Ch 10.4 Protein Synthesis

I) Flow of Genetic Information

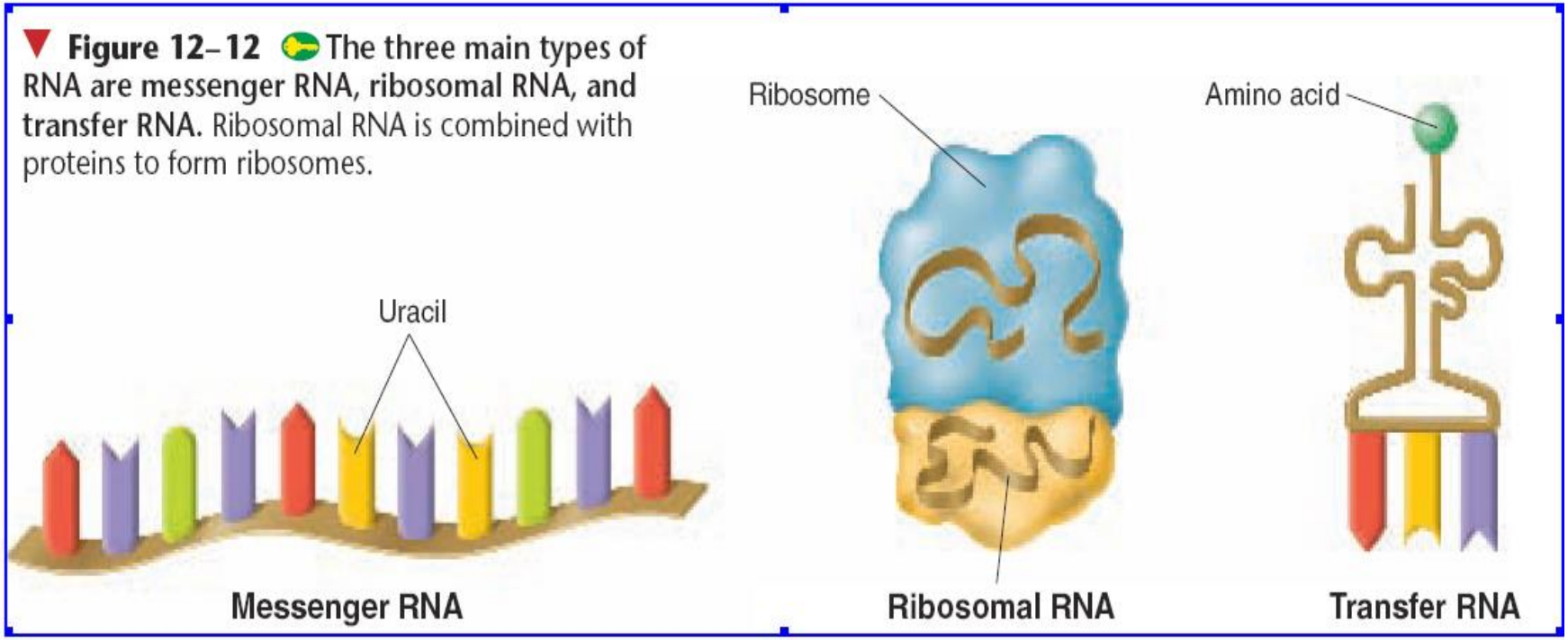
A) DNA is made into RNA which undergoes transcription and translation to be made into a protein.

