Transcription Study Guide

This study guide is a written version of the material you have seen presented in the transcription unit.

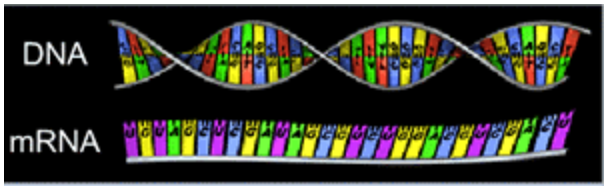
The cell's DNA contains the instructions for carrying out the work of the cell. These instructions are used by the cell's protein-making machinery to create proteins. If the cell's DNA were directly read by the protein-making machinery, however, it could be damaged and the process would be slow and cumbersome.

The cell avoids this problem by copying genetic information from its DNA into an intermediate called messenger RNA (mRNA). It is this mRNA that is read by the cell's protein-making machinery. This process is called transcription.

Components

In this section you will be introduced to the components involved in the process of RNA synthesis, called transcription. This process requires an enzyme that uses many nucleotide bases to copy the instructions present in DNA into an intermediate messenger RNA molecule.

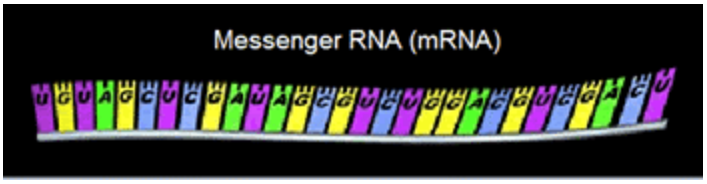
RNA



What is RNA?

- Like DNA, RNA is a polymer made up of nucleotides.
- Unlike DNA, which is composed of two strands of nucleotides twisted together, RNA is single-stranded. It can also sometimes fold into complex three-dimensional structures.
- RNA contains the same nucleotides as DNA, with the substitution of uraciluridine (U) for thymidine (T).
- RNA is chemically different from DNA so that the cell can easily tell the two apart.
- In this animation, you will see one type of RNA, messenger RNA, being put together.
- There are three types of RNA: mRNA, which you will read more about; tRNA, which is used in the translation process, and rRNA, which acts as a structural element in the ribosome (a translation component).

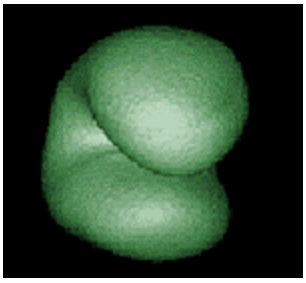
Messenger RNA (mRNA)



What is mRNA?

- mRNA acts as a messenger, conveying genetic instructions for how to assemble proteins from the cell's DNA to its protein-making machinery.
- Using mRNA for this task allows the cell to access information in discrete packets.
- Like all types of RNA, mRNA is assembled using one strand of the cell's DNA as a template.
- mRNA is made from the DNA strand that contains the gene of interest to the cell.
- mRNA contains a copy of one or a few discrete units, or genes, not the entire chromosome.
- The cell later uses this copy as a set of instructions to assemble a polypeptide chain, which is the initial step in synthesizing a protein.
- When the cell has synthesized a sufficient number of proteins, the cell disposes of the mRNA molecule. When it needs more proteins, it synthesizes new mRNA molecules.
- In the upcoming animation, you will see a chain of mRNA being assembled.

