



LECTURE 5: DNA, RNA & PROTEINS

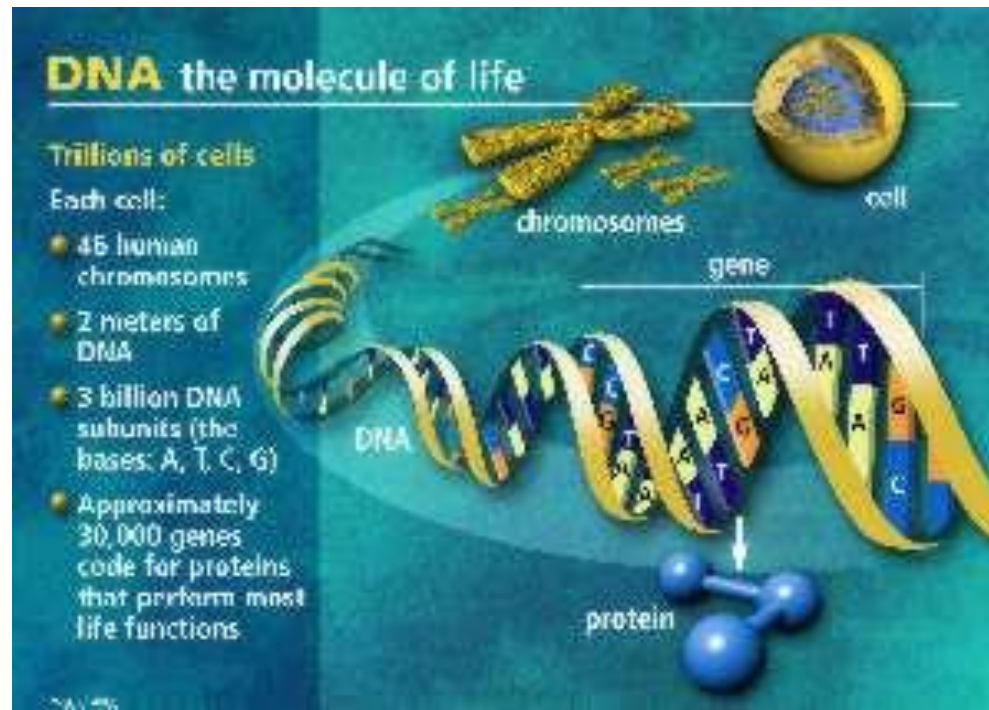
The molecules of life

Today...

- DNA structure and replication
- RNA
 - Transcription
 - Translation
- Protein synthesis
 - Amino acids

DNA

- **Deoxyribonucleic Acid (DNA)**
- is the blueprint for life:
- contains _____

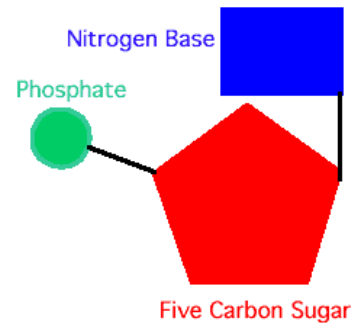


DNA structure

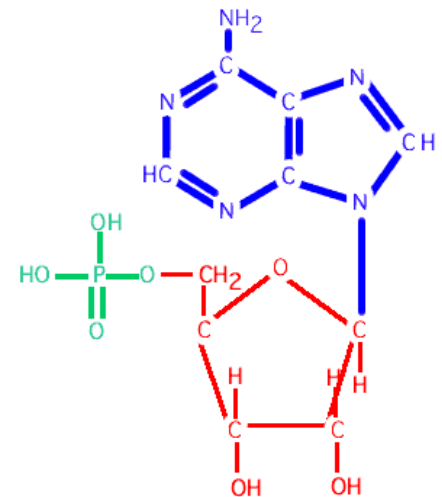
- DNA is a polymer of nucleotides

Each nucleotide composed of

Basic Nucleotide Structure



Example



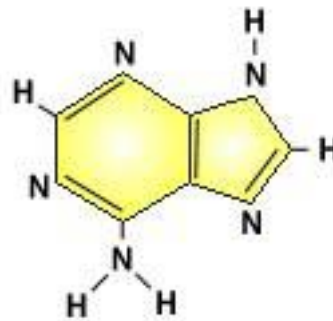
Adenosine 5' phosphoric acid

Four DNA bases

- Four kinds of nitrogenous bases:

