

# Molecular Genetics

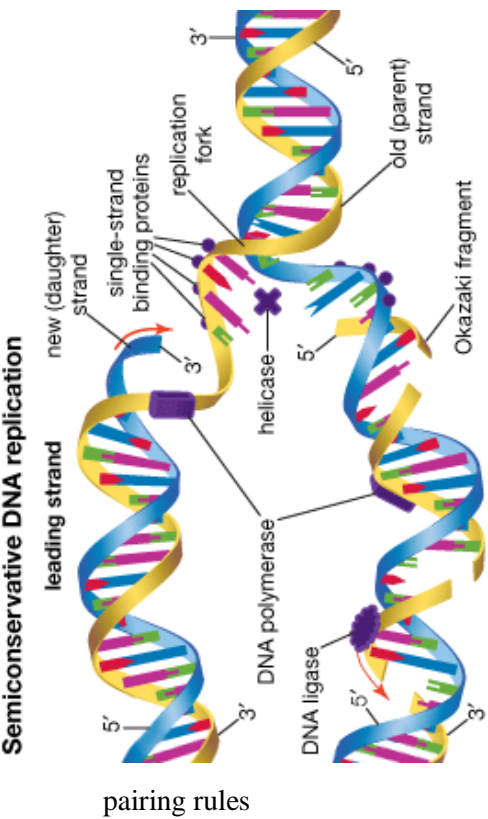
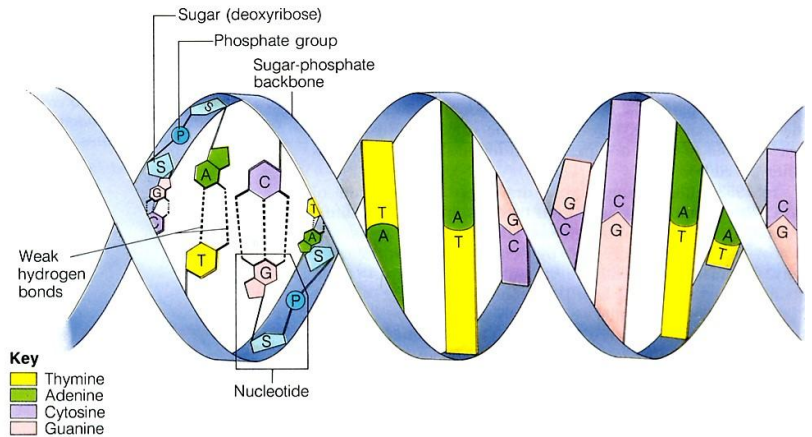
**Nucleic Acids** A biological macromolecule (DNA or RNA) composed of the elements C, H, N, O, and P that carries genetic information

## DNA Structure

**Deoxyribonucleic Acid (DNA)** A biological macromolecule that encodes the genetic information for living organisms and is capable of self-replication and the synthesis of ribonucleic acid (RNA).

Note that the monomers/building blocks of DNA are called nucleotides. Each nucleotide contains three parts

- Sugar (deoxyribose)
- Phosphate group
- Nitrogenous base (4 kinds)



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## DNA Replication

-The process in which DNA makes a duplicate copy of itself.  
**Semiconservative Replication** The process in which the DNA molecule uncoils and separates into two strands. Each original strand becomes a template on which a new strand is constructed, resulting in two DNA molecules identical to the original DNA molecule.

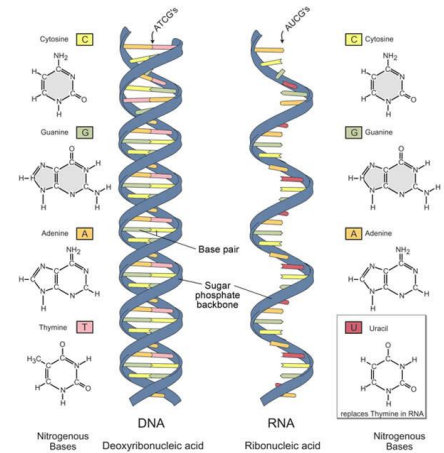
To pass on the genetic code, DNA must be copied inside of cells. In eukaryotic cells, this takes place inside of the nucleus, which stores the cell's DNA. In prokaryotes, the process of copying DNA occurs in the cytoplasm.

1. Helicase breaks the hydrogen bonds separating and unwinding the double helix
2. An enzyme (DNA polymerase) comes in and adds new bases to the open strand in the 5' to 3' direction.

Base pairing rules: Adenine pairs with Thymine (A-T) and Cytosine pairs with Guanine (G-C)

Two identical strands of DNA are formed.

These strands are said to be complementary to each other because they follow the base pairing rules

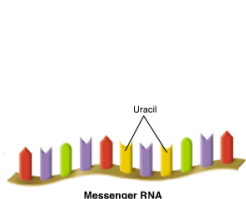


## RNA Structure

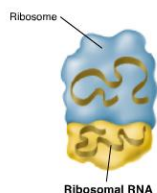
Ribonucleic acid (RNA) versus DNA.

	Deoxyribonucleic acid (DNA)	Ribonucleic acid (RNA)
Number of strands	2	1
Sugar	Deoxyribose	Ribose
Base pairs	A-T G-C	A-U G-C

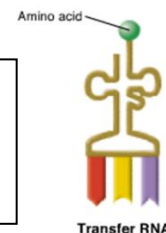
In addition to those differences, there are three different types of RNA.