II) RNA Structure and Function

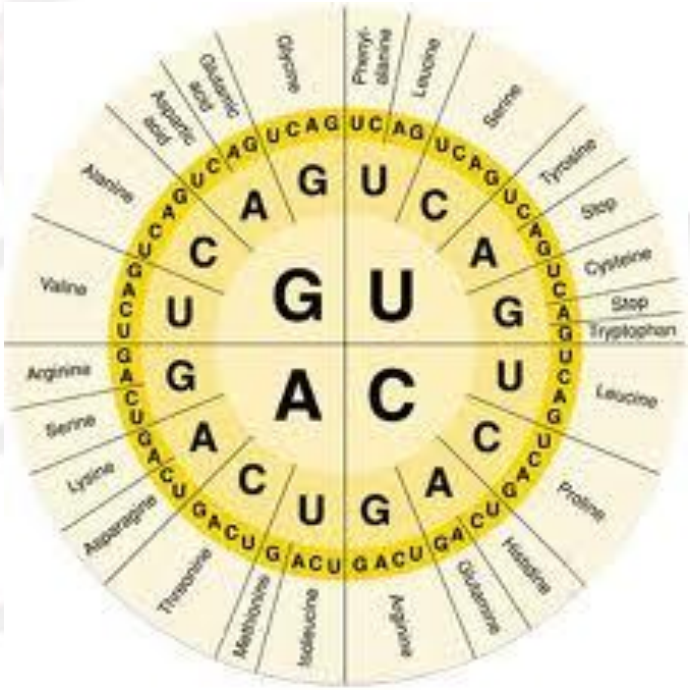
A) RNA contains 4 Nitrogenous bases

- ***Adenine, Cytosine, Guanine, Uracil***

B) 3 Types of RNA (Messenger RNA / Ribosomal RNA / Transfer RNA)



The Genetic Code



The DNA molecule, with its four nitrogenous bases, is the code for all Proteins that are made in a cell.

Genes are made of DNA. A gene is the coded DNA instructions that controls the production of specific Proteins, such as enzymes, structural proteins, oxygen-carrying proteins, etc.

Gene expression: The process by which DNA directs the synthesis of proteins.