- Purine bases

adenine



guanine



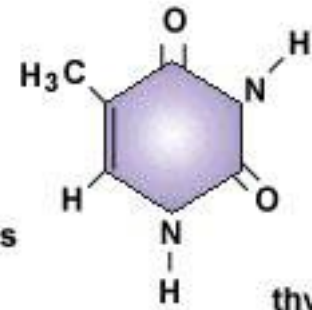
purines

- Pyrimidine bases

cytosine



pyrimidines



thymine

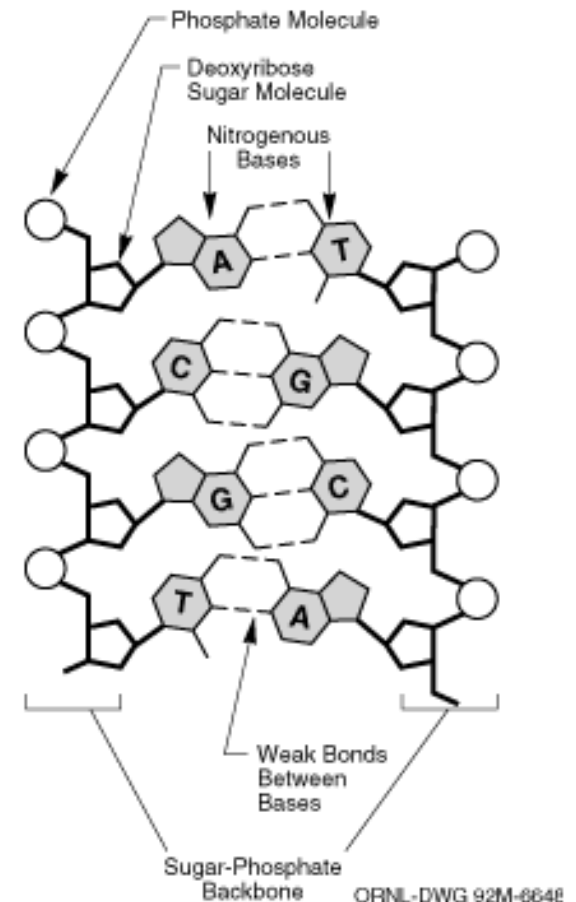
DNA: Complimentary base pairing

- Adenine pairs with _____

A =

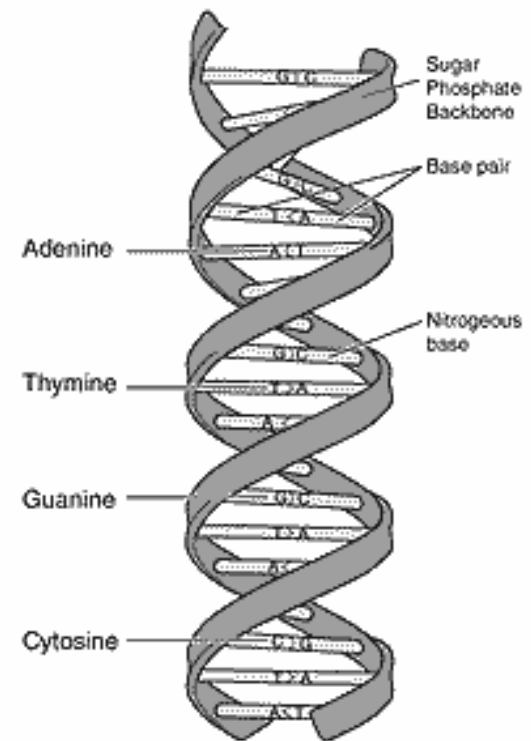
- Cytosine pairs with _____

C =



DNA STRUCTURE

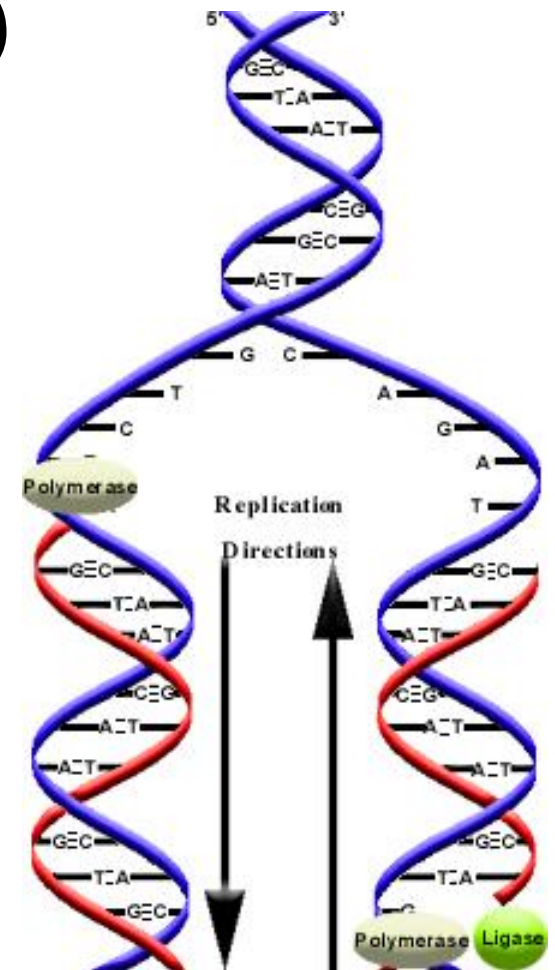
- DNA is a _____ helix
- Discovered by
Watson and Crick, 1953



DNA REPLICATION

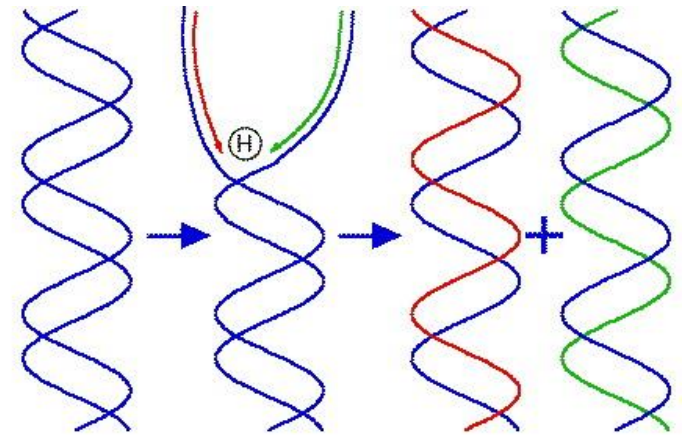
(in the nucleus)

- Each DNA strand becomes a _____, parent strand becomes apart
- Proper base-pairs are assembled on that template



