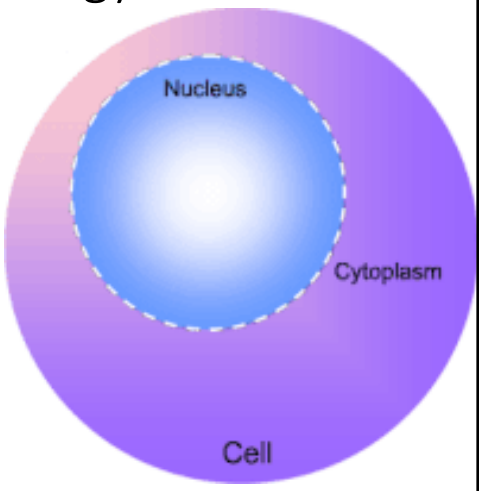
Central dogma of molecular biology

- The **central dogma of molecular biology** describes the two-step process,

1. Transcription : synthesis of an RNA copy of a segment of DNA

2. Translation: Synthesis of proteins from RNA



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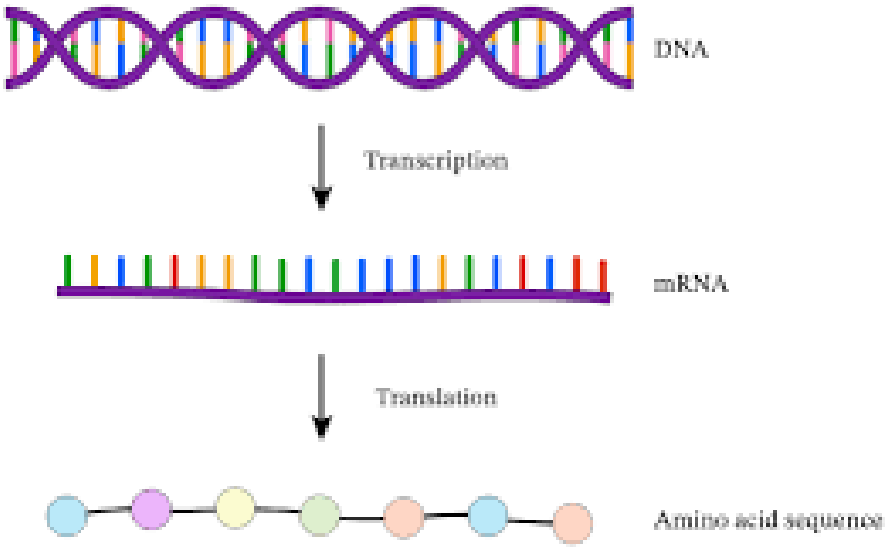