The expression of genes includes two stages: transcription and translation

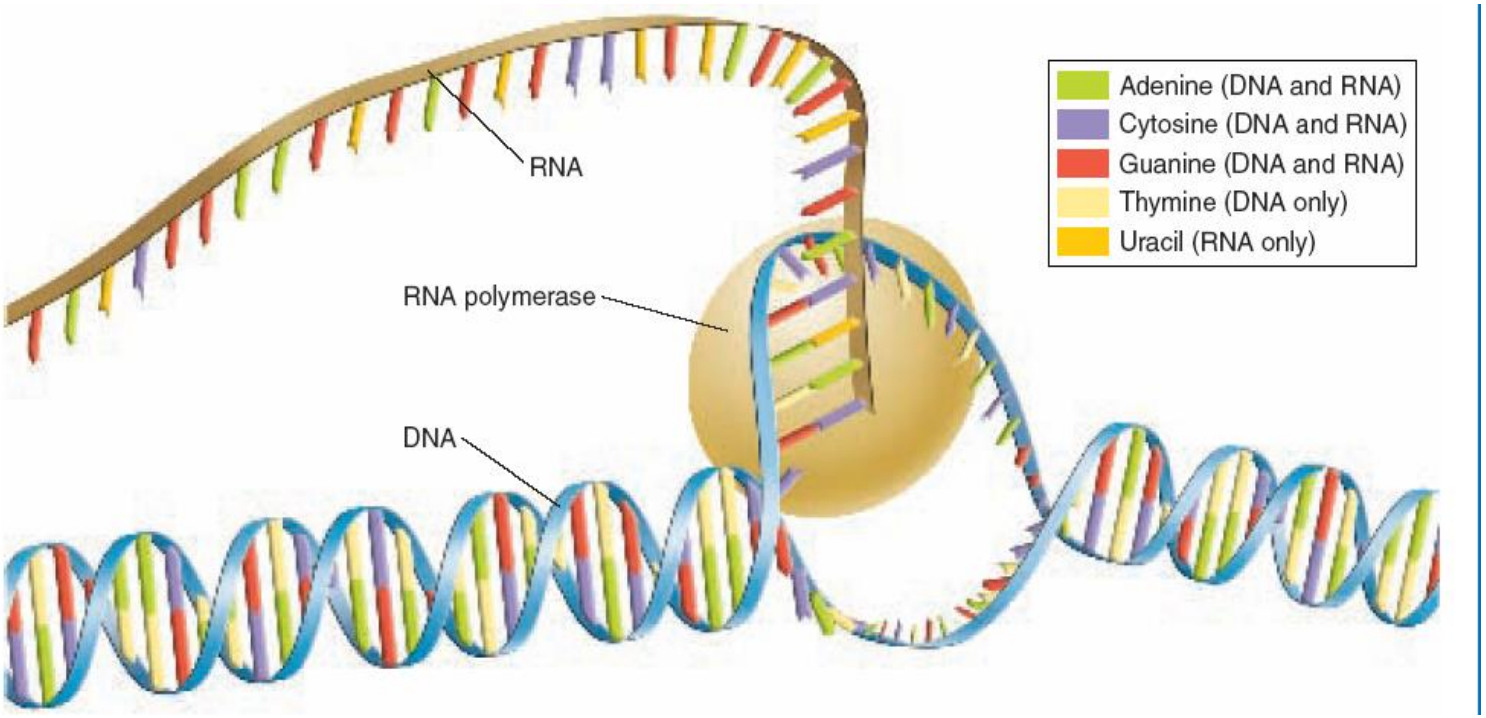
III) Transcription

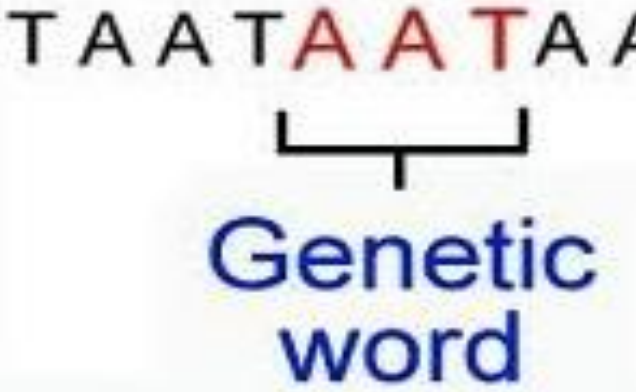
A) Transcription – Is the process by which DNA is copied into RNA

B) Promoters – signals in DNA that indicate to the enzyme where to start making RNA

C) Terminations Signal – a specific sequence of nucleotides that stops transcription

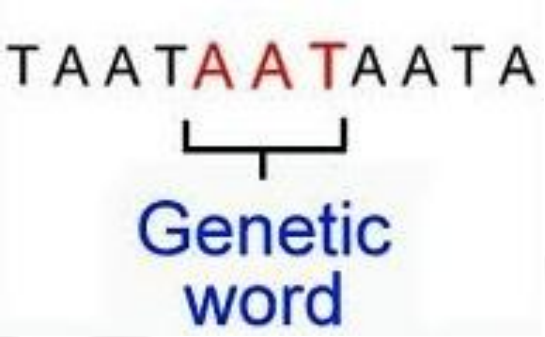
Transcription occurs inside the Nucleus





The Code Is A Triplet

1. Proteins are made of building blocks called: amino acids.
2. There are 20 different amino acids and four different nucleotides (since there are four different nitrogenous bases).
3. It was discovered that three nucleotides in sequence must specify each amino acid. This would provide for 64 possible combinations of amino acids.
4. Each triplet of nucleotides is called a codon.



The Code Is A Triplet

5. Each codon calls for a specific amino acid . When many amino acids are linked together a protein is made.
6. A few codons do not call for any amino acids. One codon acts as a "start" codon to tell where the sequence of amino acids is to begin. Three other codons are "stop" codons and act as signals for the end of a protein chain.
7. A gene on a chromosome is many, many codons long. Each gene is the code for a particular protein .
8. Genes provide the instructions for making specific proteins, but a gene does not build a protein directly. The bridge between DNA and protein synthesis is: RNA

DNA vs. RNA

- DNA
  - Sugar (Deoxyribose)
  - Phosphate Group
  - Nitogenous Bases
  - A
  - T
  - G
  - C
- Double Stranded

- RNA
  - Sugar (Ribose)
  - Phosphate group
  - Nitrogenous Bases
    - A
    - U (Not "T")
    - G
    - C
- Single Stranded

Functions of RNA

1. Proteins are made in the ribosomes in the cytoplasm.

1. DNA determines which proteins need to be made.

2. A gene on the DNA molecule is copied. This copy is called RNA. The copy of the instructions is then sent out to the ribosomes in the cytoplasm.

3. RNA carries the messages from the DNA (in the nucleus) to the ribosomes (in the cytoplasm). RNA tells the ribosomes which proteins to make and how to make them.