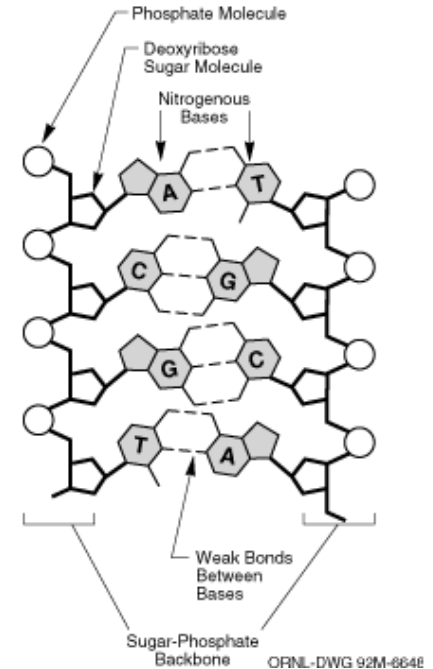
DNA replication

- Nucleotides are connected together to make a new strand that is _____ to the old strand.
- The new double strand is _____ to the old double strand
- This is called _____ replication



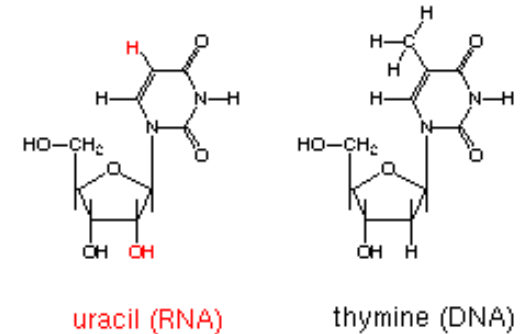
A-T vs. G-C bond

- A-T is a double bond...
- C-G is a _____ bond (stronger)...
- DNA double strand can separate into 2 single strands when heated.
- Which strand would require more heat (more energy) to separate: an A-T rich or a C-G rich double strand?



RNA structure and synthesis

- RNA: _____
- Is very similar to DNA
(repeating subunits, nucleotides).



- Difference between RNA and DNA:
Each nucleotide contains a different sugar:
_____ instead of deoxyribose.

Bases are A, G, C, and U (_____)

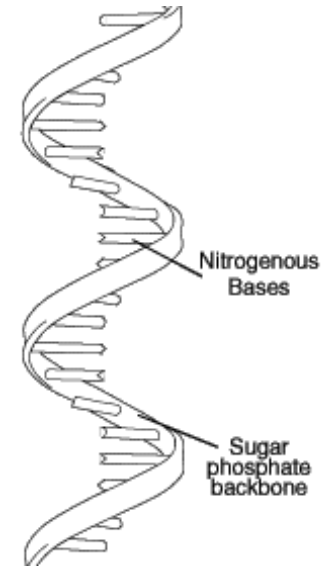
A pairs with _____; G pairs with _____

RNA

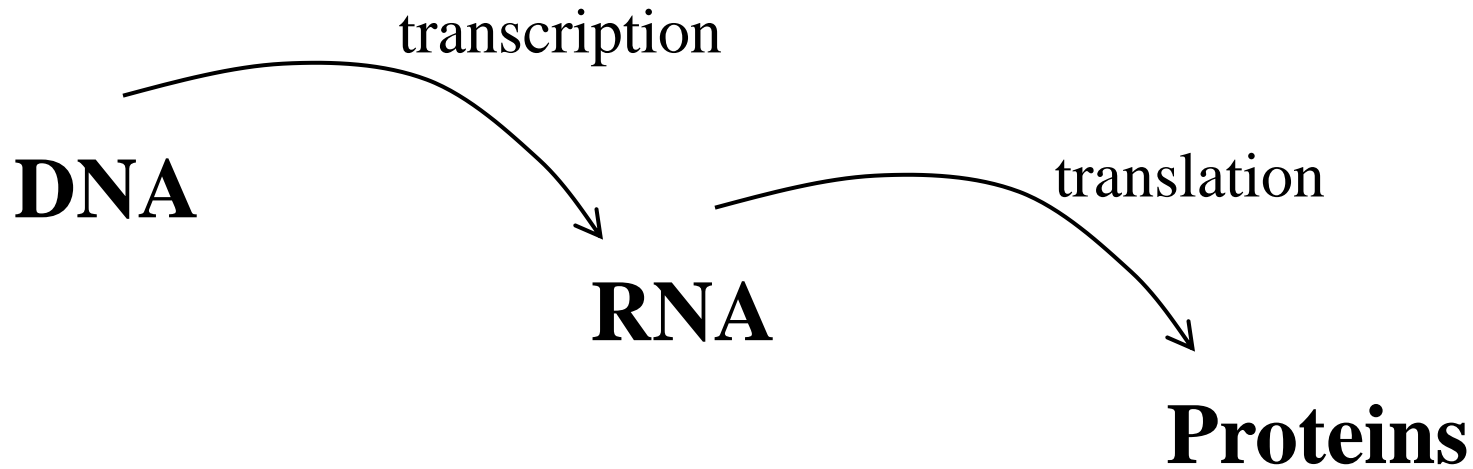
- RNA is _____ **stranded**
and shorter

- RNA is less stable than DNA:

RNA doesn't persist in the cell for long (sometimes it exists for a few seconds), whereas DNA can persist for the life of the cell.



