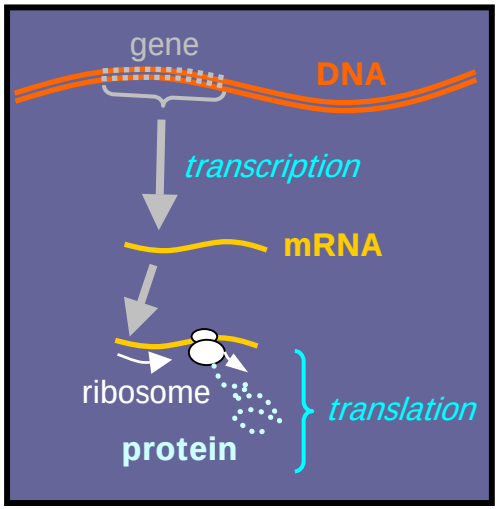
Ribosomes are proteins in the cell that make other proteins. The process begins with copying the DNA sequence of a gene into a format that can be read by the ribosomes. This copy is made from messenger RNA, or **mRNA** in a process called **transcription**. mRNA uses a slightly different chemistry to DNA – the main difference is the substitution of the DNA base-letter *thyamine* (T) for *uracil* (U). The mRNA sequence is used by ribosomes as the instruction for building a protein, in a process called **translation**. You can do this job and make a protein from lifesavers by reading and translating DNA.



Here is your DNA Sequence:

g c g g a c t c t a a g a t g a a t c a g a t t c c a a a c c a a t a g g g c c c c g t a

Look at the Codon Usage Table and find out what sequence is recognised as the 'start' or initiation codon. *Hint: the first codon-letter is an 'A', and remember that a 'T' in the DNA sequence equals a 'U' in the mRNA table!* Scan through the DNA sequence above until you find this start-codon sequence, and draw a box around those three letters. We'll refer to this as Codon 1.

Once you have found the start codon, move along the sequence (from left to right) and mark out each subsequent codon by drawing a vertical line to split up the DNA sequence after every third DNA letter. Each group of three is called a **codon**, and encodes for an **amino acid** in the polypeptide chain of the protein you are about to make.

Refer back to the Codon Usage Table to translate each codon, including the start codon, along the sequence into its appropriate amino acid residue. Write the first three letters of the amino-acid name beneath the DNA sequence.

As you write each one down, find the corresponding 'amino acid' within your packet of lifesavers (use the colour chart on the right). String together each lifesaver/amino-acid in the sequence. Keep going, building your protein in this way until you hit the codon instructing you to stop translating – now you are done and your protein is complete!

'Amino acid' Lifesavers

Green, Lime
Glutamine (Gln)

Orange
Proline (Pro)

Bright Yellow, Lemon
Isoleucine (Ile)

Red, Cherry
Asparagine (Asn)

Dark Yellow, Passionfuit
Methionine (Met)

Looking back at the DNA sequence, what happens to the protein-sequence if ...

- ☐ the DNA sequence at Codon 4 is mutated from `att` to `act`?
- ☐ the DNA sequence at Codon 5 is mutated from `cca` to `ccg`?
- ☐ the DNA sequence at Codon 3 is mutated from `cag` to `tag`?

What happens if you insert or delete a DNA letter from anywhere the DNA sequence?

Another important part of the regulation of proteins within a cell is the rate at which they are degraded. This job is carried out by **proteases**; enzymes that split proteins up into smaller peptides and amino acids in a process termed 'proteolysis'. Now that you have done a sterling job as a ribosome, you can switch over and try your hand at being a protease. Take your newly synthesised protein and remove each amino acid in turn, eating as you go. Avoid the string.

Codon Usage Table

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To use this table you look up the first base in the triplet to locate the correct row in the table. Then you use the second base in the triplet to locate the correct column in the table. Within the cell you look up the third base of the triplet to find the corresponding amino acid in the primary sequence of the protein.

Note: When DNA is being transcribed into mRNA, uracil (U) is used instead of threonine (T). So whenever you see a **T** in the DNA sequence, you need to convert it to a **U** in this table.

1st Letter	2nd Letter: U	2nd Letter: C	2nd Letter: A	2nd Letter: G	3rd Letter
U	**UUU** Phenylalanine - Phe, F	**UCU** Serine - Ser, S	**UAU** Tyrosine - Tyr, Y	**UGU** Cysteine - Cys, C	U
	UUC Phenylalanine - Phe, F	**UCC** Serine - Ser, S	**UAC** Tyrosine - Tyr, Y	**UGC** Cysteine - Cys, C	C
	UUA Leucine - Leu, L	**UCA** Serine - Ser, S	**UAA** ***Stop***	**UGA** ***Stop***	A
	UUG Leucine - Leu, L	**UCG** Serine - Ser, S	**UAG** ***Stop***	**UGG** Tryptophan - Trp, W	G
C	**CUU** Leucine - Leu, L	**CCU** Proline - Pro, P	**CAU** Histidine - His, H	**CGU** Arginine - Arg, R	U
	CUC Leucine - Leu, L	**CCC** Proline - Pro, P	**CAC** Histidine - His, H	**CGC** Arginine - Arg, R	C
	CUA Leucine - Leu, L	**CCA** Proline - Pro, P	**CAA** Glutamine - Gln, Q	**CGA** Arginine - Arg, R	A
	CUG Leucine - Leu, L	**CCG** Proline - Pro, P	**CAG** Glutamine - Gln, Q	**CGG** Arginine - Arg, R	G
A	**AUU** Isoleucine – Ile, I	**ACU** Threonine – Thr, T	**AAU** Asparagine – Asn, N	**AGU** Serine - Ser, S	U
	AUC Isoleucine – Ile, I	**ACC** Threonine – Thr, T	**AAC** Asparagine – Asn, N	**AGC** Serine - Ser, S	C
	AUA Isoleucine – Ile, I	**ACA** Threonine – Thr, T	**AAA** Lysine – Lys, K	**AGA** Arginine - Arg, R	A
	AUG ***Start*** Methionine – Met,M	**ACG** Threonine – Thr, T	**AAG** Lysine – Lys, K	**AGG** Arginine - Arg, R	G
G	**GUU** Valine – Val, V	**GCU** Alanine – Ala, A	**GAU** Aspartate – Asp, D	**GGU** Glycine – Gly, G	U
	GUC Valine – Val, V	**GCC** Alanine – Ala, A	**GAC** Asparate – Asp, D	**GGC** Glycine – Gly, G	C
	GUA Valine – Val, V	**GCA** Alanine – Ala, A	**GAA** Glutamate – Glu, E	**GGA** Glycine – Gly, G	A
	GUG Valine – Val, V	**GCG** Alanine – Ala, A	**GAG** Glutamate – Glu, E	**GGG** Glycine – Gly, G	G