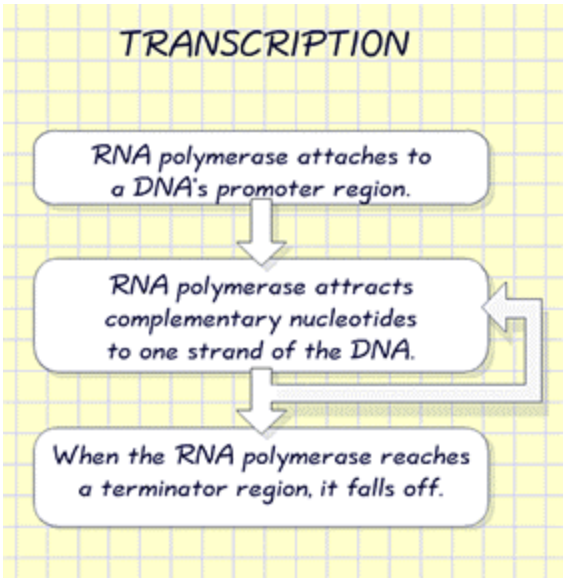
RNA polymerase



What is RNA polymerase?

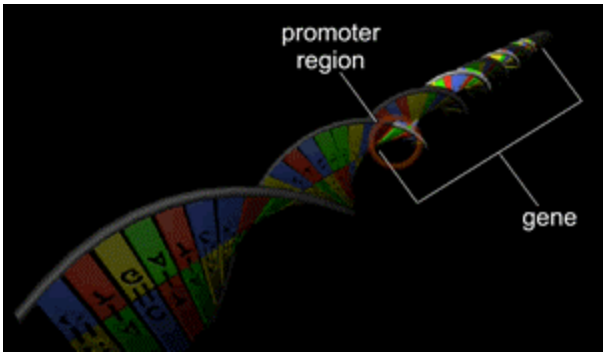
- This molecular machine is an enzyme that assembles a strand of mRNA.
- It brings together nucleotides that are complementary to one strand of DNA to create this mRNA. In this animation, you will see this process at work.

Process Flow Chart

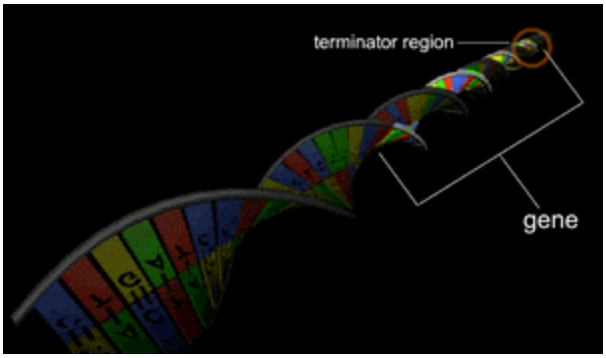


Animation script

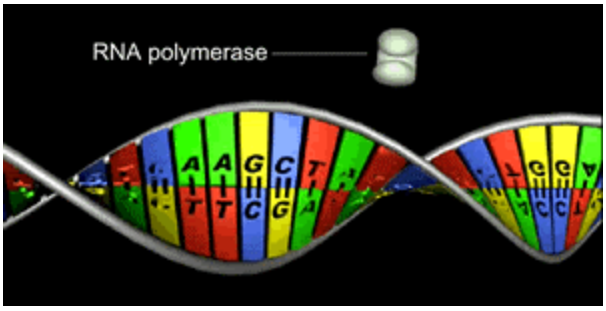
Cells need to make proteins to carry out their day-to-day activities, like processing nutrients and growing. The cell's DNA contains instructions for building these proteins, but reading those instructions directly from the DNA is cumbersome and could damage the DNA. The cell therefore copies information from its DNA into a temporary intermediate, called messenger RNA, or mRNA, a molecule made up of a long sequence of nucleotides. The cell's protein-producing machinery reads this intermediary molecule.



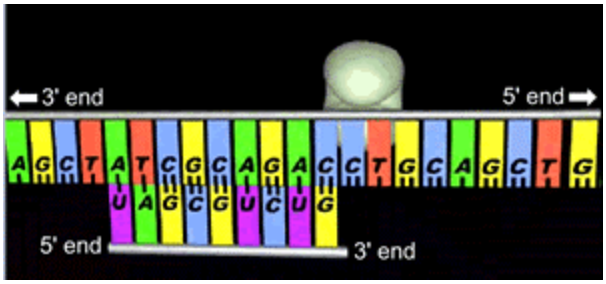
Only certain segments of DNA, called genes, contain information about proteins. These genes can be located on either strand. The cell creates mRNA copies of just these parts of the DNA. Sequences of nucleotides called promoter regions signal where the cell should begin copying…



...and other sequences, called terminator regions, tell the cell where to stop copying.

