

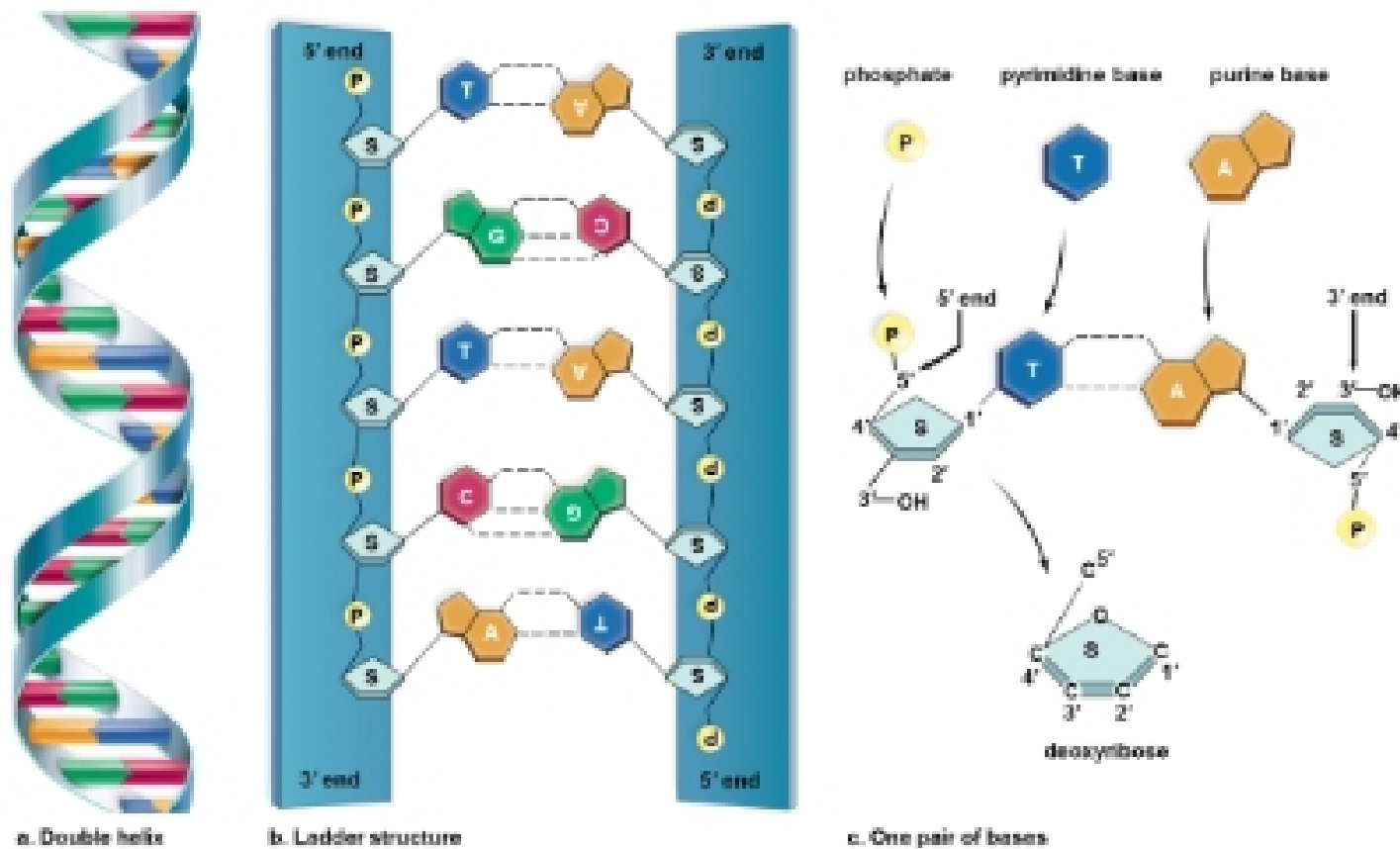
## Chapter 21: DNA Biology & Technology

What does DNA do?

