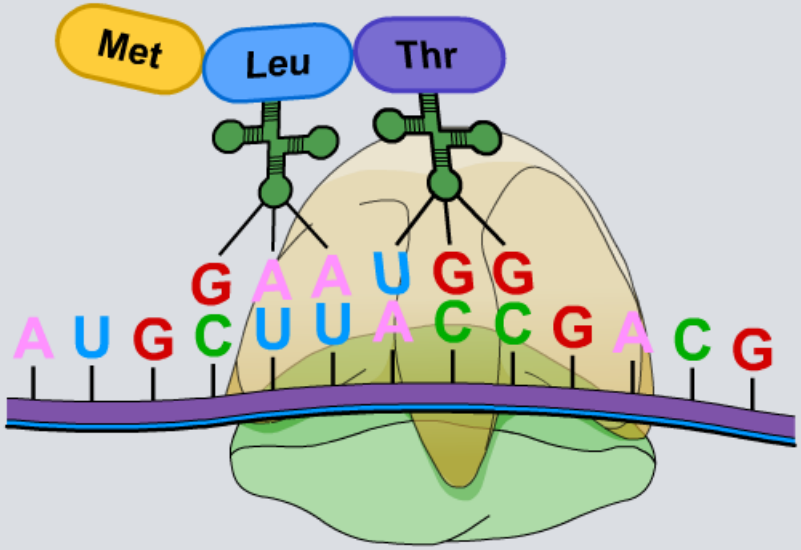
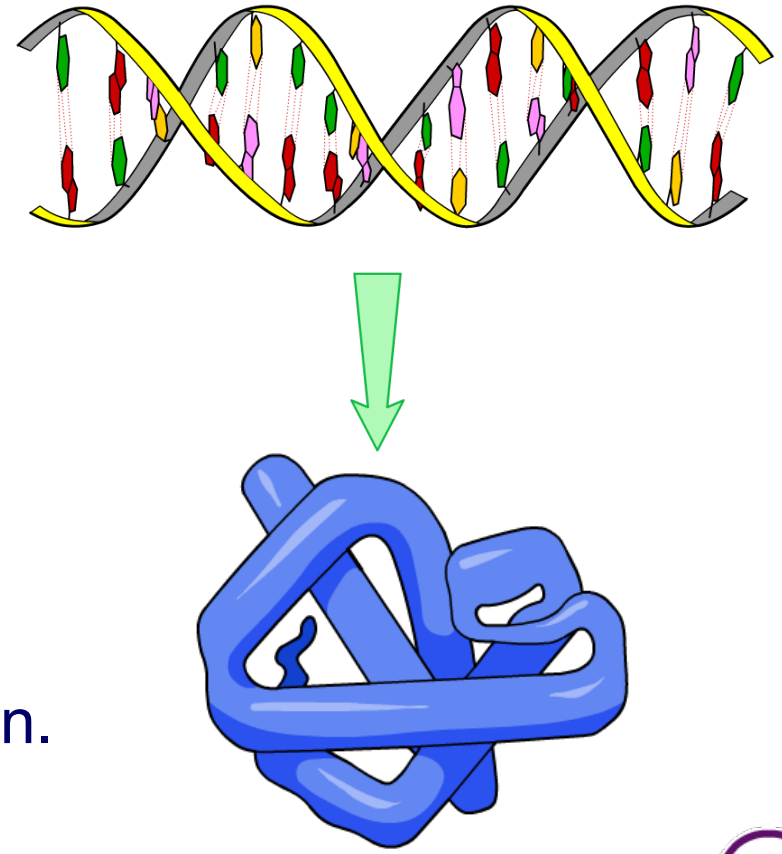
Controlling Protein Synthesis



Gene expression

When a gene is ‘switched on’ or expressed, it is **transcribed** into an mRNA strand which is then **translated** into a protein.

Proteins, such as enzymes, can control chemical reactions and therefore determine how an organism grows, develops and functions.