CENTRAL DOGMA

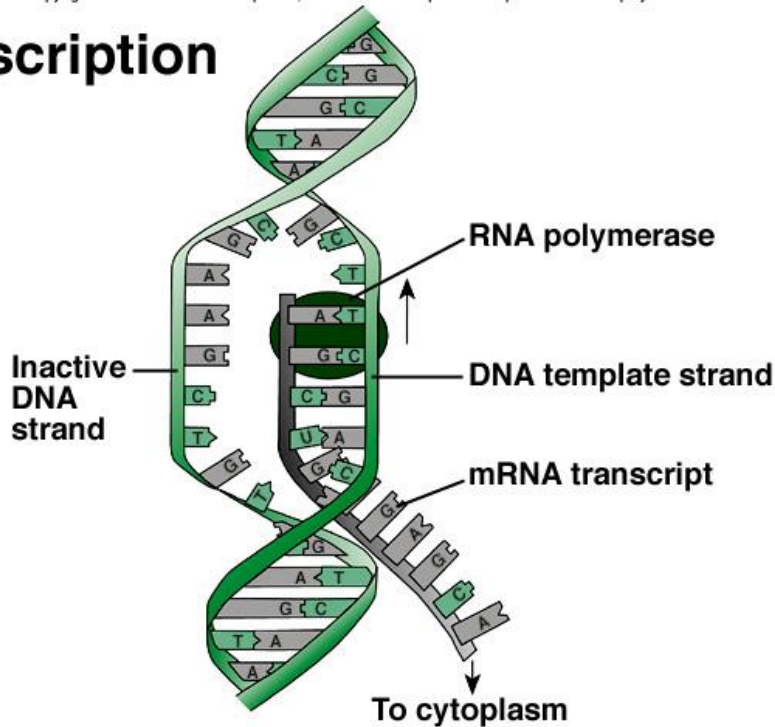


- 3 different RNA molecules involved in protein synthesis: mRNA, rRNA, _____
- TRANSCRIPTION: RNA synthesis from DNA.

Transcription: DNA → RNA

- **Transcription** occurs in the _____
- mRNA carries the message about what type of protein to make from the DNA in the nucleus to the ribosome
- The nucleotide sequences of RNA and DNA are the same (except in RNA _____ is used instead of thymine)
- mRNA is synthesized from DNA using base pairing
- DNA unwinds in a section

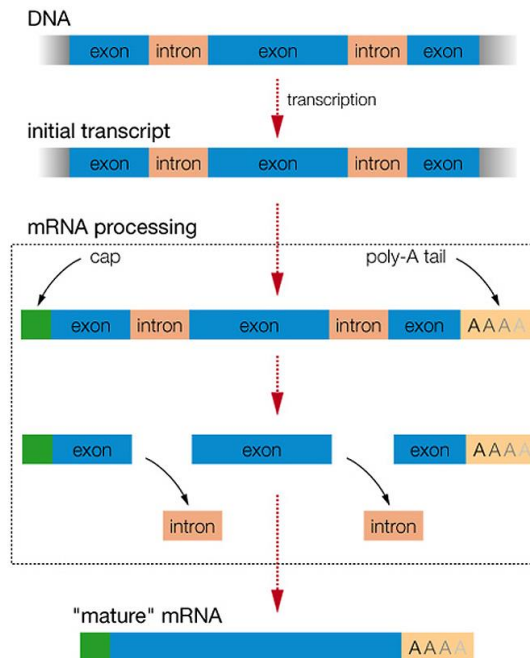
Transcription



- RNA _____ attaches at the promoter sequence of DNA, and it moves along the DNA, unzipping the strands – this allows for one mRNA molecule to be formed.
- During _____, a molecule of messenger RNA is formed as a complementary copy of a region on one strand of the DNA molecule

Transcription

- Once mRNA is formed, enzymes in the nucleus remove the
- Introns _____ and leave the
- Exons _____



