14.1 RNA

The Role of RNA

Genes contain coded DNA instructions that tell cells how to build proteins.

The first step in decoding these genetic instructions is to copy part of the base sequence from DNA into RNA.

RNA, like DNA, is a nucleic acid that consists of a long chain of nucleotides.

RNA then uses the base sequence copied from DNA to direct the production of proteins.

Comparing RNA and DNA

Each nucleotide in both DNA and RNA is made up of a 5-carbon sugar, a phosphate group, and a nitrogenous base.

There are three important differences between RNA and DNA:

(1) The sugar in RNA is ribose instead of deoxyribose.

(2) RNA is generally single-stranded and not double-stranded.

(3) RNA contains uracil in place of thymine.

These chemical differences make it easy for the enzymes in the cell to tell DNA and RNA apart.

Comparing RNA and DNA

The roles played by DNA and RNA are similar to the master plans and blueprints used by builders.

Comparing RNA and DNA

A master plan has all the information needed to construct a building. Builders never bring a valuable master plan to the building site, where it might be damaged or lost. Instead, they prepare inexpensive, disposable copies of the master plan called blueprints.

Comparing RNA and DNA

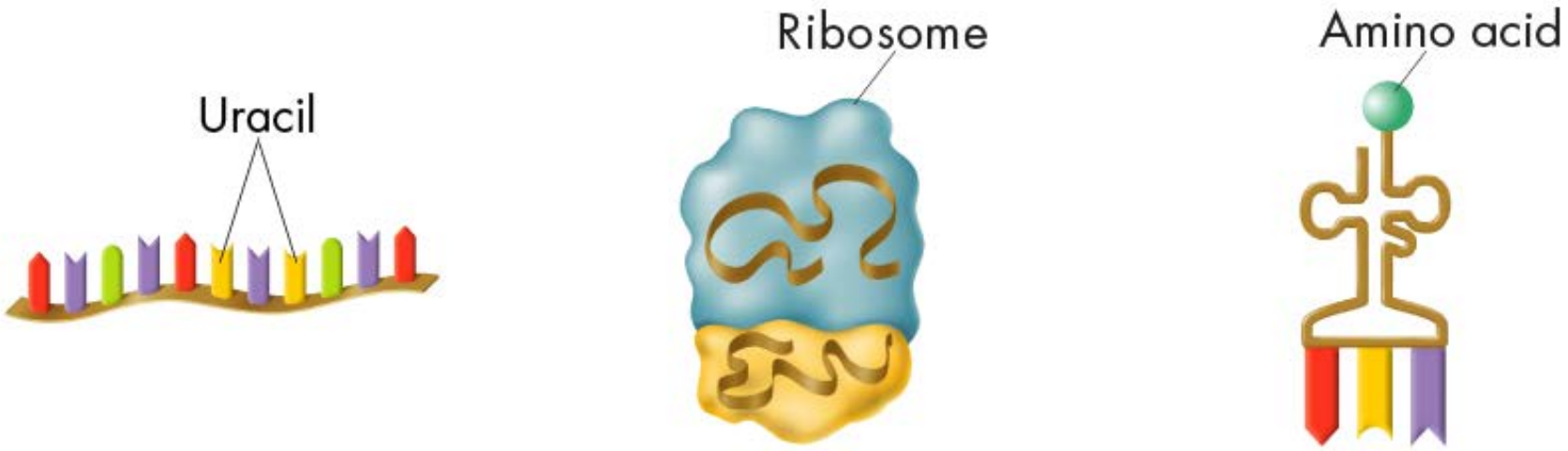
Similarly, the cell uses DNA “master plan” to prepare RNA “blueprints.”

The DNA molecule stays safely in the cell’s nucleus, while RNA molecules go to the protein-building sites in the cytoplasm—the ribosomes.