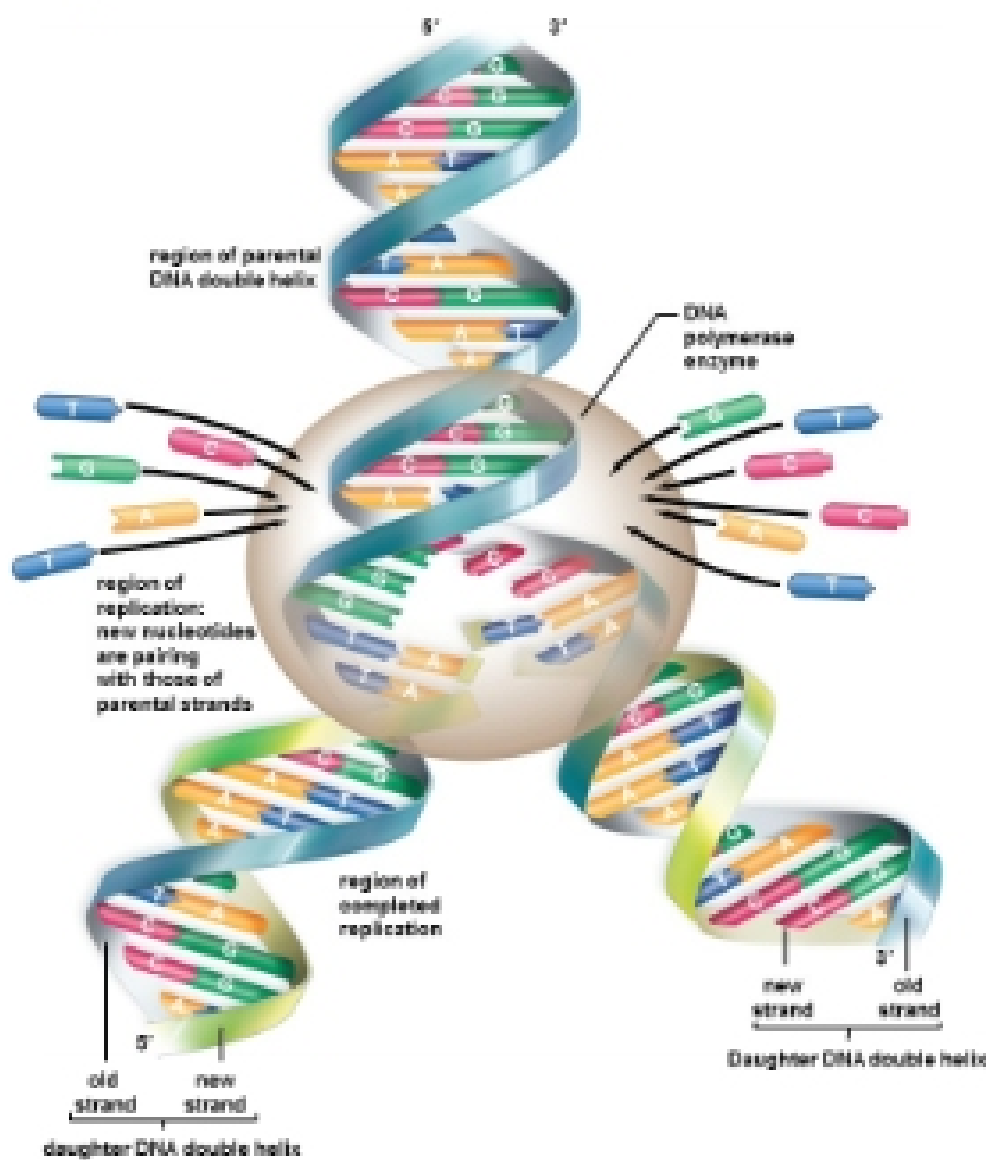
- o It replicates to be passed on to the next generation.
- o DNA stores genetic / hereditary information.
- o It undergoes mutations to provide genetic diversity. (Some mutations are good)

