

12–3 RNA and Protein Synthesis

Genes are coded DNA instructions that control the production of proteins.

Genetic messages can be decoded by copying part of the nucleotide sequence from DNA into RNA.

RNA contains coded information for making proteins.

The Structure of RNA

RNA consists of a long chain of nucleotides.

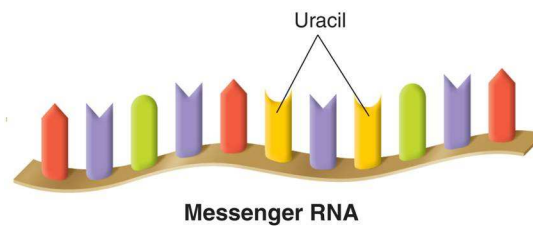
Each nucleotide is made up of a 5-carbon sugar, a phosphate group, and a nitrogenous base.

There are three main differences between RNA and DNA:

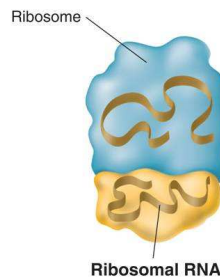
- The sugar in RNA is ribose instead of deoxyribose.
- RNA is generally single-stranded.
- RNA contains uracil in place of thymine.

There are Three Main Types of RNA:

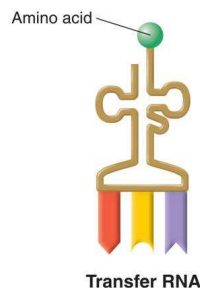
- messenger RNA
- ribosomal RNA
- transfer RNA



Messenger RNA (mRNA) carries copies of instructions for assembling amino acids into proteins.



Ribosomes are made up of proteins and **ribosomal RNA (rRNA)**.



During protein construction, **transfer RNA (tRNA)** transfers each amino acid to the ribosome.

Transcription

RNA molecules are produced by copying part of a nucleotide sequence of DNA into a complementary sequence in RNA. This process is called **transcription**.

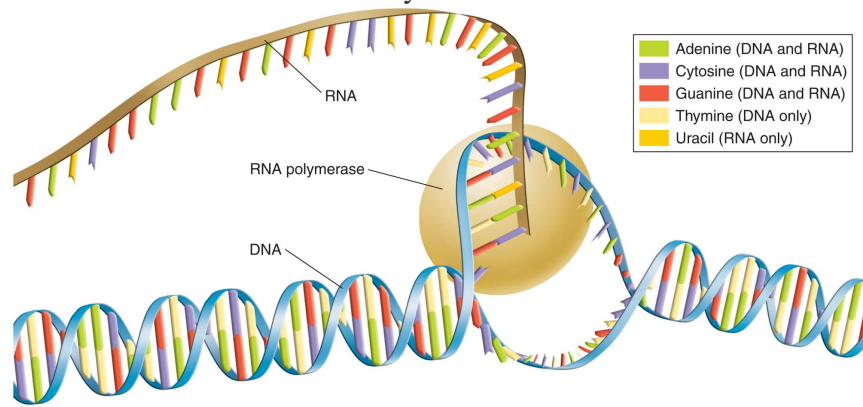
Transcription requires the enzyme **RNA polymerase**.

During transcription, RNA polymerase binds to DNA and separates the DNA strands.

RNA polymerase then uses one strand of DNA as a template from which nucleotides are assembled into a strand of RNA.

RNA polymerase binds only to regions of DNA known as **promoters**.

Promoters are signals in DNA that indicate to the enzyme where to bind to make RNA.



RNA Editing

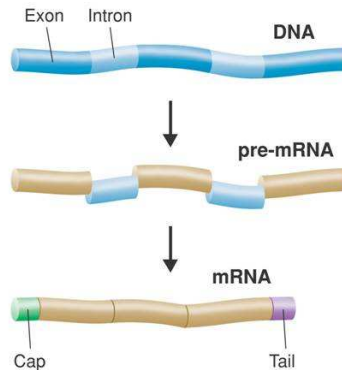
The DNA of eukaryotic genes contains sequences of nucleotides, called **introns**, that are not involved in coding for proteins.

The DNA sequences that code for proteins are called **exons**.

When RNA molecules are formed, introns and exons are copied from DNA.

The introns are cut out of RNA molecules.

The exons are spliced together to form mRNA.

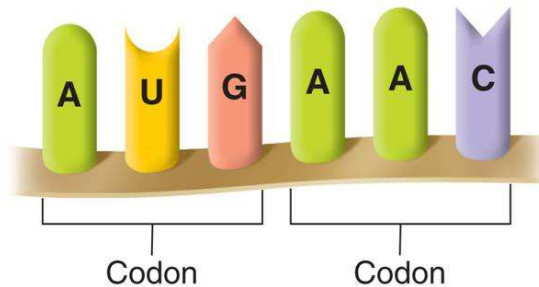


The Genetic Code

The genetic code is the “language” of mRNA instructions.

The code is written using four “letters” (the bases: A, U, C, and G).

A **codon** consists of three consecutive nucleotides on mRNA that specify a particular amino acid.



Each codon specifies a particular amino acid that is to be placed on the polypeptide chain.

