

Transcription of DNA to RNA

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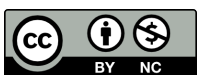
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CHAPTER

1

Transcription of DNA to RNA

- Define transcription.
- Describe the role of a gene's promoter.
- Summarize the transcription process.
- Describe mRNA processing.
- Distinguish introns from exons.
- Explain the significance of polyadenylation.



How does a cell use the information in its DNA?

To transcribe means "to paraphrase or summarize in writing". The information in DNA is transcribed - or summarized - into a smaller version - RNA - that can be used by the cell. This process is called transcription.

Transcription

The process in which cells make proteins is called **protein synthesis**. It actually consists of two processes: **transcription** and **translation**. Transcription takes place in the nucleus. It uses DNA as a template to make an

RNA molecule. RNA then leaves the nucleus and goes to a ribosome in the cytoplasm, where translation occurs. Translation reads the genetic code in mRNA and makes a protein.

Transcription is the first part of the central dogma of molecular biology: $DNA \rightarrow RNA$. It is the transfer of genetic instructions in DNA to messenger RNA (mRNA). During transcription, a strand of mRNA is made that is complementary to a strand of DNA. **Figure 1.1** shows how this occurs. You can watch an animation of the process at this link: http://www.biostudio.com/d_%20Transcription.htm .

- A detailed video about transcription is available at this link: <http://vcell.ndsu.edu/animations/transcription/movie-flash.htm> .

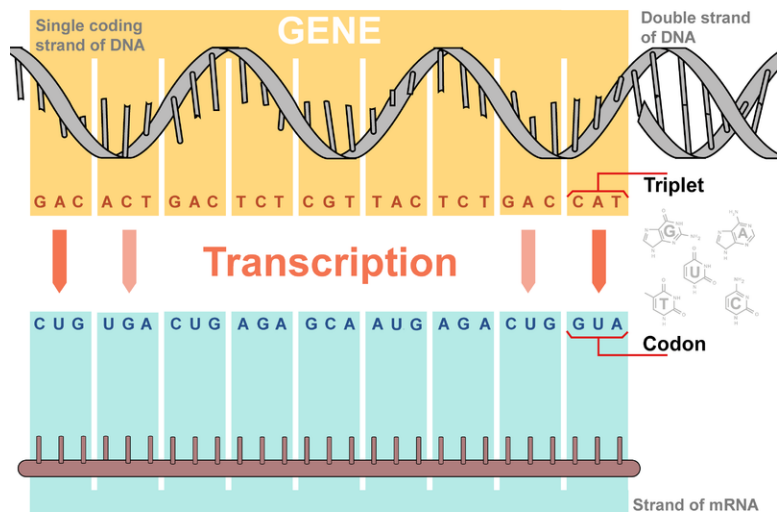


FIGURE 1.1

Overview of Transcription. Transcription uses the sequence of bases in a strand of DNA to make a complementary strand of mRNA. Triplets are groups of three successive nucleotide bases in DNA. Codons are complementary groups of bases in mRNA.

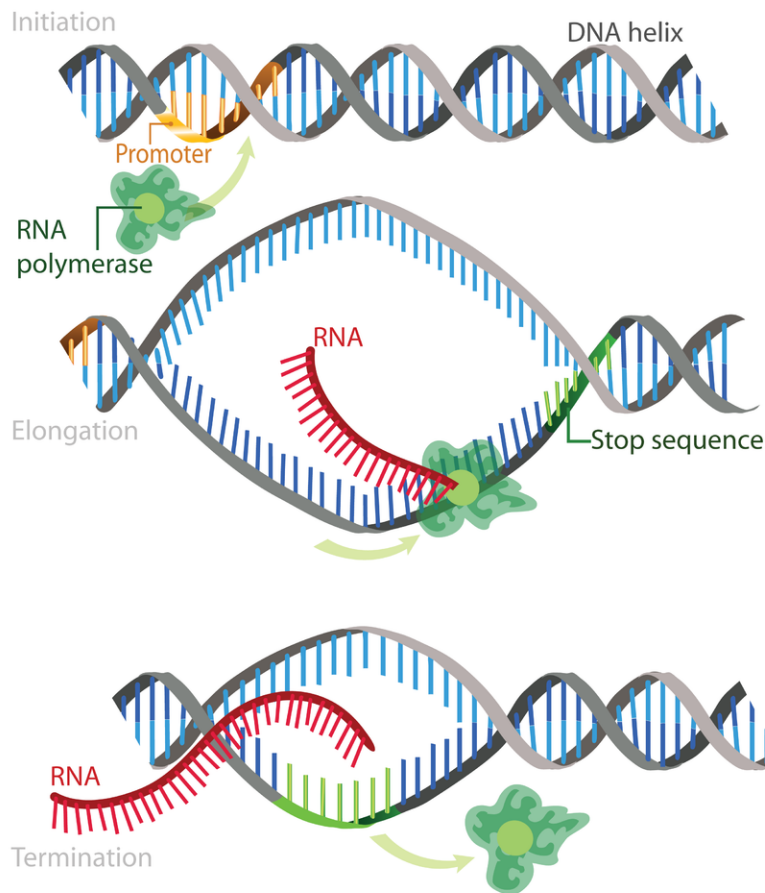
Steps of Transcription

Transcription takes place in three steps: initiation, elongation, and termination. The steps are illustrated in **Figure 1.2**.