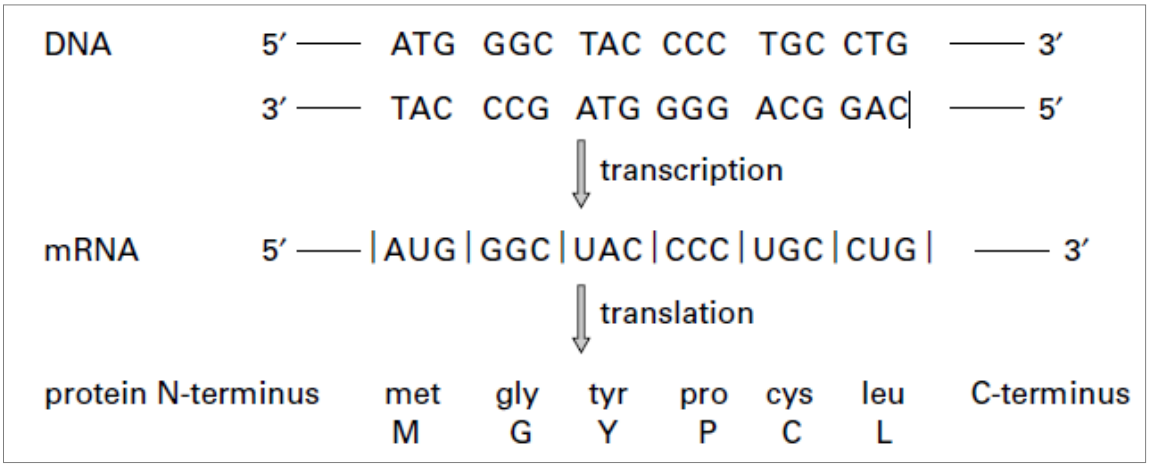

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TRANSCRIPTION

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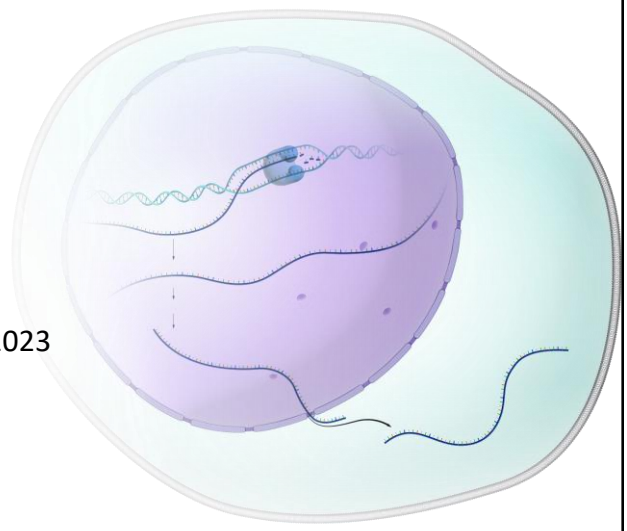
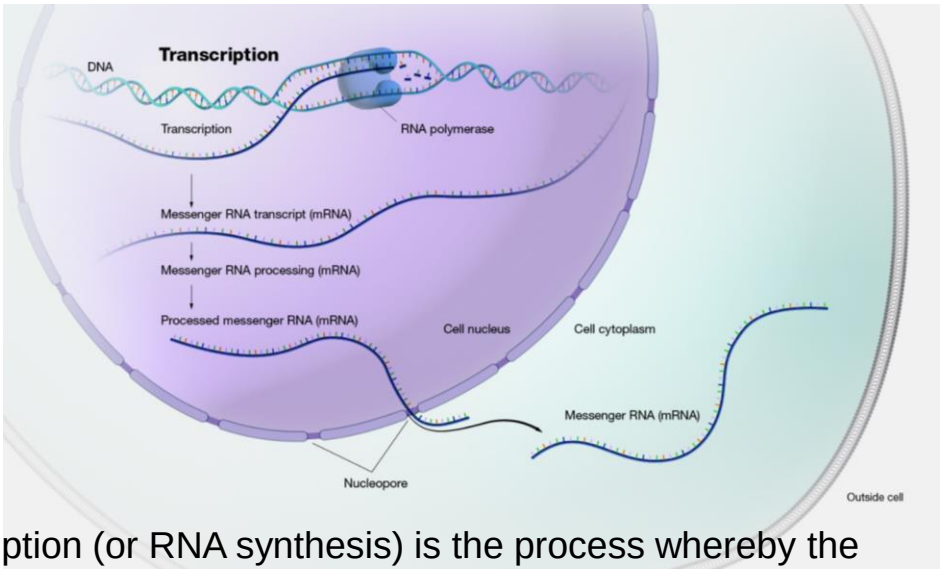
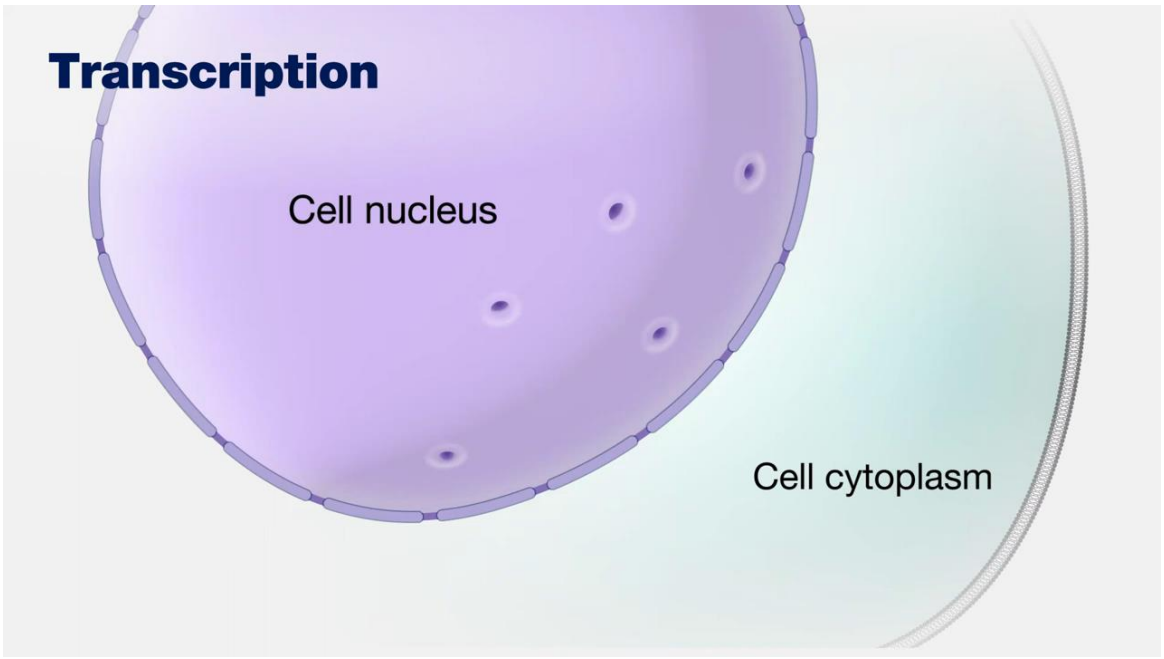