**Messenger RNA (mRNA)** carries the message from DNA to the ribosome to make proteins



**Ribosomal rna (rRNA)** part of the ribosome and the site of protein synthesis



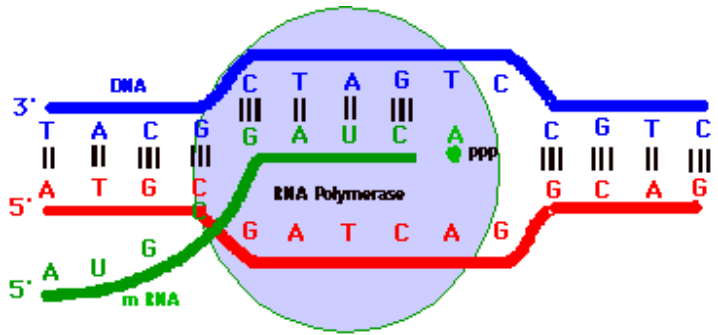
**Transfer RNA (tRNA)** brings the amino acids to the ribosome for protein synthesis

# Protein Synthesis and Gene Expression

The process in which amino acids are arranged in a linear sequence through the processes of transcription of DNA and to RNA and the translation of RNA to a polypeptide chain or the process in which a nucleotide sequence of a gene is used to make a functional product such as protein or RNA.

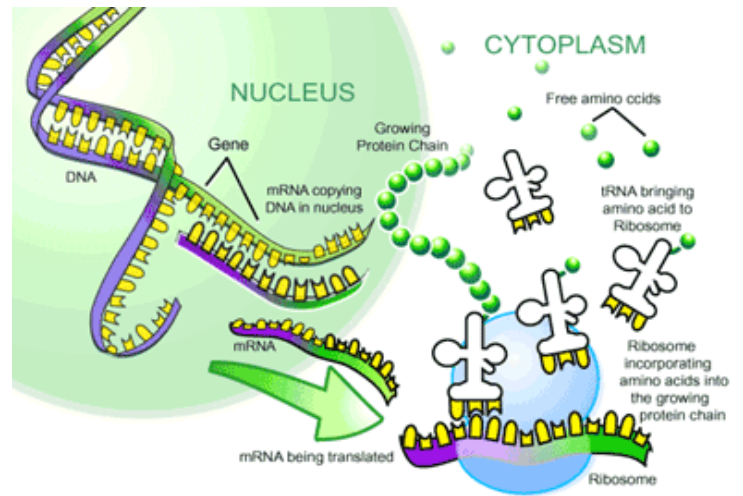
## Transcription

In the nucleus of eukaryotes a strand of messenger RNA (mRNA) is synthesized by using the genetic information found on a strand DNA as a template. The double-stranded molecule of DNA separates along the hydrogen bonds. An enzyme called RNA polymerase adds in corresponding base pairs (A-U and G-C).



## Translation

This process occurs in the cytoplasm where messenger RNA (mRNA) molecule on a ribosome is decoded to produce a sequence of amino acids for protein synthesis. mRNA is read by the ribosome in groups of three letters (codons). Each 3-letter portion of mRNA (codon) codes for a specific amino acid. These codes match up to the anticodons on the bottom of the tRNA molecules. The corresponding tRNA molecule brings in the correct amino acid (20 amino acids) (building block of proteins). The ribosome joins the amino acids together to make a protein.



## Chromosomal and Genetic Mutations

A mutation is any permanent transmissible change of genetic material. Many different types of mutations can occur. They can either affect a few nucleotides (point mutations) or affect large portions of DNA (chromosomal mutations). These will ultimately affect the shape and size of the protein constructed, and the appearance of the cell or organism.

**Chromosomal Mutation** A change in the structure of a chromosome (e.g., deletion, duplication, inversion, translocation, and nondisjunction)

**Nondisjunction** The process in which sister chromatids fail to separate during and after mitosis or meiosis.

**Translocation** The process in which a segment of a chromosome breaks off and attaches to another chromosome.

**Genetic Mutation** A change in the sequence of nucleotides

**Frame-shift Mutation** The addition (insertion mutation) or removal (deletion mutation) of one or more nucleotides that is not indivisible by three, therefore resulting in a completely different amino acid sequence than would be normal. The earlier in the sequence nucleotides are added or removed, the more altered the protein will be.

**Point Mutation** A single-base substitution causing the replacement of a single-base nucleotide with another nucleotide (e.g., silent mutation, in which there is no change in an amino acid; missense mutation, in which there is a different amino acid; and nonsense mutation, in which there is an insertion of a stop codon in the amino acid which stops protein synthesis).

(a) Point mutations and small deletions

Wild-type sequences	
Amino acid	N-Phe Arg Trp Ile Ala Asn-C
mRNA	5'-UUU CGA UGG AUA GCC AAU-3'
DNA	3'-AAA GCT ACC TAT CGG TTA 5'
	5'-TTT CGA TGG ATA GCC AAT 3'
<b>Missense</b>	
3'-AAT	GCT ACC TAT CGG TTA-5'
5'-TTA	CGA TGG ATA GCC AAT-3'
N-Leu	Arg Trp Ile Ala Asn-C
<b>Nonsense</b>	
3'-AAA	GCT ATC TAT CGG TTA-5'
5'-TTT	CGA TAG ATA GCC AAT-3'
N-Phe	Arg Stop
<b>Frameshift by addition</b>	
3'-AAA	GCT ACC ATA TCG GTT A-5'
5'-TTT	CGA TGG TAT AGC CAA T-3'
N-Phe	Arg Trp Tyr Ser Gln
<b>Frameshift by deletion</b>	
	GCTA
	CGAT
3'-AAA	CCT ATC GGT TA-5'
5'-TTT	GGA TAG CCA AT-3'
N-Phe	Gly Stop

(b) Chromosomal abnormalities