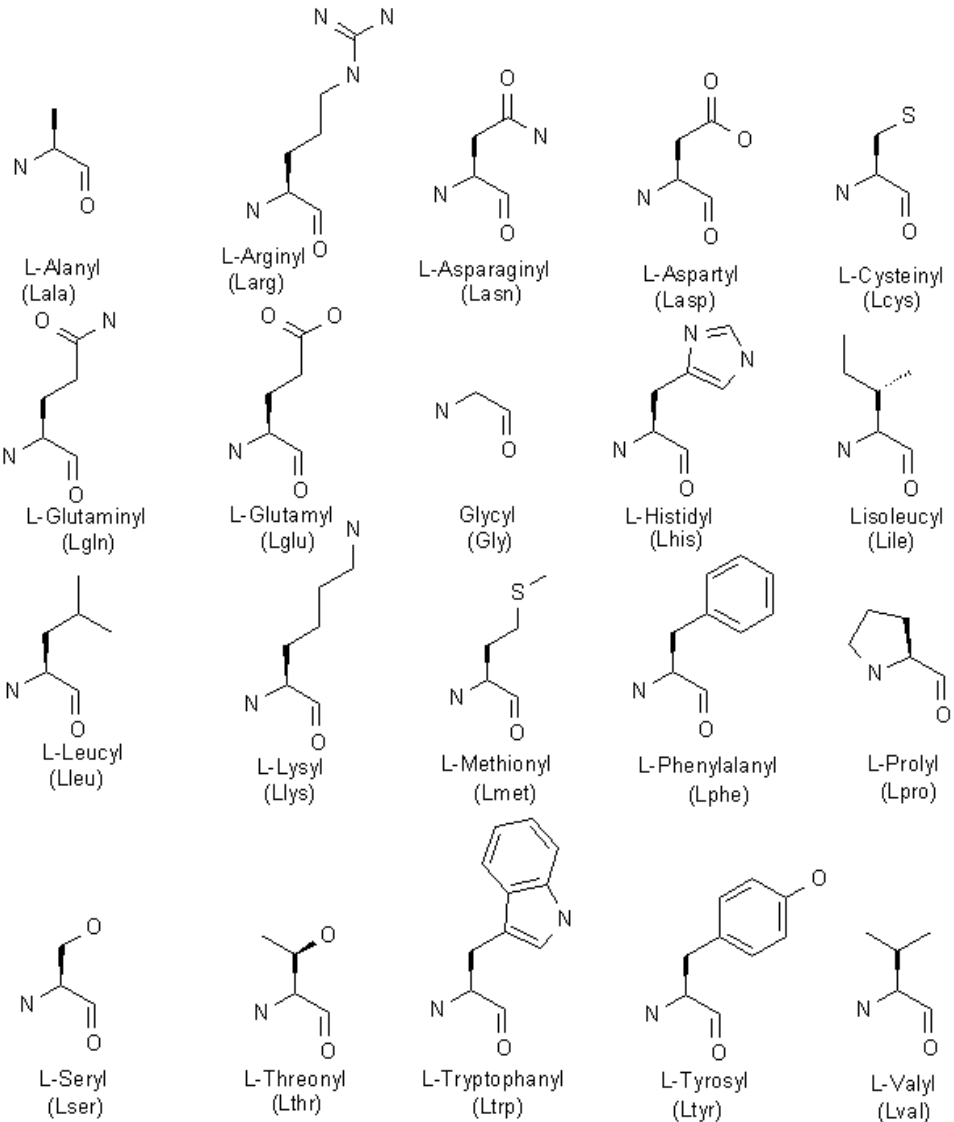
The Genetic Code

- Each 3 consecutive bases on the mRNA is a code word, codon, that specifies an amino acid.
- The genetic code consists of _____ codons,
- but only _____ code amino acids.
- Three codons act as signal **terminators**
(_____, _____, _____)
- One codon, **AUG**, codes for methionine, and is also the _____ **signal** for translation

		Second Base			
		U	C	A	G
U	UUU } Phe	UCU } Ala	UAU } Tyr	UGA } Cys	
	UUC } Phe	UCC } Ala	UAC } Tyr	UGC } Cys	
	UUA } Leu	UCA } Ala	UAA } Stop	UGA } Stop	
	UUG } Leu	UCG } Ala	UAG } Stop	UGG } Trp	
C	CUU } Leu	CCU } Pro	CAU } His	CGU } Arg	
	CUC } Leu	CCC } Pro	CAC } His	CGC } Arg	
	CUA } Leu	CCA } Pro	CAA } Gln	CGA } Arg	
	CUG } Leu	CCG } Pro	CAG } Gln	CGG } Arg	
A	AUU } Ile	ACU } Thr	AAU } Asn	AGU } Ser	
	AUC } Ile	ACC } Thr	AAC } Asn	AGC } Ser	
	AUA } Met	ACA } Thr	AAA } Lys	AGA } Arg	
	AUG } Met	ACG } Thr	AAG } Lys	AGG } Arg	
G	GUU } Val	GCU } Ser	GAU } Asp	GGU } Gly	
	GUC } Val	GCC } Ser	GAC } Asp	GGC } Gly	
	GUA } Val	GCA } Ser	GAA } Glu	GGA } Gly	
	GUG } Val	GCG } Ser	GAG } Glu	GGG } Gly	

20 Amino Acids

There are _____ amino acids – they are like the ‘bricks’, or building blocks to make all _____

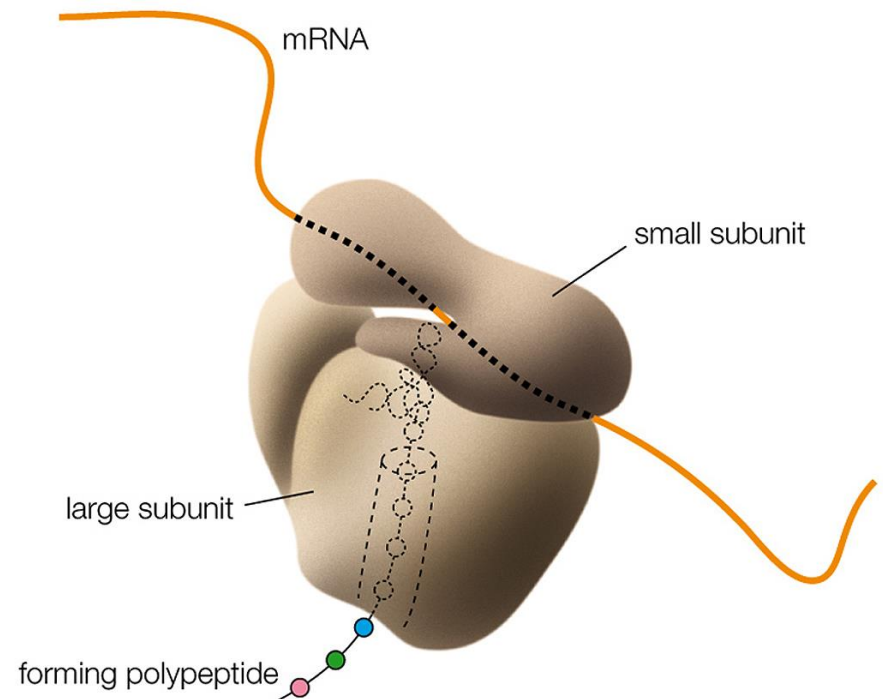


Translation: RNA → Protein

- **Translation:** synthesizing a _____ from amino acids, according to the sequences of the nucleotides in mRNA.
- Occurs at the _____, in cytoplasm of cell
- Ribosomal RNA, **rRNA**, is needed for protein synthesis – helps mRNA bind to the _____
- _____ RNA, tRNA, brings specific amino acids to the ribosome to be assembled as proteins.