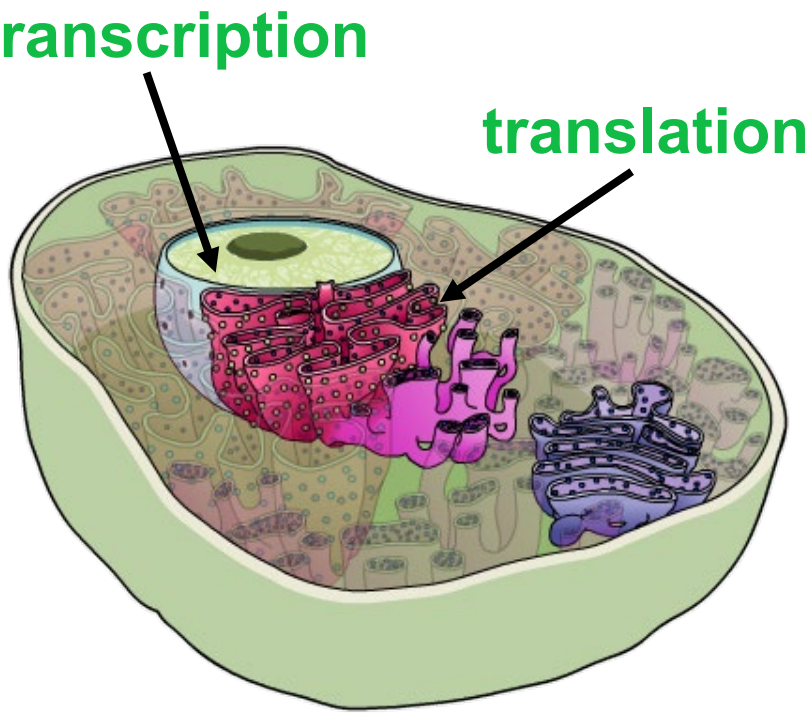
Only some of the many genes in a cell will be expressed at any one time. This is key to controlling development and cell differentiation.

How are proteins synthesized from DNA?

Protein synthesis involves the production of a chain of amino acids that forms the primary structure of a protein. The sequence of amino acids are coded for by a gene.

The stages of protein synthesis include:

1. **Transcription** of the gene in the **nucleus** – an mRNA strand is formed.
2. Processing of the mRNA.
3. **Translation** of the mRNA in a **ribosome** – a polypeptide chain is formed.
4. Modification of the protein.



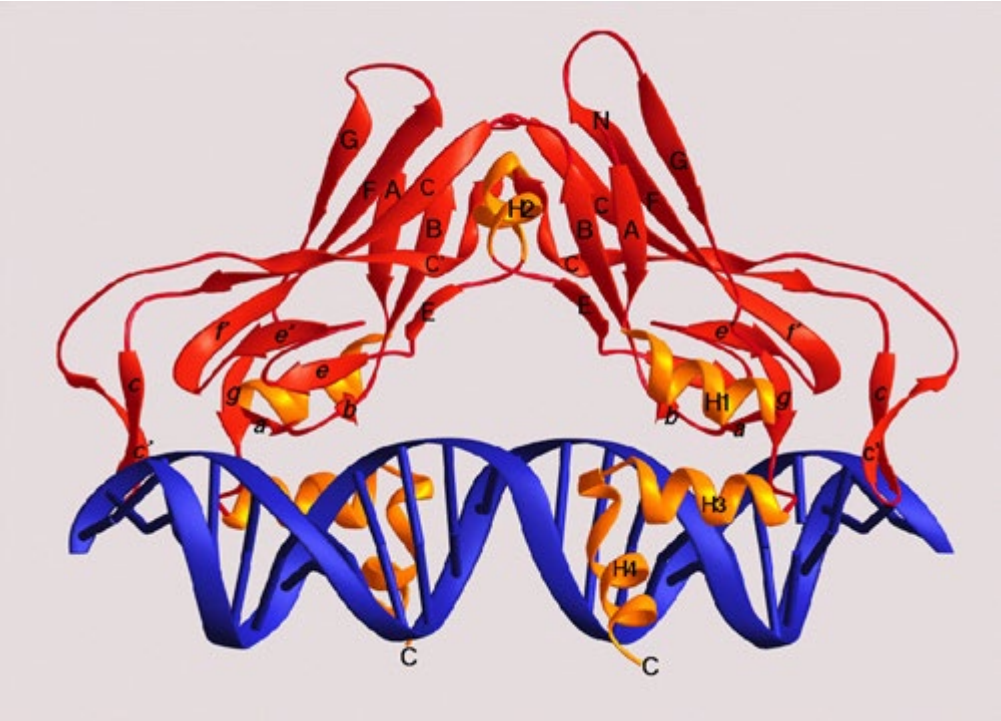
Transcription of DNA

How is transcription initiated?