DNA structure: A review

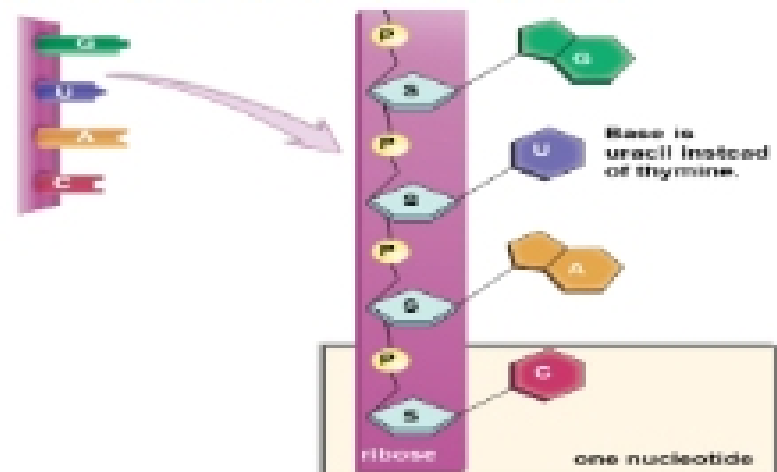
- o It is a double-stranded helix. (One DNA strands flipped (inverted) in respect to another.)
- o DNA is composed of repeating nucleotides (made of a pentose sugar, phosphate, and a nitrogenous base). (THEY ARE COMPLIMENTARY ANTIPARALLEL)
- o Sugar and phosphate make up the backbone, while the bases make up the "rungs" of the ladder.
- o Bases have complementary pairing: cytosine (C) pairs with guanine (G), and adenine (A) pairs with thymine (T).



DNA replication



- o The 2 strands unwind as the H bonds are broken by helicase enzyme.
- o Complementary nucleotides are added to each strand (5' → 3' of new strand) by DNA polymerase enzyme.
- o Each new double-stranded helix is made of 1 new strand and one old strand (semiconservative replication).
- o The sequence of bases makes each individual unique.
- o Second phase in interphase



## RNA structure and function

- o It is single-stranded.
- o It is composed of repeating ribonucleotides.
- o Ribose sugar-phosphate is the backbone.
- o Bases are A, C, G and uracil (U).

## RNA structure and function

- o 3 types of RNA
- o Messenger RNA (mRNA) carries genetic information from DNA to the ribosomes.
- o Ribosomal RNA (rRNA) joins with proteins to form ribosomes.
- o Transfer RNA (tRNA) transfers amino acids to a ribosome where they are added to a forming protein.

## Comparing DNA and RNA

### Similarities

- They are nucleic acids.
- They are made of nucleotides.
- They have sugar-phosphate backbones.
- They are found in the nucleus.

### Differences

- DNA is double-stranded while RNA is single-stranded.
- DNA has T while RNA has U.
- DNA has deoxyribonucleotides; RNA has ribonucleotides.
- RNA is also found in the cytoplasm as well as the nucleus while DNA is not.

## Proteins: A review

- o Proteins are composed of subunits called amino acids.
- o The sequence of amino acids determines the shape of the protein.
- o They are synthesized at the ribosomes.
- o Peptide bonds connect amino acids in a protein together.
- o Proteins are important for diverse functions in the body including hormones, enzymes, and transport.
- o They can denature, causing a loss of function. (When exposed to extreme conditions, high or low pressures, etc. That's why we need to maintain homeostasis)