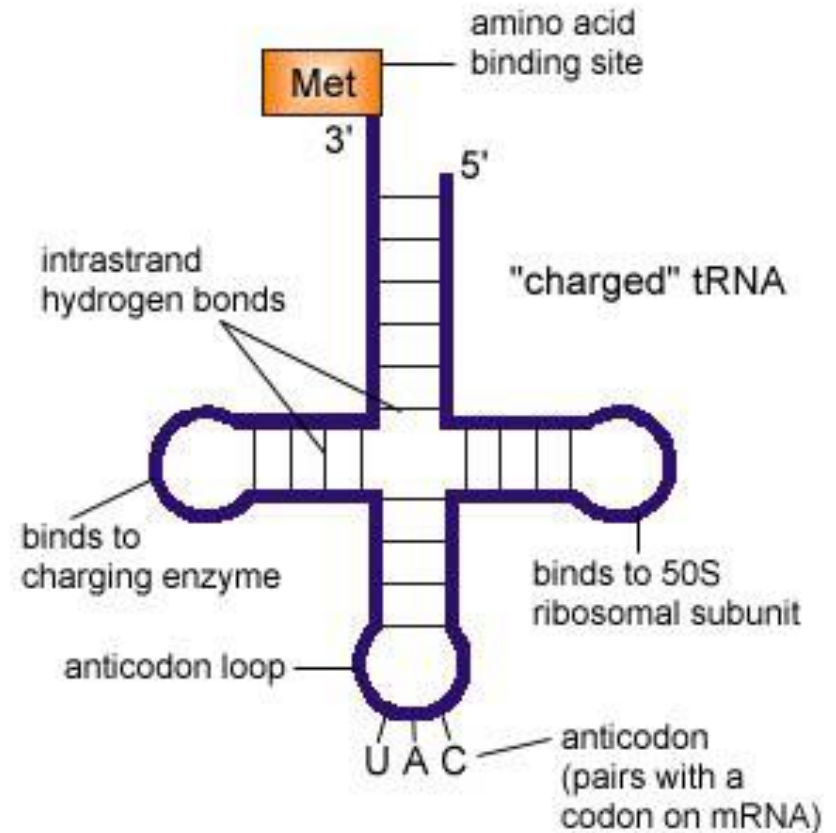
Translation

- _____ RNA, **rRNA**, joins with a number of proteins to form ribosomes
- **Ribosomes** are the sites of _____
- Ribosomes consist of a large subunit and a small subunit. mRNA binds to the _____ subunit.

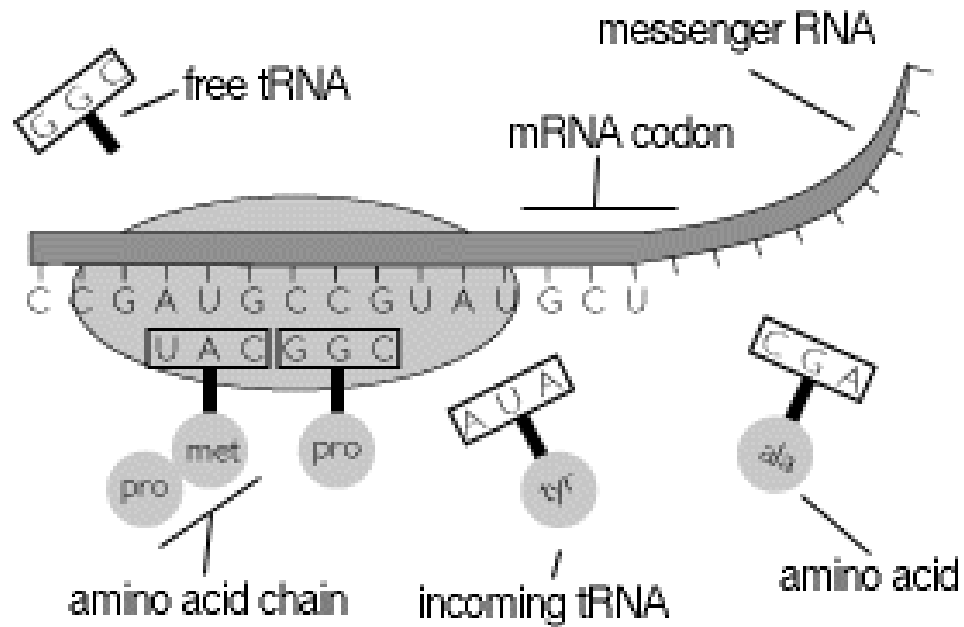


Transfer RNA (tRNA)

- Transport molecule that carries specific _____ to a ribosome (80 nucleotides long)
- Folded
- Each tRNA recognizes the correct codon on the mRNA molecule



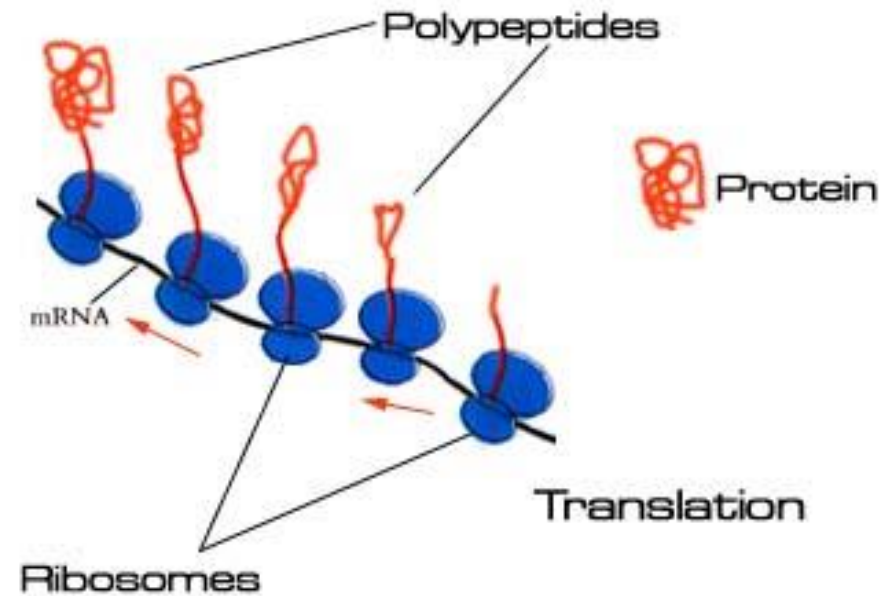
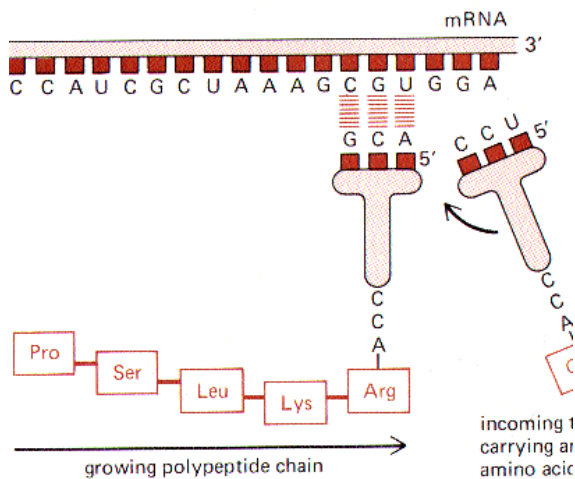
Translation