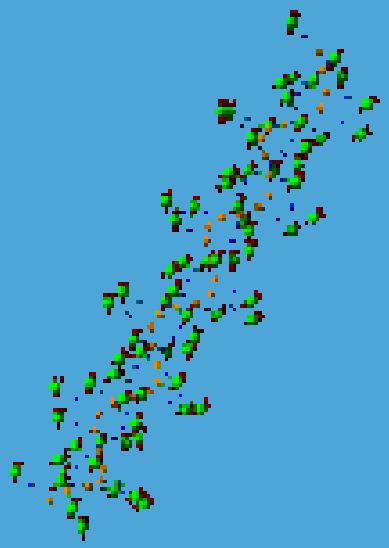
Replication
DNA TO DNA

A → T

C → G

G → C

T → A



Transcription
DNA to mRNA

A → U

C → G

G → C

T → A

Transcribe the following DNA strands.

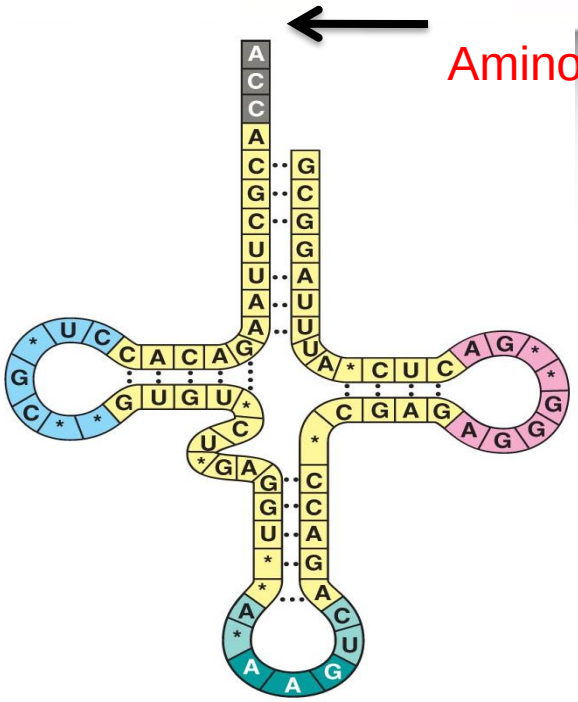
- ATTCGACG
- UAAGCUGC

- TTACCAGC
- AAUGGUCG

- TTAAAACG
- AAUUUUGC

Transfer RNA -- tRNA

Transfer RNA reads the message carried by mRNA and gathers the right amino acids for making that protein.



Transfer RNA transfers amino acids from the cytoplasmic pool of amino acids to a ribosome.

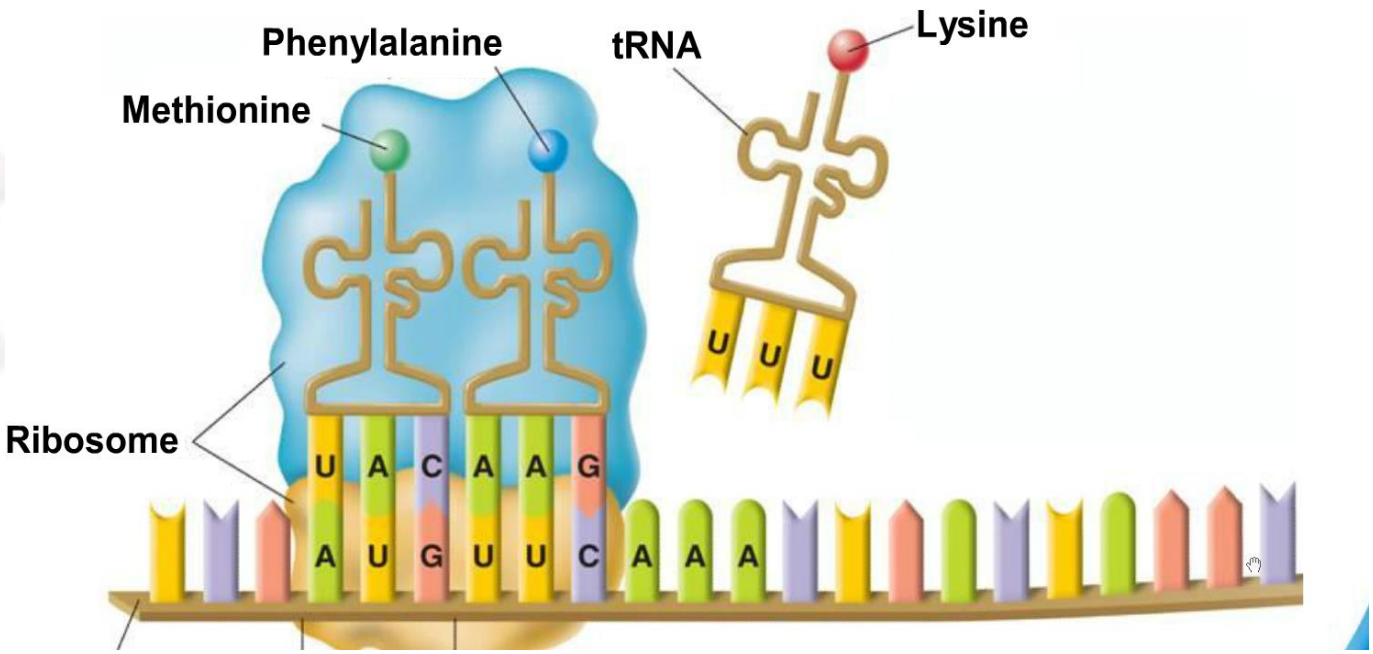
A cell keeps its cytoplasm stocked with all 20 amino acids.