1. **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.
2. **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. There is a brief time during this process when the newly formed RNA is bound to the unwound DNA. During this process, an adenine (A) in the DNA binds to an uracil (U) in the RNA.
3. **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 mRNA

In eukaryotes, the new mRNA is not yet ready for translation. It must go through additional processing before it leaves the nucleus. This may include splicing, editing, and polyadenylation. These processes modify the mRNA in various ways. Such modifications allow a single gene to be used to make more than one protein.

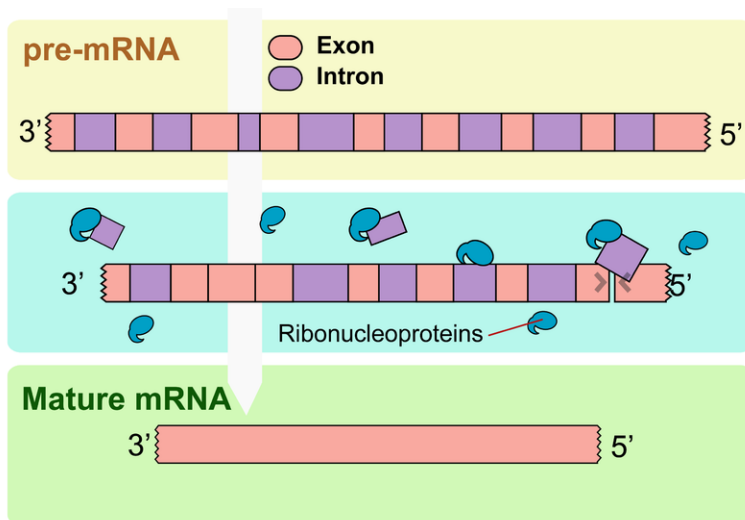
**FIGURE 1.2**

Steps of Transcription. Transcription occurs in the three steps - initiation, elongation, and termination - shown here.

- **Splicing** removes **introns** from mRNA (see **Figure 1.3**). Introns are regions that do not code for proteins. The remaining mRNA consists only of regions that do code for proteins, which are called **exons**. You can watch a video showing splicing in more detail at this link: <http://vcell.ndsu.edu/animations/mrnasplicing/movie-flash.htm>. Ribonucleoproteins are nucleoproteins that contains RNA. Small nuclear ribonucleoproteins are involved in pre-mRNA splicing.
- **Editing** changes some of the nucleotides in mRNA. For example, the human protein called APOB, which helps transport lipids in the blood, has two different forms because of editing. One form is smaller than the other because editing adds a premature stop signal in the mRNA.
- **Polyadenylation** adds a "tail" to the mRNA. The tail consists of a string of As (adenine bases). It signals the end of mRNA. It is also involved in exporting mRNA from the nucleus. In addition, the tail protects mRNA from enzymes that might break it down.

Summary

- Transcription is the DNA → RNA part of the central dogma of molecular biology.
- Transcription occurs in the nucleus.
- During transcription, a copy of mRNA is made that is complementary to a strand of DNA. In eukaryotes, mRNA may be modified before it leaves the nucleus.

**FIGURE 1.3**

Splicing. Splicing removes introns from mRNA. UTR is an untranslated region of the mRNA.

Explore More

Explore More I

Use this resource to answer the questions that follow.

- **Transcription** at <http://www.ndsu.edu/pubweb/~mcclean/plsc731/transcript/transcript1.htm> .
1. What is transcription?
 2. Describe the three stages of transcription.
 3. What is a transcription factor?
 4. What is a promoter?

Explore More II

- **Protein Synthesis** at <http://www.wisc-online.com/Objects/ViewObject.aspx?ID=AP1302>
- **DNA Transcription** at <http://johnkyrk.com/DNAtranscription.html>
- **How Do Cells Make Proteins?** at <http://ca.pbslearningmedia.org/content/lps07.sci.life.stru.lpbiosystems/#content/4dd2fb6badd2c73bce006585>
- **What is a Gene?** at <http://learn.genetics.utah.edu/content/begin/dna/>
- **Transcribe and Translate a Gene** at <http://learn.genetics.utah.edu/content/begin/dna/transcribe/>

Review

1. What is protein synthesis?
2. What enzyme is involved in transcription?
3. Describe transcription.
4. Describe splicing. Distinguish introns from exons.
5. How may mRNA be modified before it leaves the nucleus?

References

1. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. [Overview of transcription of DNA to mRNA](#) . CC BY-NC 3.0
2. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. [Steps of transcription: initiation, elongation, termination](#) . CC BY-NC 3.0
3. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. [Splicing introns from mRNA](#) . CC BY-NC 3.0