- Transcription (or RNA synthesis) is the process whereby the information held in the nucleotide sequence of DNA is transferred to RNA.

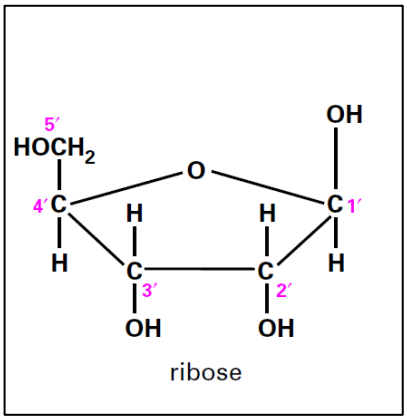


Structure of RNA molecule

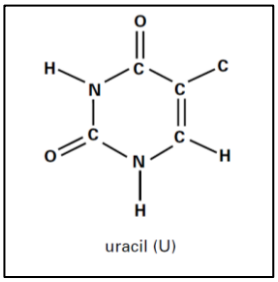
- Ribonucleic acid is a polymer made up of monomeric nucleotide units.
- RNA has a chemical structure similar to DNA, but with two major differences:

1. The sugar in RNA is a ribose sugar instead of deoxyribose.

2. The Purines are adenine, guanine and the pyrimidines are cytosine and uracil.



ribose



uracil (U)

- Transcription takes place in three steps: initiation, elongation, and termination.
- The mRNA made is complementary to a strand of DNA.

Step 1: Initiation

- **Initiation** is the beginning of transcription.
- It occurs when the enzyme **RNA polymerase** binds to a region of a gene called the **promoter**.
- This signals the DNA to unwind so the enzyme can "read" the bases in one of the DNA strands. The enzyme is now ready to make a strand of mRNA with a complementary sequence of bases.

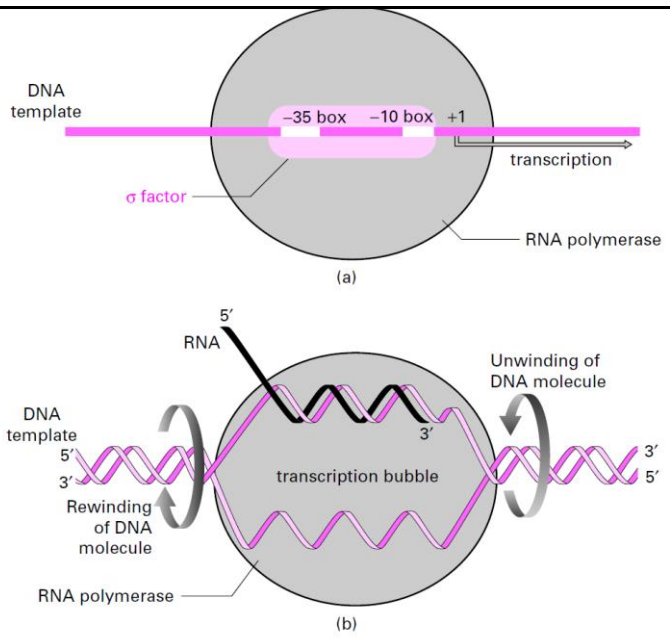
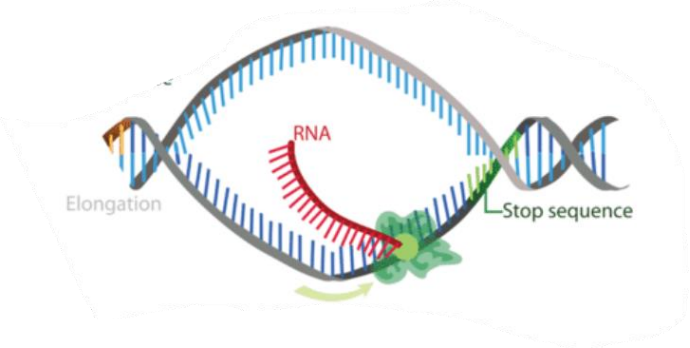


Figure 6.4. (a) RNA polymerase binds to the promoter. (b) DNA helix unwinds and RNA polymerase synthesizes an RNA molecule.