One end of the tRNA attaches to one amino acid and carries it to the ribosome.

IV) The Genetic Code

A) Codon – Is a 3 letter code word that specifies a particular amino acid

B) Start Codon is AUG / Stop Codons are UAA, UAG, UGA



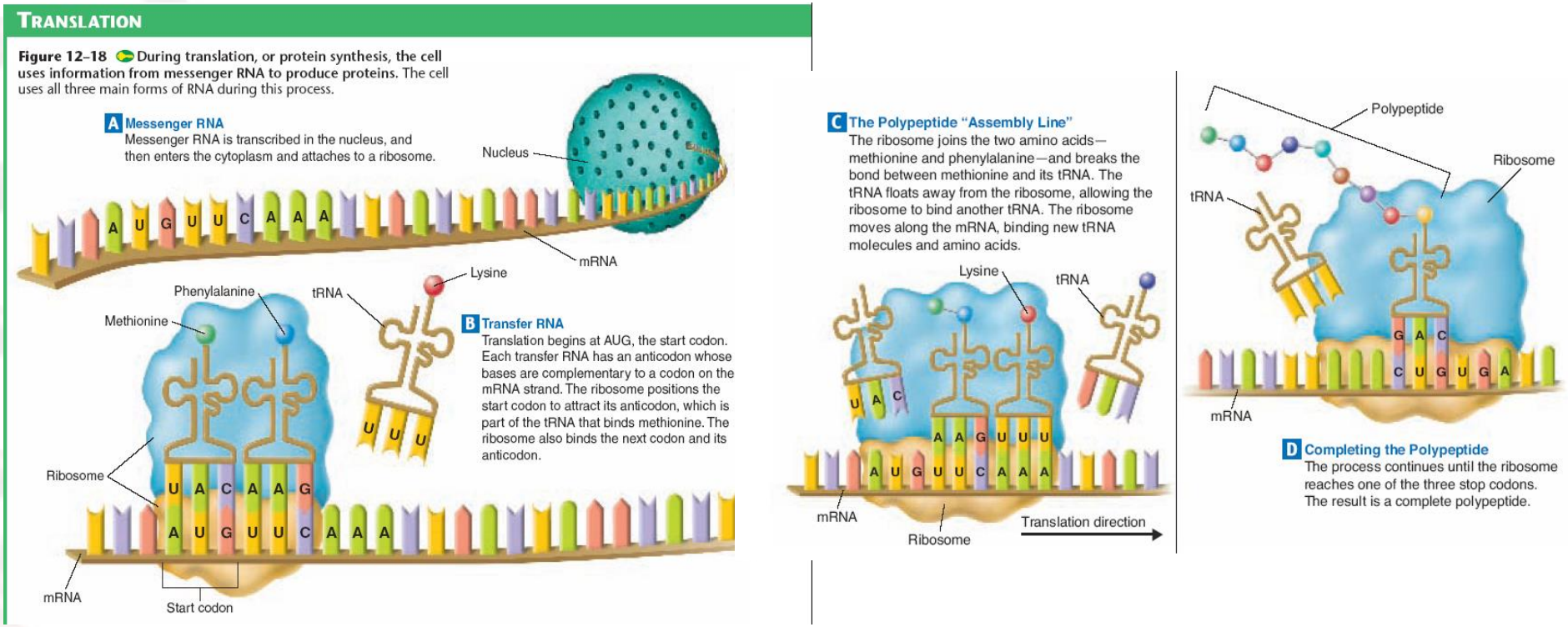
Remember: The purpose of transcription is NOT to copy the entire length of the DNA molecule, but to copy only small portions - a gene's worth - to be sent to the ribosome as the: instructions for protein synthesis.