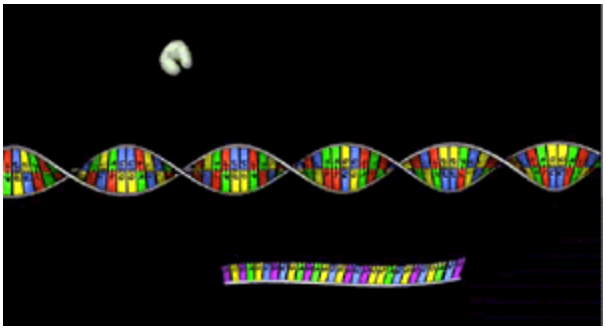


RNA polymerase, an enzyme in the cell, is responsible for creating mRNA from the correct gene. RNA polymerase is similar to DNA polymerase, but it makes an RNA strand rather than a DNA strand. RNA polymerase attaches to the promoter region of a DNA helix.



It attracts nucleotides that complement those on the DNA strand containing the gene of interest. RNA polymerase copies one strand of DNA to create a lengthening piece of single-stranded mRNA. RNA polymerase creates the mRNA strand in what is called the 5' to 3' direction.

Instead of pairing adenosine with thymidine, however, RNA polymerase pairs adenosine with uridine, a nucleotide specific to RNA.



RNA polymerase continues transcribing the gene until it reaches a terminator region. All of the components separate, and RNA polymerase is free to find another gene in need of copying. The newly created mRNA is read by the cell's protein-producing machinery, which generates the proteins important to the cell's function. In the upcoming section on translation, you will find out how this protein-making process works.

Glossary of terms

adenosine - one of the nucleotide bases in which cells store their genetic code. Adenosine bonds with thymidine in DNA and uridine in RNA.

complementary - matching, such as between pairs of nucleotides in a DNA molecule

cytidine - one of the nucleotide bases in which cells store their genetic code. Cytidine bonds with guanosine in both DNA and RNA.

DNA - the molecule that stores and encodes an organism's genetic information. DNA is a double helix molecule made up of two twisted strands that are held together by hydrogen bonds between paired nucleotides. The two strands are chemically oriented in opposite directions.

DNA polymerase - a molecular machine that helps DNA molecules to reproduce

enzyme - a type of protein that performs cellular activities

gene - a discrete segment of a cell's DNA that codes for a specific output or trait

guanosine - one of the nucleotide bases in which cells store their genetic code. Guanosine bonds with cytidine in both DNA and RNA.

helix - a spiraling coiled shape

nucleotides - the building blocks of DNA and RNA molecules that contain the cell's genetic code. Adenosine, cytidine, guanosine, thymidine, and uridine are all nucleotides.

protein - a molecular machine that carries out vital tasks in the cell, such as providing structural support, processing nutrients, copying a cell's DNA, and regulating other cellular functions. Proteins are made of long chains of amino acids that fold into complex three-dimensional shapes. Each type protein has a unique amino acid sequence and a specific function in the cell.

RNA - A polymer made of a single strand of nucleotides. RNA contains the same nucleotides as DNA, with the substitution of uridine for thymidine.

RNA polymerase - A molecular machine that assembles a strand of RNA.

thymidine - one of the nucleotide bases in which cells store their genetic code. Thymidine is found only in DNA, where it bonds with adenosine.

transcription - The process in which a cell's DNA is copied into messenger RNA, which is then read by the cell's protein-making machinery. Transcription is a major step in the transfer of information in biology. Transcribe is the verb associated with transcription.

uridine - One of the nucleotide bases in which cells store their genetic code. Uridine is found only in RNA, where it bonds with adenosine.