In eukaryotic cells, before transcription can begin a gene needs to be stimulated by a regulatory protein, called **transcriptional factor**.

Each transcriptional factor contains sites that can bind to a specific region of the DNA.

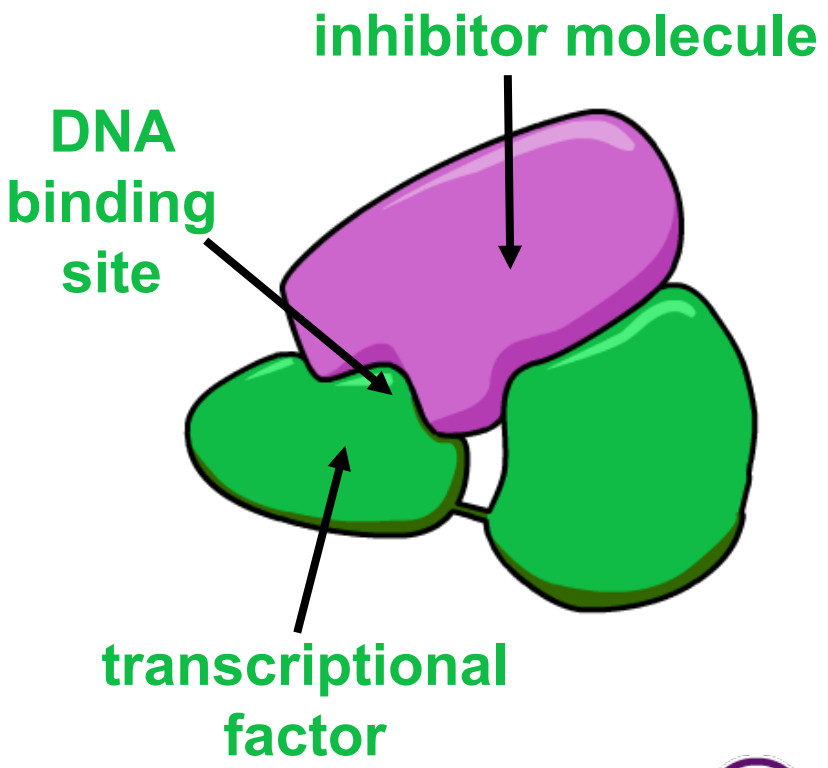
They cannot initiate transcription alone, but form a pre-initiation complex with RNA polymerase.



Function of transcriptional factors

Transcriptional factors function in different ways. Some transcriptional factors recognize parts of the promoter sequence at the start of a gene and bind to them. They can either promote or block the functioning of **RNA polymerase**.

The action of a transcriptional factor can be switched off by an **inhibitor molecule**. This can bind to the transcriptional factor, preventing it from attaching to DNA. Without the transcriptional factor the gene cannot be transcribed.