Steps in Translation

1. mRNA leaves the nucleus and migrates to ribosome
2. mRNA binds to small ribosomal subunit
3. tRNA brings an amino acid to the ribosome, where anticodon on the tRNA binds to the codon of the mRNA
4. The amino acid bonds to its adjoining amino acid to form a growing polypeptide molecule
5. The tRNA without the amino acid is released from the ribosome
6. Other tRNA's bring amino acids to the ribosome to complete the protein molecule

Protein synthesis



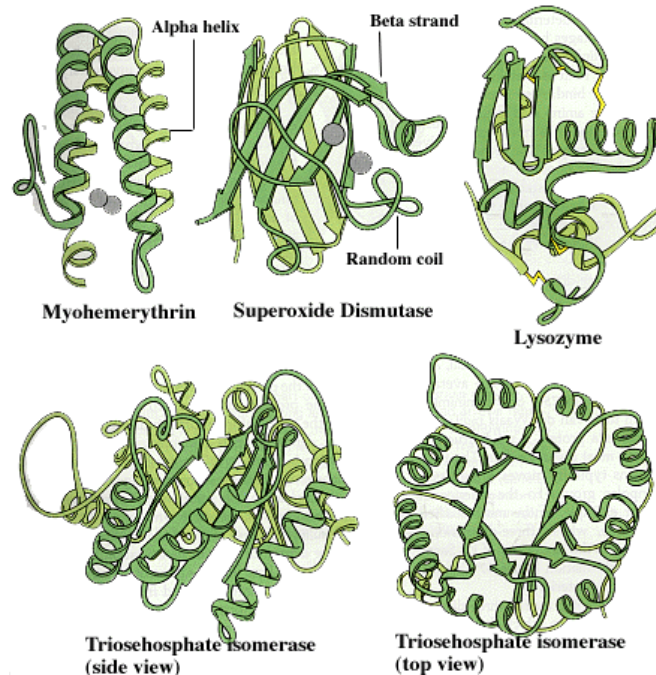
- Occurs in the cytoplasm of the cell

Protein synthesis

- **Amino acids** are the repeating sub-units of protein molecules.
- Amino acid order determines the protein
- _____ amino acids exist in all life forms
- _____ of amino acids is important, determines the 3-dimensional shape of the molecule.
- Structure of the protein determines its _____

Proteins

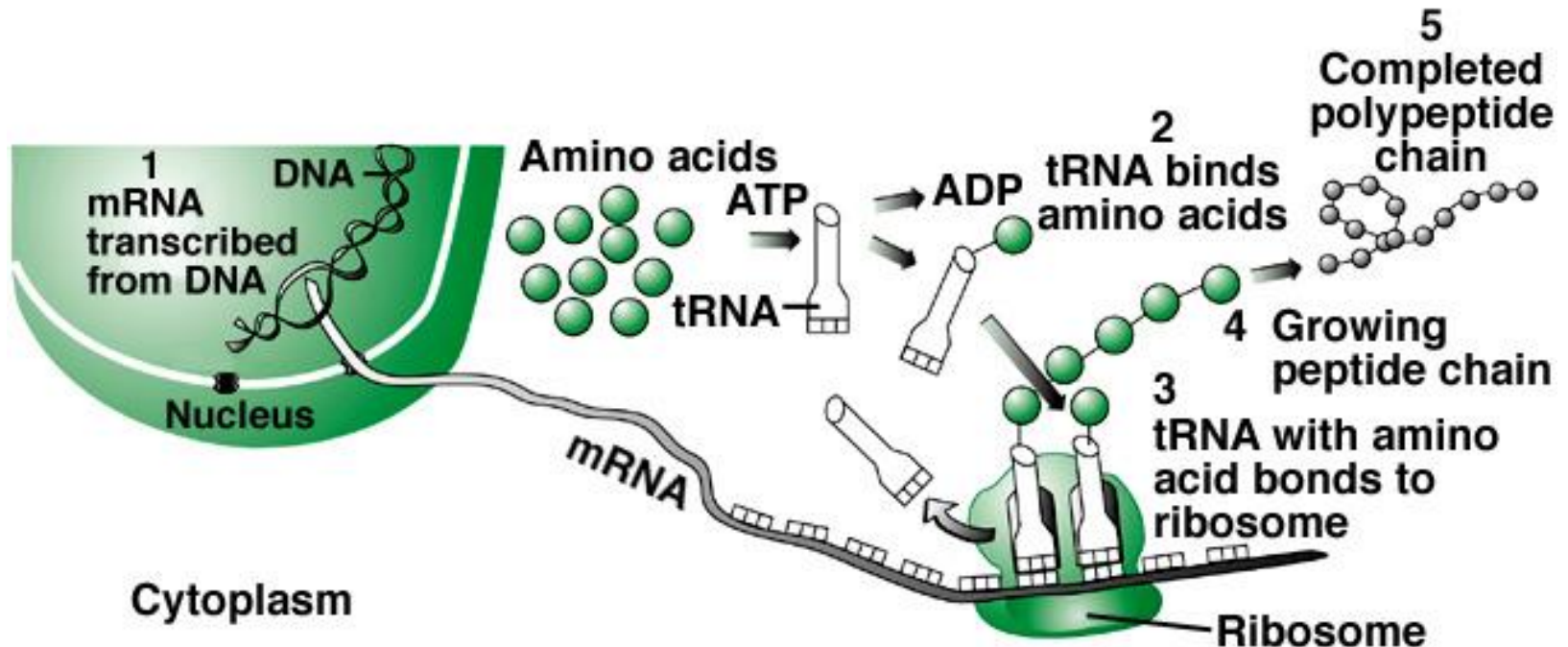
- Biological activity (function) of proteins depends largely on its 3-D structure