Some amino acids can be specified by more than one codon.

There is one codon AUG that can either specify the amino acid methionine or serve as a “start” codon for protein synthesis.

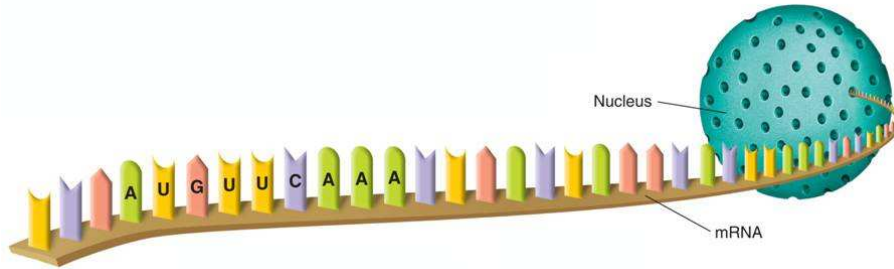
There are three “stop” codons that do not code for any amino acid. These “stop” codons signify the end of a polypeptide.

Translation

Translation is the decoding of an mRNA message into a polypeptide chain (protein). Translation takes place on ribosomes.

During translation, the cell uses information from messenger RNA to produce proteins.

Messenger RNA is transcribed in the nucleus, and then enters the cytoplasm where it attaches to a ribosome.



Translation begins when an mRNA molecule attaches to a ribosome.

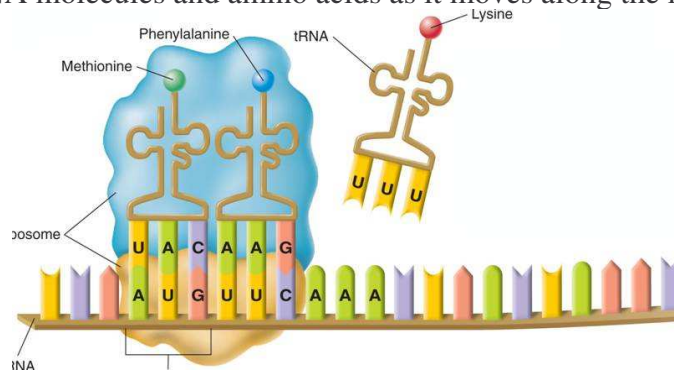
As each codon of the mRNA molecule moves through the ribosome, the proper amino acid is brought into the ribosome by tRNA. In the ribosome, the amino acid is bonded to the growing polypeptide chain through peptide bonds. The process is called “elongation”.

Each tRNA molecule carries only one kind of amino acid.

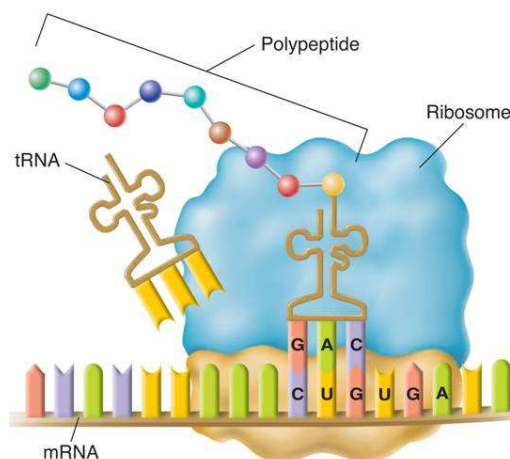
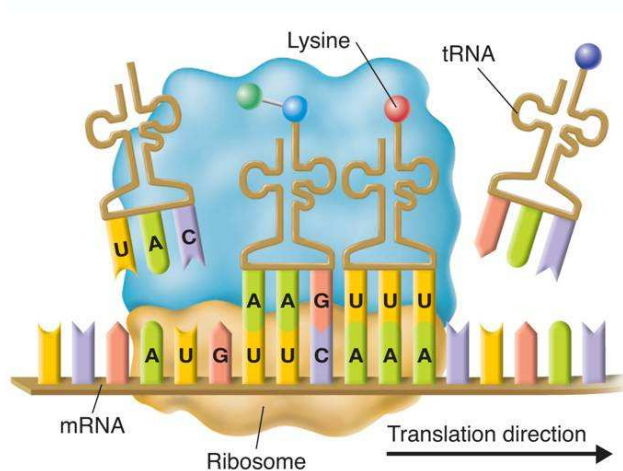
In addition to an amino acid, each tRNA molecule has three unpaired bases.

These bases, called the **anticodon**, are complementary to one mRNA codon.

The ribosome binds new tRNA molecules and amino acids as it moves along the mRNA.



Protein Synthesis



The process continues until the ribosome reaches a stop codon.

The Roles of RNA and DNA

The cell uses the DNA “master plan” to prepare RNA “blueprints.” The DNA stays in the nucleus. The RNA molecules go to the protein building sites in the cytoplasm—the ribosomes.

Genes and Proteins

Genes contain instructions for assembling proteins.

Many proteins are enzymes, which catalyze and regulate chemical reactions.

Proteins are each specifically designed to build or operate a component of a living cell.

The sequence of bases in DNA is used as a template for mRNA.

The codons of mRNA specify the sequence of amino acids in a protein.