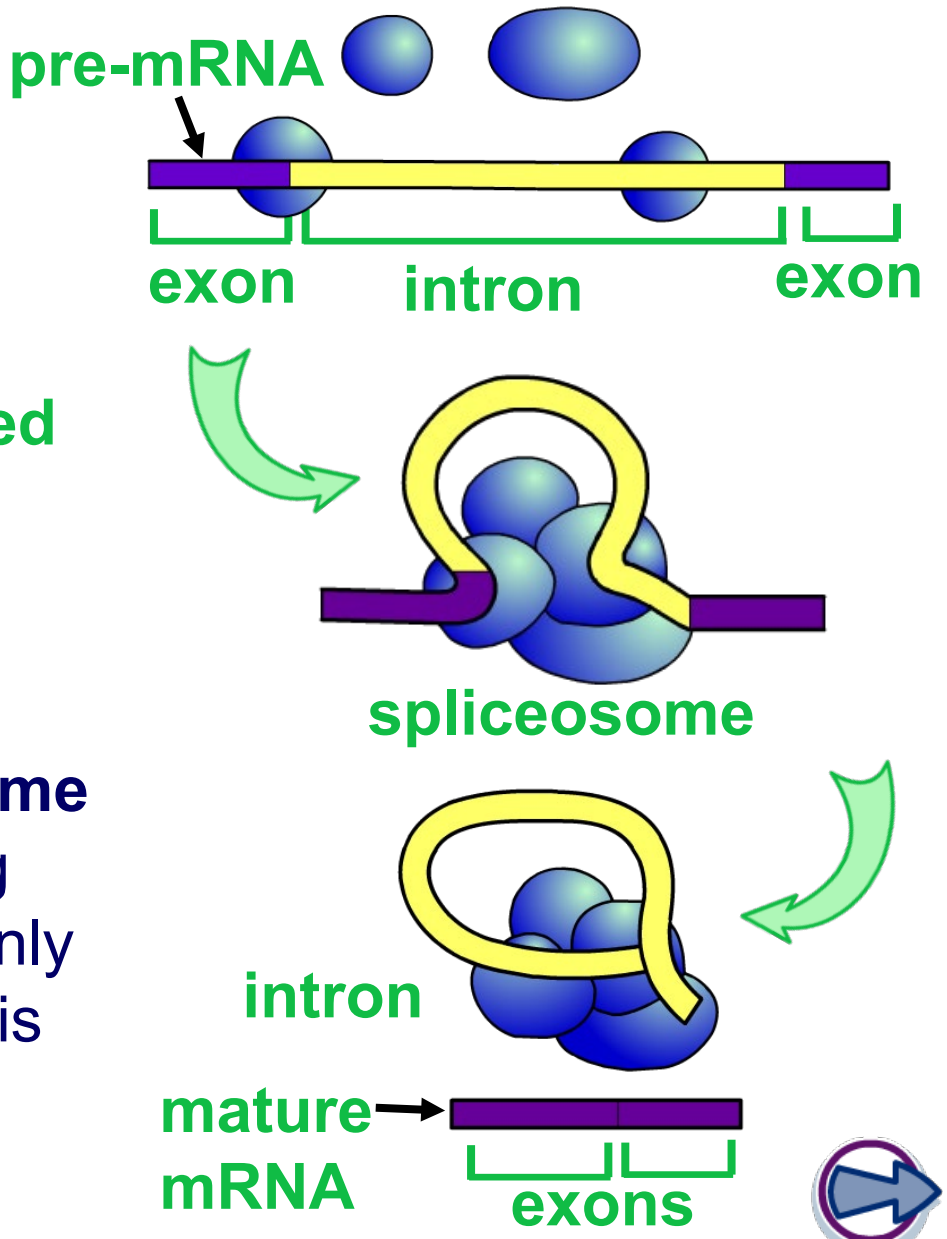


Processing of mRNA

DNA contains some regions that do not code for proteins. These are known as **introns**.

To produce functional proteins these introns need to be **spliced** out of the mRNA, leaving only the regions that code for proteins, called **exons**.

A molecule called a **spliceosome** removes the introns, producing **mature mRNA** that contains only exons. Before splicing, mRNA is known as **pre-mRNA**.



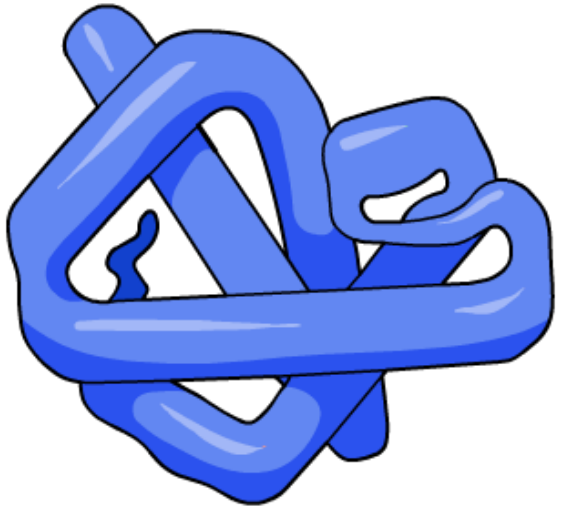
Transcription

Translation

Post-translational modifications

Once translated a **polypeptide chain** may undergo changes. These **post-translational modifications** include:

- removal of methionine – the start codon for each gene codes for a methionine; in many cases this will be removed
- addition of functional groups – e.g. phosphate or acetate
- structural changes – e.g. the addition of disulfide bridges or cleavage of a part of the chain



Modifications of the primary structure give the protein its specific secondary structure that allows it to perform its function.

Protein synthesis

The stages of protein synthesis