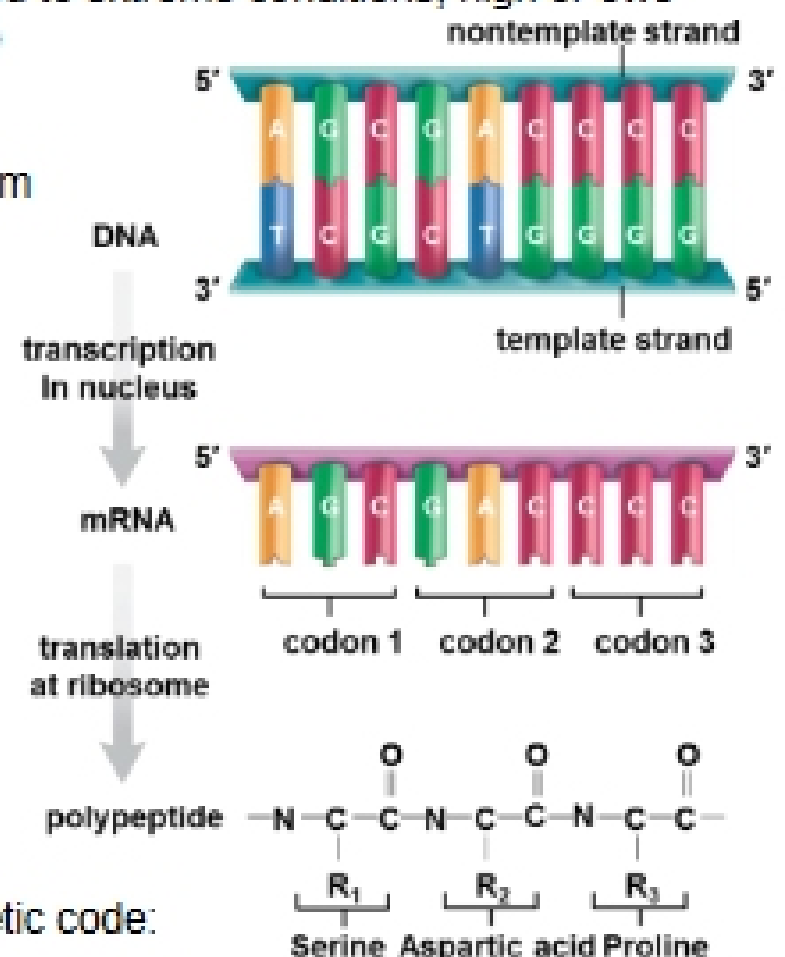
## 2 steps of gene expression

1. Transcription – DNA is read to make a mRNA in the nucleus
2. Translation – mRNA is read to make a protein in the cytoplasm

\*Combinations of condons make genetic code.

\*Codon: sequence of nucleotide \*\*\*?

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop	UGA stop	A
	UUG leucine	UCG serine	UAG stop	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG (start) methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartic acid	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartic acid	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamic acid	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamic acid	GGG glycine	G



## The genetic code:

- It is made of 4 kinds of bases.
- Bases act as a code for amino acids used in translation.
- Every 3 bases of the mRNA is called a codon; a typical codon specifies a particular amino acid in translation.

Transcription: (helicase: enzyme unwinds the double helix)

- mRNA is made from a DNA template.
- mRNA is processed before leaving the nucleus.
- mRNA moves to the ribosomes to be read.



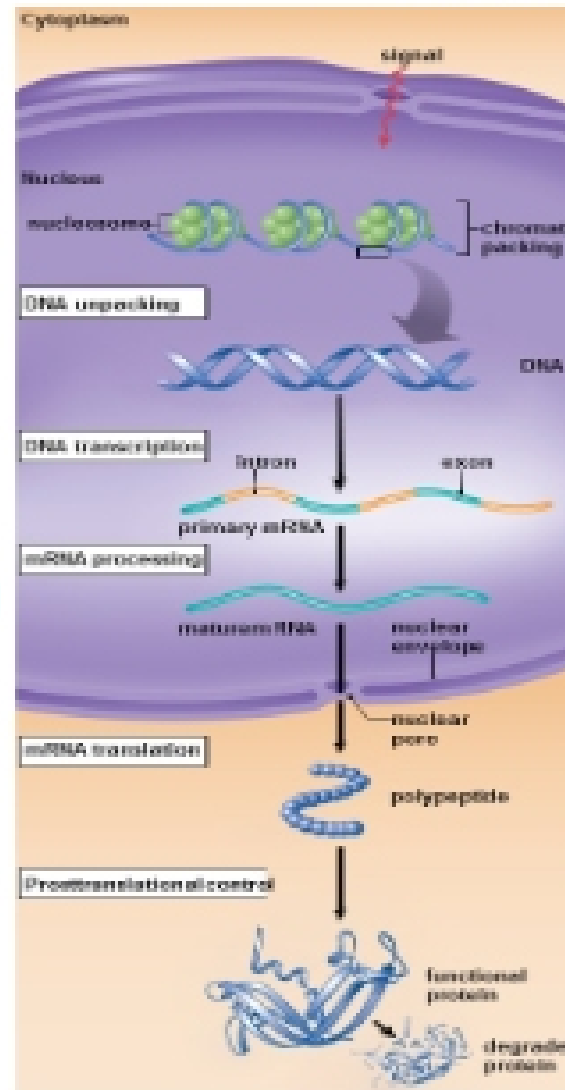
Processing of mRNA after transcriptions

- Modifications of mRNA
  - o 5'-Capping: One end (5') of the RNA is capped.
  - o Splicing: Introns (non-coding sequences) are removed.
  - o Poly-A tailing: A poly-A tail is added to 3'-end.