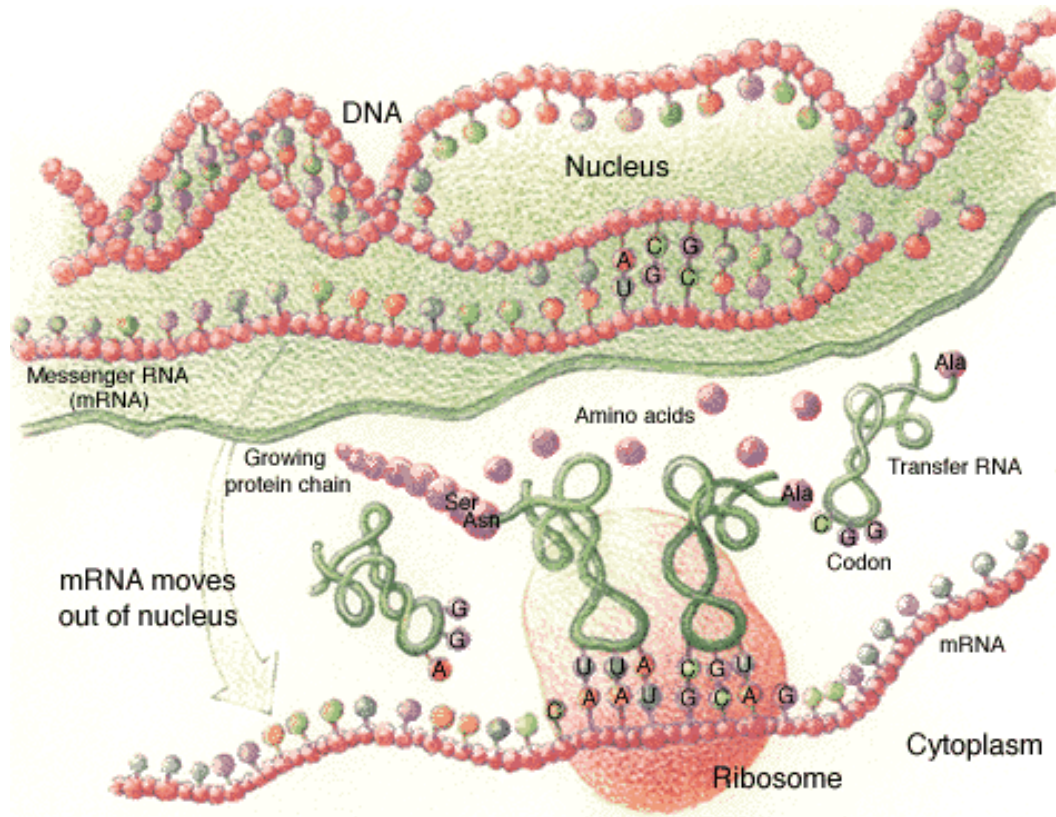
Summary:

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Protein Synthesis Summary



Genomic Geography



- In **Cell Nucleus**: **RNA** is produced by transcription.
- **RNA** is single-stranded; substitutes the sugar ribose for deoxyribose and the base uracil for thymine
- **Messenger RNA** or mRNA, conveys the DNA recipe for protein synthesis to the **cell cytoplasm**.
- mRNA binds to **ribosome**, each three-base codon of the mRNA links to a specific form of **transfer RNA** (tRNA) containing the complementary three-base sequence.
- This tRNA, in turn, transfers a single **amino acid** to a growing protein chain.
- Each codon directs the addition of one amino acid to the protein. Note: the same amino acid can be added by different codons; in this illustration, the mRNA sequences GCA and GCC are both specifying the addition of the amino acid alanine (Ala).

Important

- Both DNA and RNA have a direction: one end is the 3' the other is the 5' end.
- Thus, codons are read in one direction only.
- Also, note there is redundancy in the genetic code: the different sequences can specify for the same amino acid.

Example: _____ = Leucine

When things go wrong...

- **Mutations:** changes in the DNA sequence, that may be passed along to future generations.
- **Point mutations:** a single base substitution
THE CAT SAW THE **R**AT
THE CAT SAW THE **H**AT
- **Deletion:** a small DNA segment is lost
- **Insertion:** a segment of DNA is added
- **Frame-shift mutation:** modification of the reading frame after a deletion or insertion, resulting in all codons downstreams being different.

Somatic Mutations

- _____ mutations: occur in body cells, or cells that do not lead to gametes.
- Somatic mutations that occur in leaves, roots or stems are usually not passed on to future generations...
- UNLESS the plant reproduces _____

