1.3. Control of gene expression

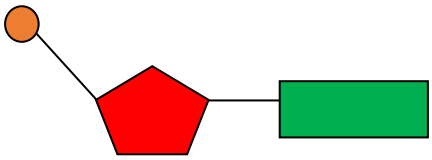
A cell's _ _ _ _ _ _ _ _ (genetic constitution) is determined by the sequence of the DNA bases in its genes (the genetic code).

A cell's _ _ _ _ _ _ _ _ _ (physical and chemical state) is determined by the proteins that are synthesised when the genes are expressed.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ is controlled by the regulation of transcription and translation. It is influenced by _ acting inside and outside of the cell. Only a fraction of the genes in a cell are expressed.

RNA

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ (RNA) is a single strand of RNA nucleotides. Each RNA nucleotide is composed of a molecule of _ _ _ _ _ _ _ sugar, a _ _ _ _ _ _ _ _ _ _ group and an organic _ _ _ _. In RNA, the base _ _ _ _ _ _, replaces thymine (found in DNA).



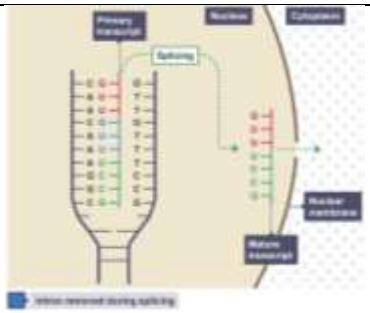
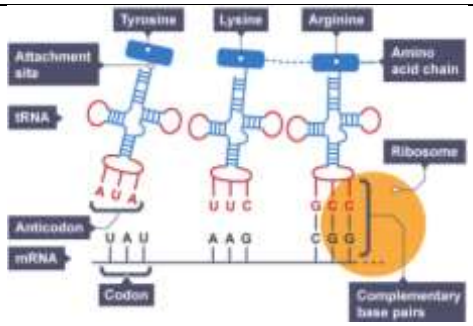
Characteristic	RNA	DNA
number of nucleotide strands present in one molecule		
complementary base partner of adenine		
sugar present in a nucleotide		

There are three types of RNA

	carries a complementary copy of the DNA code from the **nucleus** to **ribosomes** in the cytoplasm.
	is a type of RNA found in the **cytoplasm**. tRNA folds due to base pairing to form a triplet anticodon site and an attachment site for a specific amino acid. tRNA carries specific amino acids to ribosomes, where they can be assembled to form polypeptide chains.
	rRNA and proteins are **components** of the **ribosome** and therefore they are both essential for protein synthesis to take place in all living cells.

Transcription

- Transcription takes place in the _ _ _ _ _ _ _ and is the first step in gene expression.
- _ _ _ _ _ _ _ _ _ _ _ _ unwinds and unzips the double helix, of the gene to be expressed, by breaking the hydrogen bonds between the complementary bases.
- RNA polymerase then aligns complementary **free** _ _ _ _ _ _ _ _ _ _ _ _ _ _ against the exposed DNA nucleotides of the template strand.
- These free RNA nucleotides join together to form a _ _ _ _ _ _ _ transcript of mRNA, which is made up of groups of three bases called _ _ _ _ _ _.
- Each primary transcript of mRNA has both _ _ _ _ _ _ _ (non-coding regions) and _ _ _ _ _ (coding regions). During a process called _ _ _ _ _ _ _ _ _ the introns are removed and the exons are spliced together to form a _ _ _ _ _ _ transcript of mRNA.
- This mature mRNA transcript then passes out of the _ _ _ _ _ _ _ to the _ _ _ _ _ _ _ _ _ (found in the cytoplasm) to be translated.

Transcription	Translation
	

Translation

- During this second stage, the mature mRNA transcript binds onto a _ _ _ _ _ _ _ _
- mRNA carries a _ _ _ _ _ codon, to begin transcription
- _ _ _ _ molecules transport a specific amino acid from the cytoplasm to the mRNA on the ribosome
- **mRNA** _ _ _ _ _ _ recognise incoming **tRNA** _ _ _ _ _ _ _ _ _ _ _ _ and match up to form _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ base pairs.
- Empty tRNA molecules exit the ribosome and collect another specific amino acid.
- _ _ _ _ _ _ _ _ _ _ _ _ _ form between the adjacent amino acids to form the polypeptide chain
- The mRNA carries a _ _ _ _ codon, to signal the end of translation, releasing the polypeptide chain
- The polypeptide chain folds into a **three**-dimensional shape to form a protein, which is held together by peptide bonds, _ _ _ _ _ _ _ _ bonds and other molecular interactions between amino acids.

Different proteins can be expressed from the one gene, as a result of alternative RNA splicing and post-translational modifications.

Alternative RNA splicing	Post-translational modifications
Different mRNA molecules are produced from the same primary transcript depending on which _ _ _ _ _ are included in the _ _ _ _ _ _ mRNA transcript.	After translation, the polypeptide chain can be changed by _ _ _ _ _ _ _ and _ _ _ _ _ _ _ _ _ chains or by adding _ _ _ _ _ _ _ _ _ or _ _ _ _ _ _ _ _ _ _ _ _ groups to a protein.