Protein Synthesis

RNA, Transcription, & Translation

RNA – Ribonucleic Acid

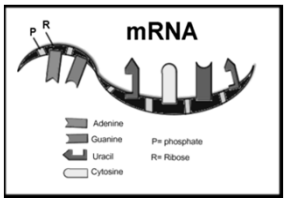
- 3 **differences** between RNA & DNA
  - 1) The sugar is **ribose** instead of deoxyribose
  - 2) The base **uracil** replaces thymine
  - 3) **RNA = single**-stranded instead of double

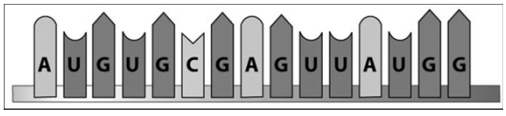
Three (3) Types of RNA

- There are three types of RNA
  - **1) Messenger** RNA (*mRNA*)
  - **2) Transfer** RNA (*tRNA*)
  - 3) Ribosomal RNA **(*rRNA*)**

mRNA

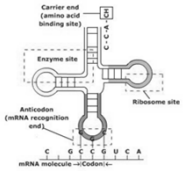
- **Single** uncoiled chain that carries the **genetic** information from the **nucleus** to the **ribosome**

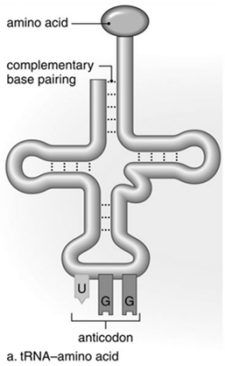




tRNA

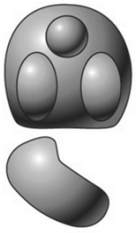
- Consists of a single **chain** folded into a **cross/T** shape
- Each binds to a specific **amino** acid



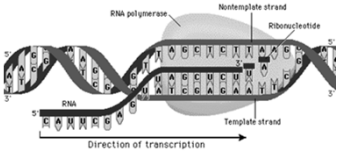


rRNA

- **Nucleotides** glob up along with **proteins** in order to make up ribosomes
- **Ribosomes** are where **proteins** are made



Transcription



- The process of copying DNA into **RNA**
- *RNA* **polymerase** makes RNA by reading specific sequences of **DNA** called **genes**

1) Initiation 2) Elongation 3) Termination

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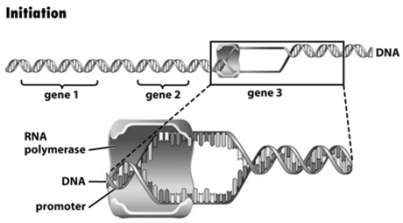
Transcription – 3 step process

1) Initiation

- Begins by RNA **polymerase** binding to the **promoter**

Initiation



RNA polymerase binds to the promoter region of DNA near the beginning of a gene, separating the double helix near the promoter.

Transcription – 3 step process

1) Initiation

- Begins by RNA **polymerase** binding to the promoter

2) Elongation

- RNA polymerase reads the **template** strand of DNA

Transcription (cont…)

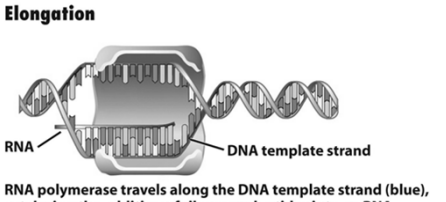
2) Elongation (cont.)

- RNA polymerase adds **complementary** RNA nucleotides to form the mRNA

*** Base** pairs are the same except that A now pairs with **U**

DO: Practice DNA → RNA pairing on right side

Elongation



RNA polymerase travels along the DNA template strand (blue), catalyzing the addition of ribose nucleotides into an RNA molecule (pink). The nucleotides in the RNA are complementary to the template strand of the DNA.

Transcription (cont…)

2) Elongation (cont.)

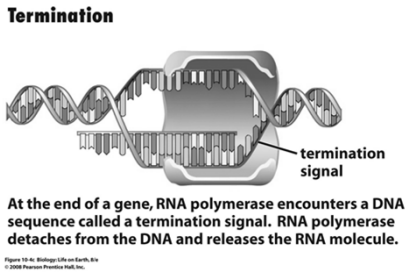
- RNA polymerase adds **complementary** RNA nucleotides to form the mRNA

*** Base** pairs are the same except that A now pairs with **U**

3) Termination

- Transcription **occurs** until a **termination** signal is reached

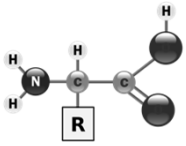
Termination



Quick Review

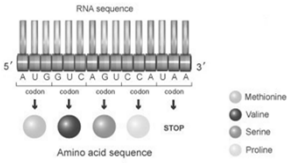
- **Function of mRNA?**
- **Location of Transcription?**

Amino Acid Role



- The amino acid **sequence** determines the **structure** of the protein and therefore determines the protein's **function**
- There are **20** amino acids found in **proteins**
  - 9 **essential** ones; must be consumed (**Can't** be made)