You can think of an RNA molecule, as a disposable copy of a segment of DNA, a working copy of a single gene

Functions of RNA

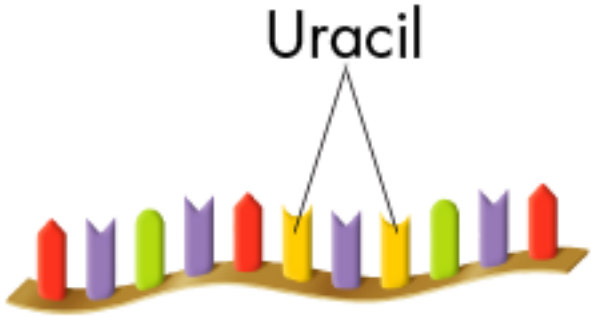
The three main types of RNA are messenger RNA, ribosomal RNA, and transfer RNA.



Messenger RNA

Most genes contain instructions for assembling amino acids into proteins.

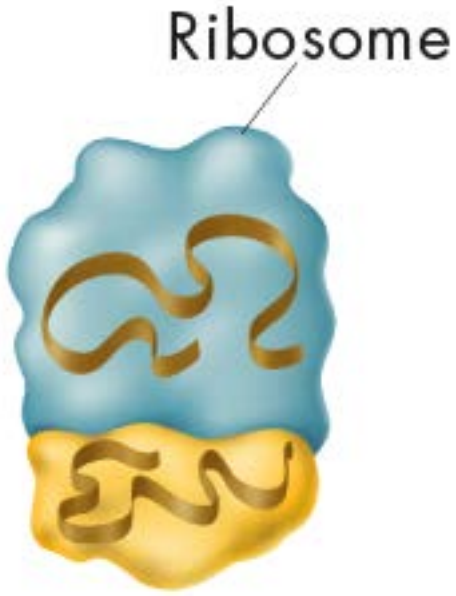
The RNA molecules that carry copies of these instructions are known as **messenger RNA** (mRNA): They carry information from DNA to other parts of the cell.



Ribosomal RNA

Proteins are assembled on ribosomes, small organelles composed of two subunits.

These ribosome subunits are made up of several **ribosomal RNA** (rRNA) molecules and as many as 80 different proteins.



Transfer RNA

When a protein is built, a **transfer RNA** (tRNA) molecule transfers each amino acid to the ribosome as it is specified by the coded messages in mRNA.

Transcription

Most of the work of making RNA takes place during **transcription.** During transcription, segments of DNA serve as templates to produce complementary RNA molecules.

The base sequences of the transcribed RNA complement the base sequences of the template DNA.

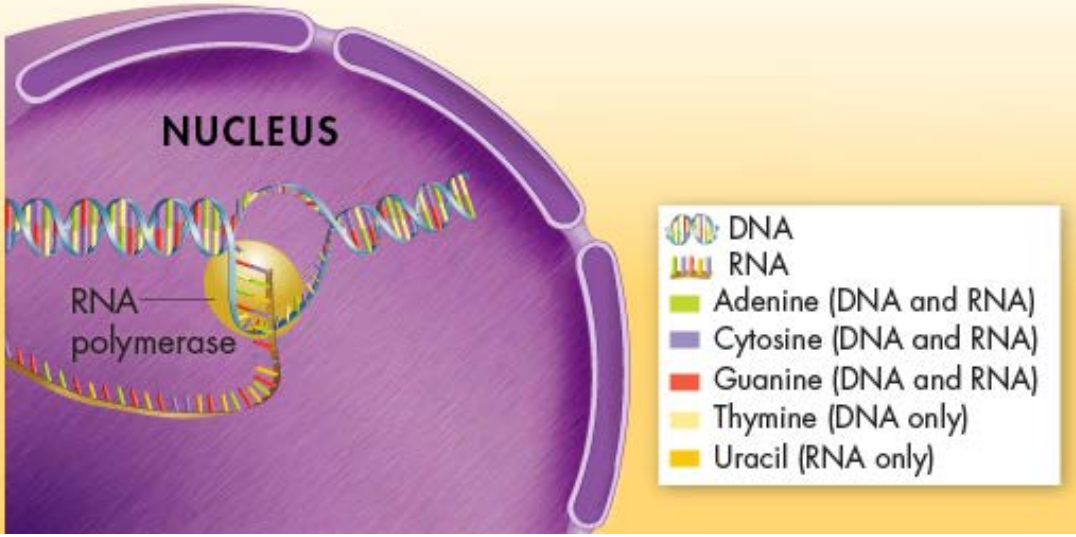
Transcription

In prokaryotes, RNA synthesis and protein synthesis take place in the cytoplasm.