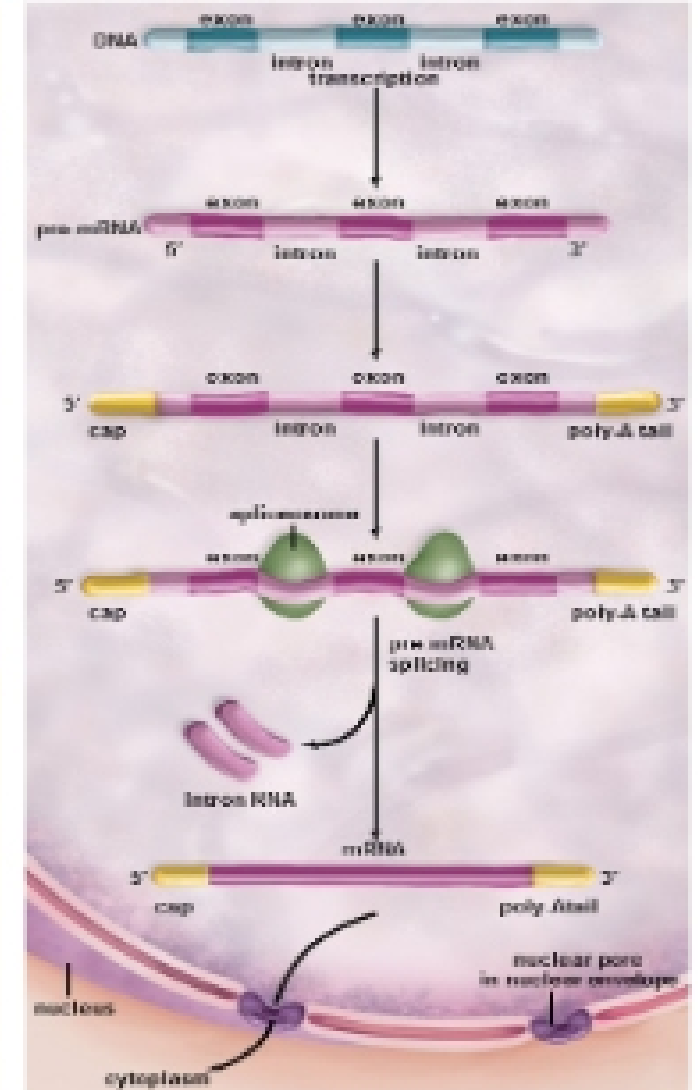
Regulation of gene expression

5 levels:

1. Pretranscriptional control (nucleus) e.g., chromatin density and DNA accessibility
2. Transcriptional control (nucleus) e.g., transcription factors
3. Post-transcriptional control (nucleus) e.g., mRNA processing
4. Translational control (cytoplasm) e.g., differential ability of mRNA to bind ribosomes
5. Posttranslational control (cytoplasm) e.g., changes to the protein to make it functional.



Processing of mRNA after transcriptions



DNA technology:

- Gene cloning through recombinant DNA: altering DNA in bacteria, virus through recombinant DNA technology. (Recombinant DNA: contains DNA from 2 or more different sources)
  - o Automated DNA sequencer and an electropherogram
    - The order of nucleotides in a DNA sequence is determined
    - Now performed using dyes attached to nucleotides, with a laser and computerized machine to determine sequence
  - o Recombinant DNA – contains DNA from 2 or more different sources that allows genes to be cloned
  - o Bacteria used to clone the human insulin gene
    - Restriction enzyme is used to cut the vector (plasmid) and the human DNA with the insulin gene.
    - DNA ligase seals together the insulin gene and the plasmid.
    - Bacterial cells take up plasmid, the gene is copied, and the product can be made.