V) Translation

A) Translation – The process of decoding a messenger RNA into a protein

B) Anticodon – the three bases on the tRNA that are complimentary to the mRNA

C) Protein Assembly – ribosomes attach to the start codon on an mRNA, than pairs with an anticodon on the tRNA to make the correct amino acid



Protein Synthesis

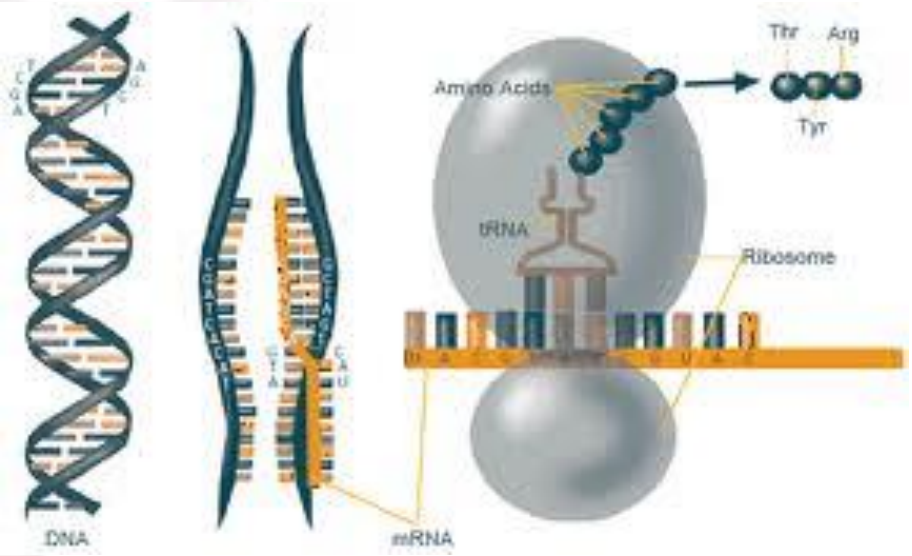
1. Transcription

The genetic code is copied or "trancribed" onto mRNA in the cell nucleus

2. Translation

mRNA leaves the nucleus and travels to ribosomes in the cytoplasm where the coded info is translated into specific amino acid sequences in a protein