In eukaryotes, RNA is produced in the cell's nucleus and then moves to the cytoplasm to play a role in the production of proteins. Our focus will be on transcription in eukaryotic cells.

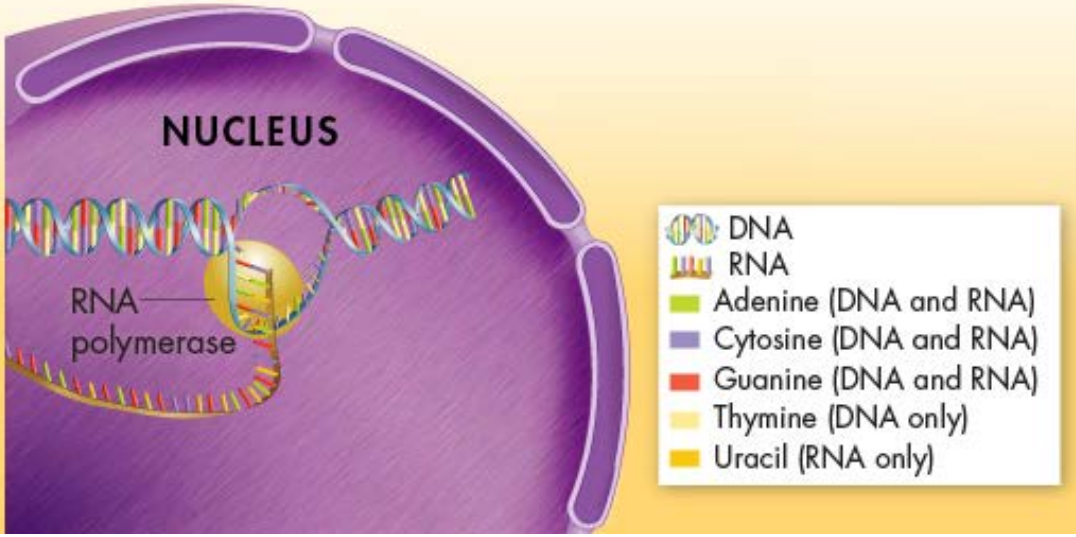
Transcription

Transcription requires an enzyme, known as **RNA polymerase**, that is similar to DNA polymerase.



Transcription

RNA polymerase binds to DNA during transcription and separates the DNA strands.



Transcription

RNA polymerase then uses one strand of DNA as a template from which to assemble nucleotides into a complementary strand of RNA.

Promoters

RNA polymerase binds only to **promoters**, regions of DNA that have specific base sequences.

Promoters are signals in the DNA molecule that show RNA polymerase exactly where to begin making RNA.

Similar signals in DNA cause transcription to stop when a new RNA molecule is completed.