Step 2: Elongation

- **Elongation** is the addition of nucleotides to the mRNA strand.
- RNA polymerase reads the unwound DNA strand and builds the mRNA molecule, using complementary base pairs.
- During this process, an uracil (U) in the RNA binds to an adenine (A) in the DNA.



Step 3: Termination

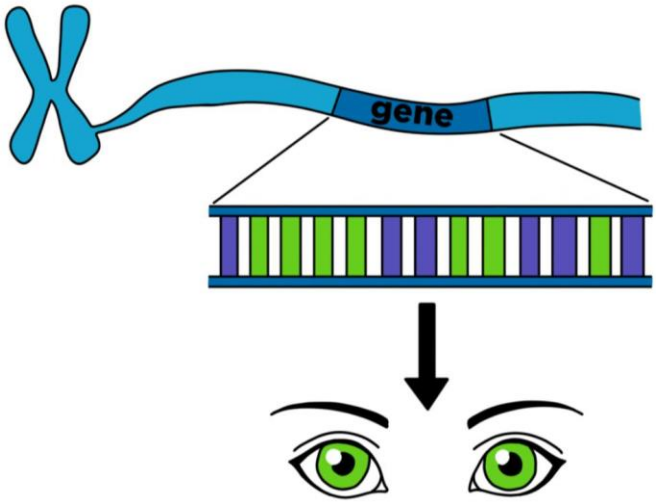
- **Termination** is the ending of transcription, and occurs when RNA polymerase crosses a **stop (termination) sequence** in the gene. The mRNA strand is complete, and it detaches from DNA.

Processing of mRNA

- The eukaryotic pre-mRNA undergoes extensive processing before it is ready to be translated.
- The three most important steps of pre-mRNA processing are the

1. **addition of stabilizing and signaling factors at the 5′ and 3′ ends of the molecule**
2. **removal of intervening sequences that do not specify the appropriate amino acids.**

WHAT IS A GENE?



Genes are segments of DNA

Each gene contains information about a certain trait

Genes are transcribed and translated by the cell to make proteins

Proteins create a visible phenotype

Example:

One gene might code for eye color.

The gene is used by cells to make proteins which create green pigment in our eyes

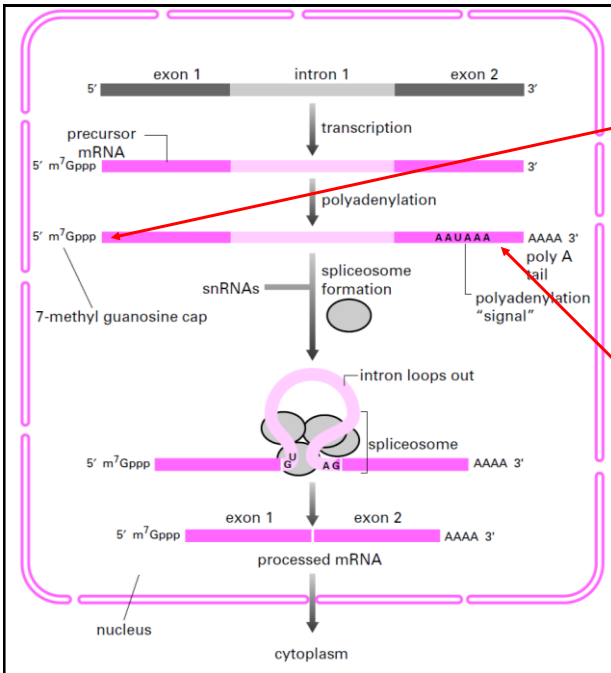


Figure 6.13. mRNA processing in eukaryotes.

5′ Capping: **A cap** is added to the 5′ end of the growing transcript by a phosphate linkage. This addition protects the mRNA from degradation.

3′ Poly-A Tail: Once elongation is complete, an enzyme called **poly-A polymerase** adds a string of approximately 200 A residues, called the **poly-A tail** to the pre-mRNA. This modification further **protects** the pre-mRNA from **degradation** and **signals the export of the cellular factors** that the transcript needs to the cytoplasm.