Codons/Triplets



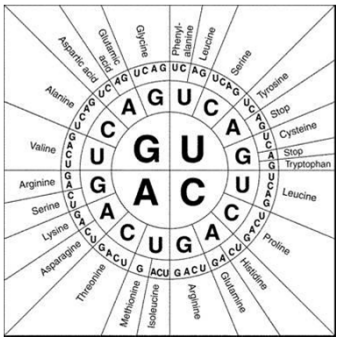
- The mRNA sequence will be read in groups of **3** nucleotides = **codons**
  - Codons determine which **amino** acid will get delivered to **ribosome**
  - Codon chart will be used to identify amino acids

mRNA Codon Chart #1 - color

First Letter	Second Letter U	Second Letter C	Second Letter A	Second Letter G	Third Letter
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	(start) methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

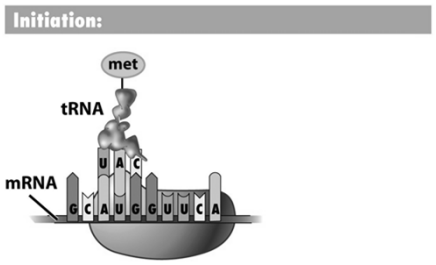
Amino Acid	3-Letters
Alanine	Ala
Arginine	Arg
Asparagine	Asn
Aspartic acid	Asp
Cysteine	Cys
Glutamic acid	Glu
Glutamine	Gln
Glycine	Gly
Histidine	His
Isoleucine	Ile
Leucine	Leu
Lysine	Lys
Methionine	Met
Phenylalanine	Phe
Proline	Pro
Serine	Ser
Threonine	Thr
Tryptophan	Trp
Tyrosine	Tyr
Valine	Val

mRNA Codon Chart #2 - color



Translation: Step 1: Initiation

A. **mRNA** leaves the nucleus and migrates to a **ribosome** in the **cytoplasm**
B. The mRNA enters the **ribosome** between the large and small **subunits**
C. The **mRNA** is then read by the **ribosome** in groups of 3 called **codons**
D. **AUG** is always the first codon "**Start"** codon



The initiation complex binds to an mRNA molecule. The methionine (met) tRNA anticodon (UAC) base-pairs with the start codon (AUG) of the mRNA.

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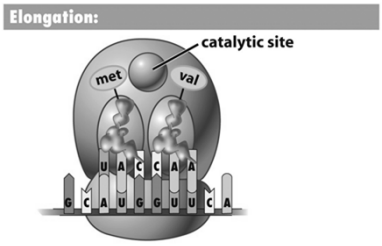
Translation: Step 2: Elongation

E. One codon is read by the **ribosome**, while a **tRNA** brings in the correct **amino** acid for that codon (1st amino acid will always be **Methionine** (Met.))

F. The **tRNA** has an **anticodon** (complementary) so that it can match up to the codon

G. The next **codon** is read, and another **tRNA** carrying the correct **amino** acid comes to the **ribosome**



The second codon of mRNA (GUU) base-pairs with the anticodon (CAA) of a second tRNA carrying the amino acid valine (val). This tRNA binds to the second tRNA site on the large subunit.

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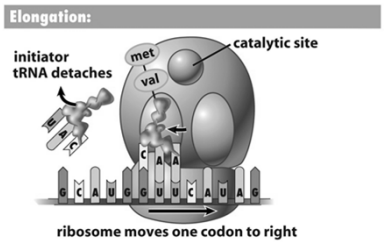
Step 2: Elongation (cont.)

H. The two **amino** acids are bonded together with a **peptide** bond

I. The first **tRNA** can now leave the ribosome to go get another **amino** acid

J. The process continues the entire length of the mRNA that codes for the **gene**



The "empty" tRNA is released and the ribosome moves down the mRNA, one codon to the right. The tRNA that is attached to the two amino acids is now in the first tRNA binding site and the second tRNA binding site is empty.

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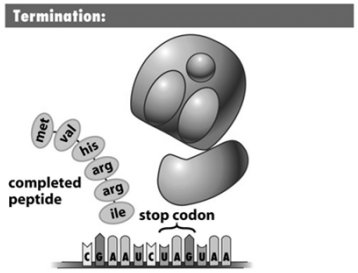
Translation: Step 3: Termination

K. Once a "**STOP"** codon enters the ribosome, **termination** begins

L. These do **NOT** code for an amino acid; instead they release the newly formed **polypeptide**



This process repeats until a stop codon is reached; the mRNA and the completed peptide are released from the ribosome, and the subunits separate.

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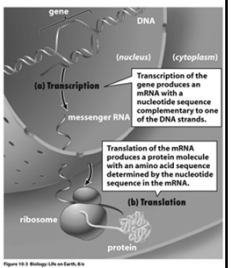
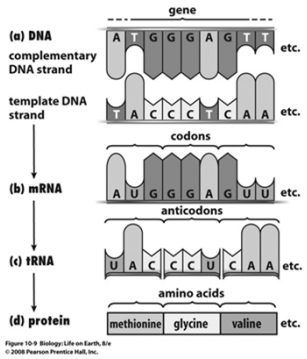
In Summary..

- ***Transcription*** = reading a single strand of DNA in order to make RNA, occurs in the nucleus
- ***Translation*** = using an mRNA to code for the linking of amino acids, occurs in the ribosome
- Product is a ***polypeptide chain*** that can fold itself into a protein



Central Dogma



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