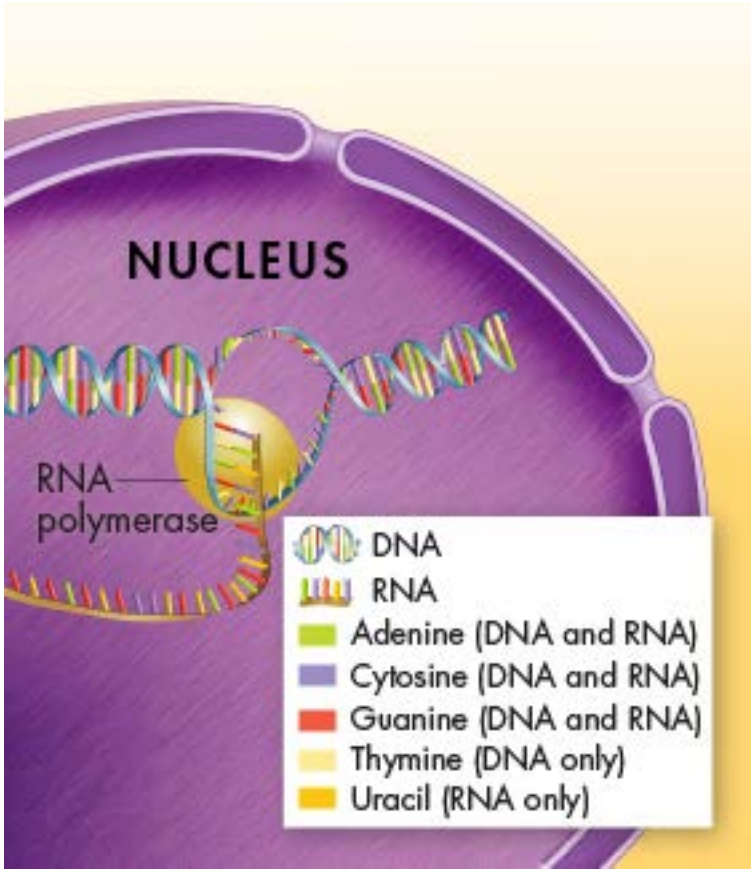
RNA Editing

RNA molecules sometimes require bits and pieces to be cut out of them before they can go into action.

The portions that are cut out and discarded are called **introns.**

In eukaryotes, introns are taken out of pre-mRNA molecules while they are still in the nucleus.

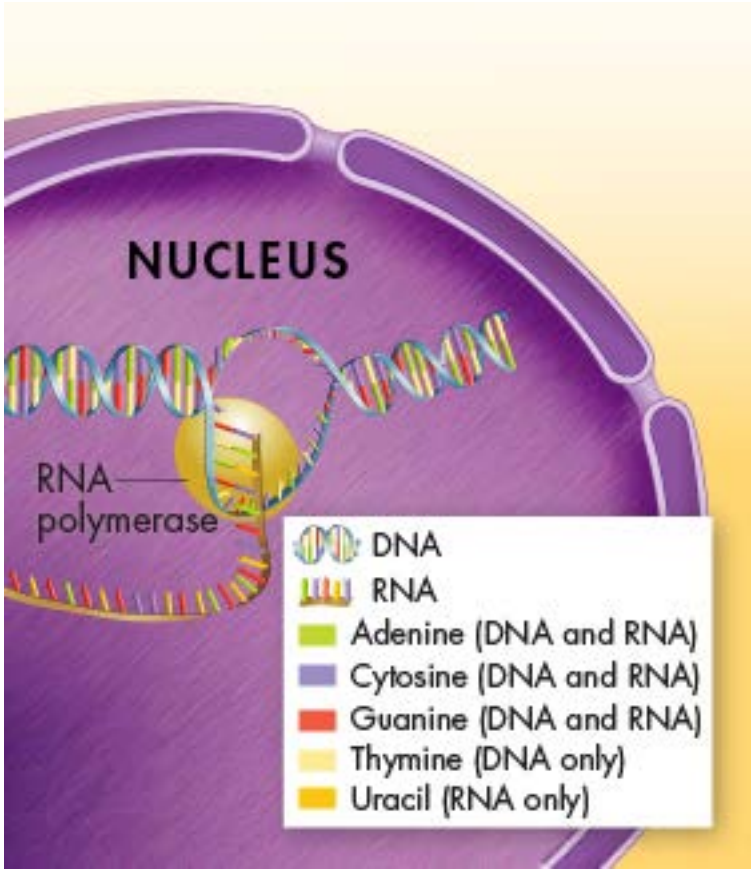
The remaining pieces, known as **exons**, are then spliced back together to form the final mRNA.



RNA Editing

Biologists don't have a complete answer as to why cells use energy to make a large RNA molecule and then throw parts of that molecule away.

Some pre-mRNA molecules may be cut and spliced in different ways in different tissues, making it possible for a single gene to produce several different forms of RNA.



RNA Editing

Introns and exons may also play a role in evolution, making it possible for very small changes in DNA sequences to have dramatic effects on how genes affect cellular function.