Transcription **Translation**

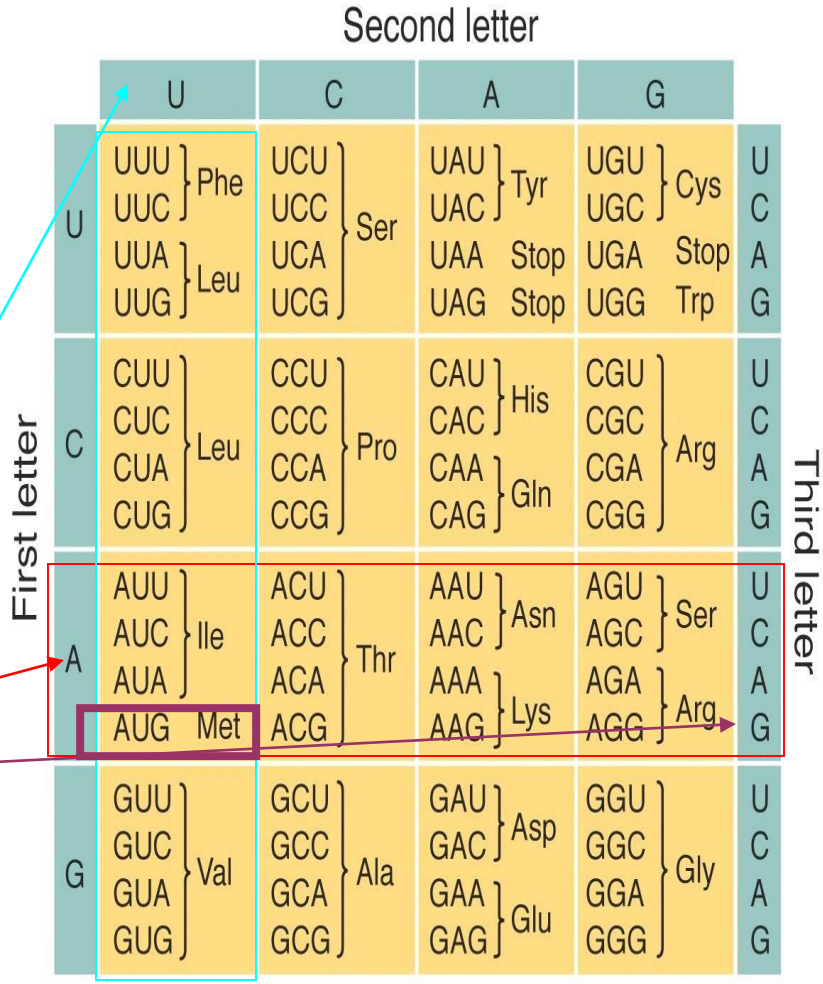


Steps in protein synthesis:

1. In the nucleus, DNA transcribes RNA.
2. The RNA is sent to the cytoplasm in the form of mRNA.
3. The mRNA attaches to a ribosome.
4. As each codon of the mRNA molecule moves through the ribosome, the proper amino acid is brought into the ribosome by tRNA. The amino acids are lined up in the right order on the ribosome.
5. The ribosome hitches the amino acids together with peptide bonds and proteins are made.

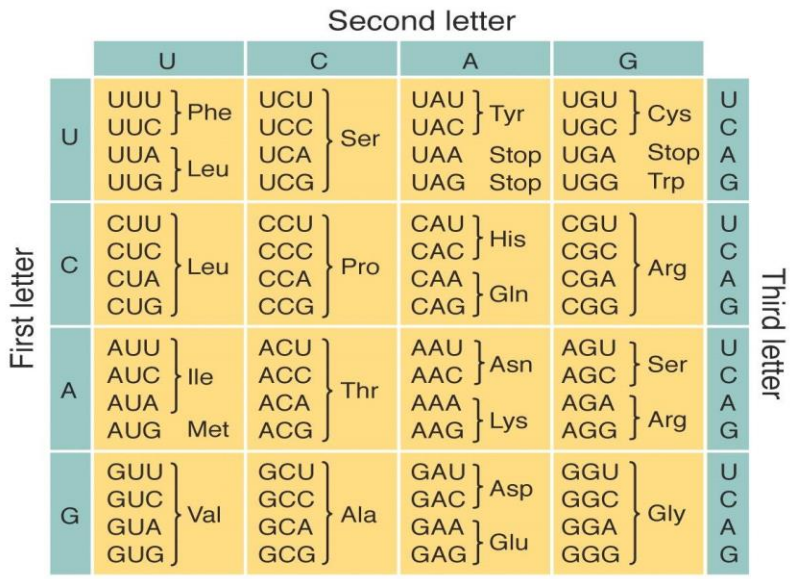
Translation (Do not copy this just read)

- 2. The ribosome reads the codons and translates them into amino acids.
- How??
  - Uses the Genetic Code
    - Match the first letter on the left
    - Match the second letter on the top
    - Match the third letter on the right
    - Ex: codon AUG
    - Amino Acid: Methionine



Example

AUG|CCC|GGG|AAA



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

Example: Putting It All together!

If the sequence on the DNA molecule calls for a protein with the following DNA codons:

(1) What would be the sequence of the mRNA?

(2) What would be the sequence on the tRNA?