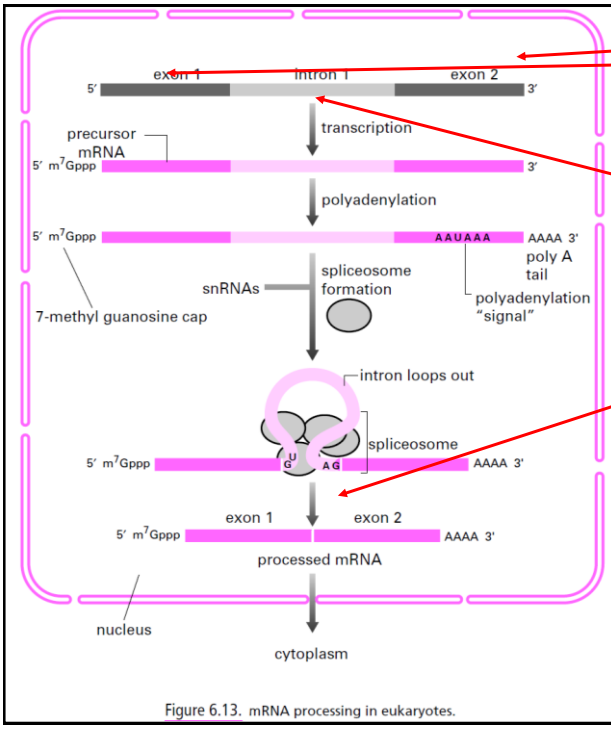
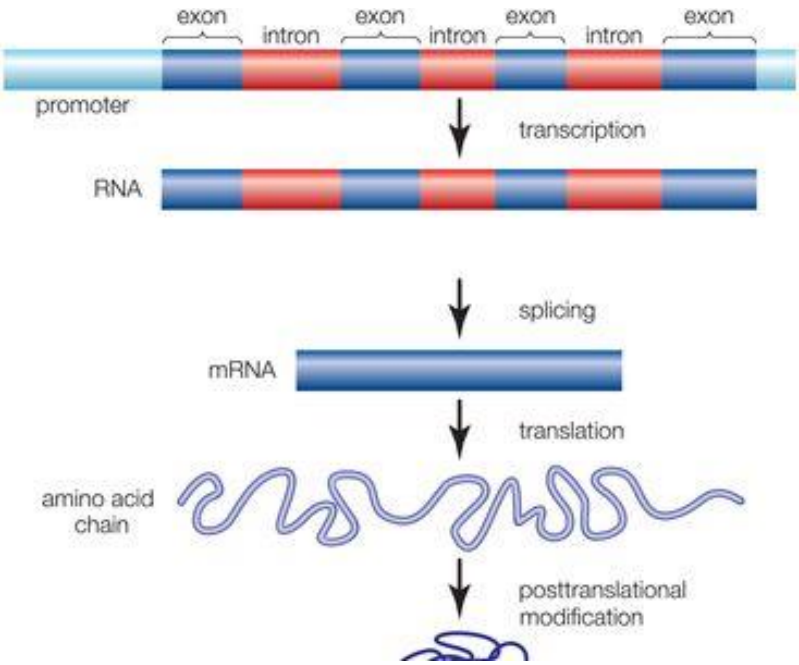


Figure 6.13. mRNA processing in eukaryotes.

Pre-mRNA Splicing: Eukaryotic genes are composed of **exons**, which are protein-coding sequences (*ex*-on signifies that they are *ex*pressed)

- *int*ervening sequences called **introns** (*int*ron denotes their *int*ervening role) which are removed from the pre-mRNA during processing. Intron sequences in mRNA do not encode functional proteins.

The process of removing introns and reconnecting exons is called splicing



Steps of mRNA processing

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3. **Pre-mRNA Splicing :** Eukaryotic genes are composed of **exons**, which correspond to protein-coding sequences (*ex*-on signifies that they are *ex*pressed), and *int*ervening sequences called **introns** (*int*ron denotes their *int*ervening role), which are removed from the pre-mRNA during processing. Intron sequences in mRNA do not encode functional proteins.

All of a pre-mRNA's introns must be completely and precisely removed before protein synthesis. If the process errs by even a single nucleotide, the reading frame of the rejoined exons would shift, and the resulting protein would be dysfunctional. The process of removing introns and reconnecting exons is called **splicing**