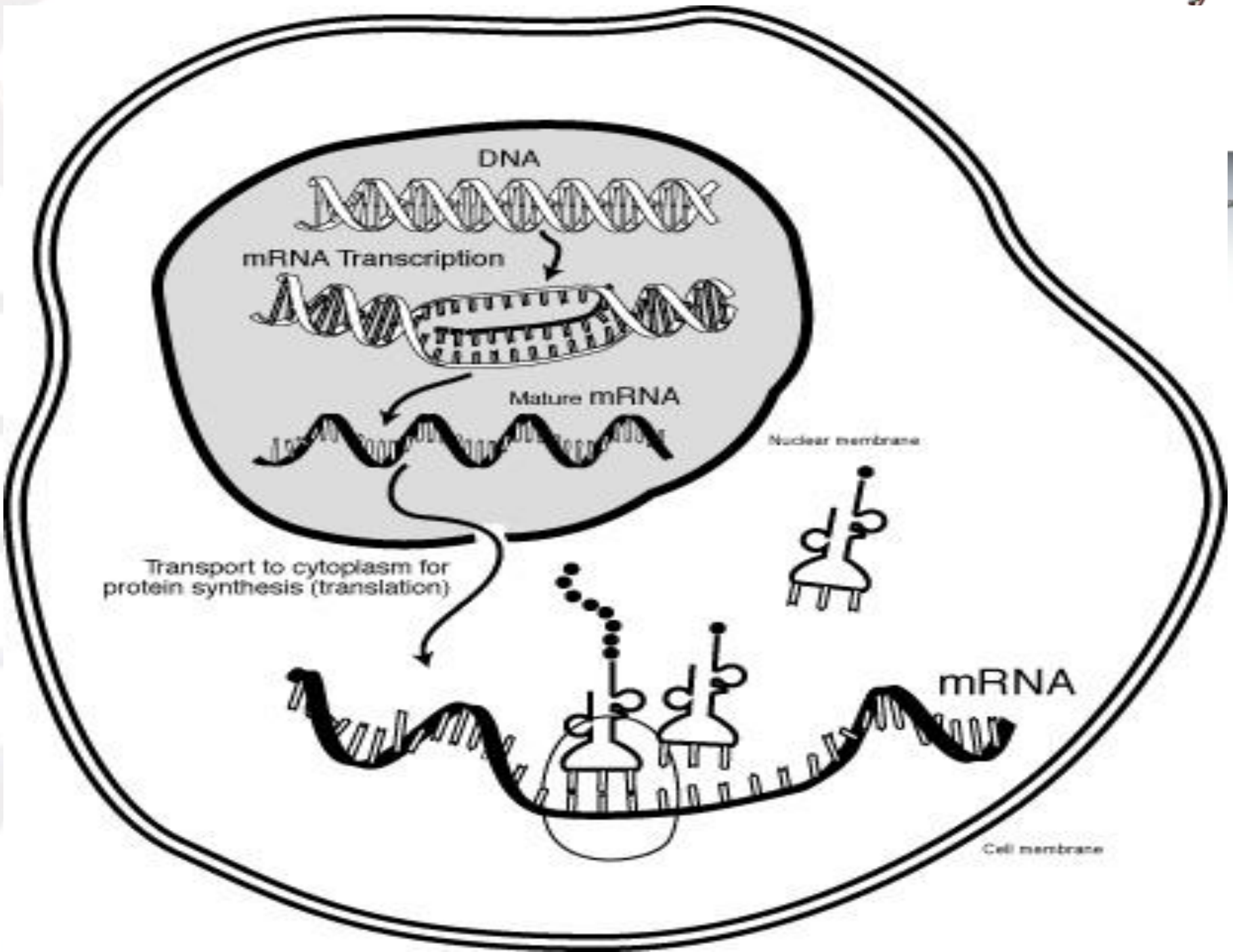
(3) What would be the amino acid sequence of the protein being made?

DNA → TAC TTA CAA ACC ATA ATT

mRNA →
CODONS

tRNA →
ANTICODONS

Amino →
Acid
Sequence


DNA
mRNA Transcription
Mature mRNA
Nuclear membrane
Transport to cytoplasm for
protein synthesis (translation)
mRNA
Cell membrane