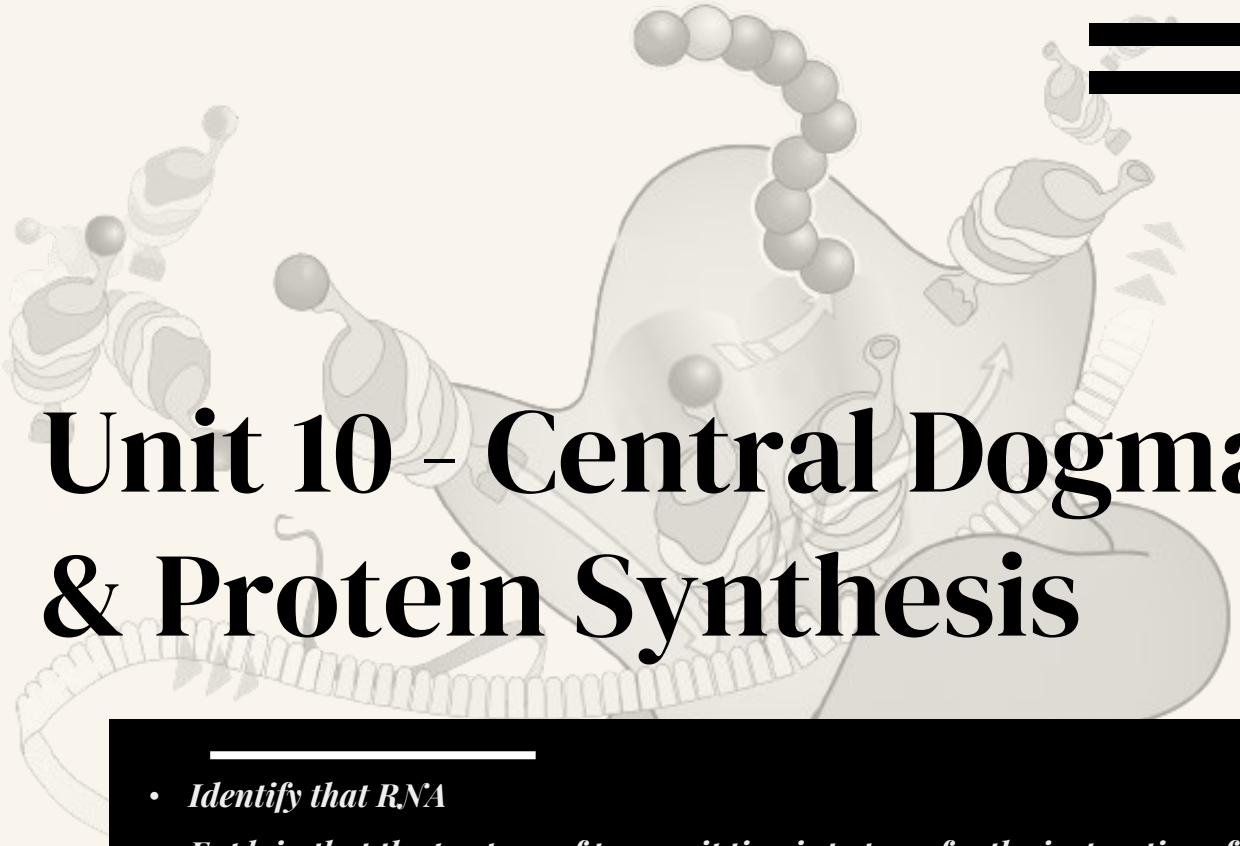
MAMMOTH

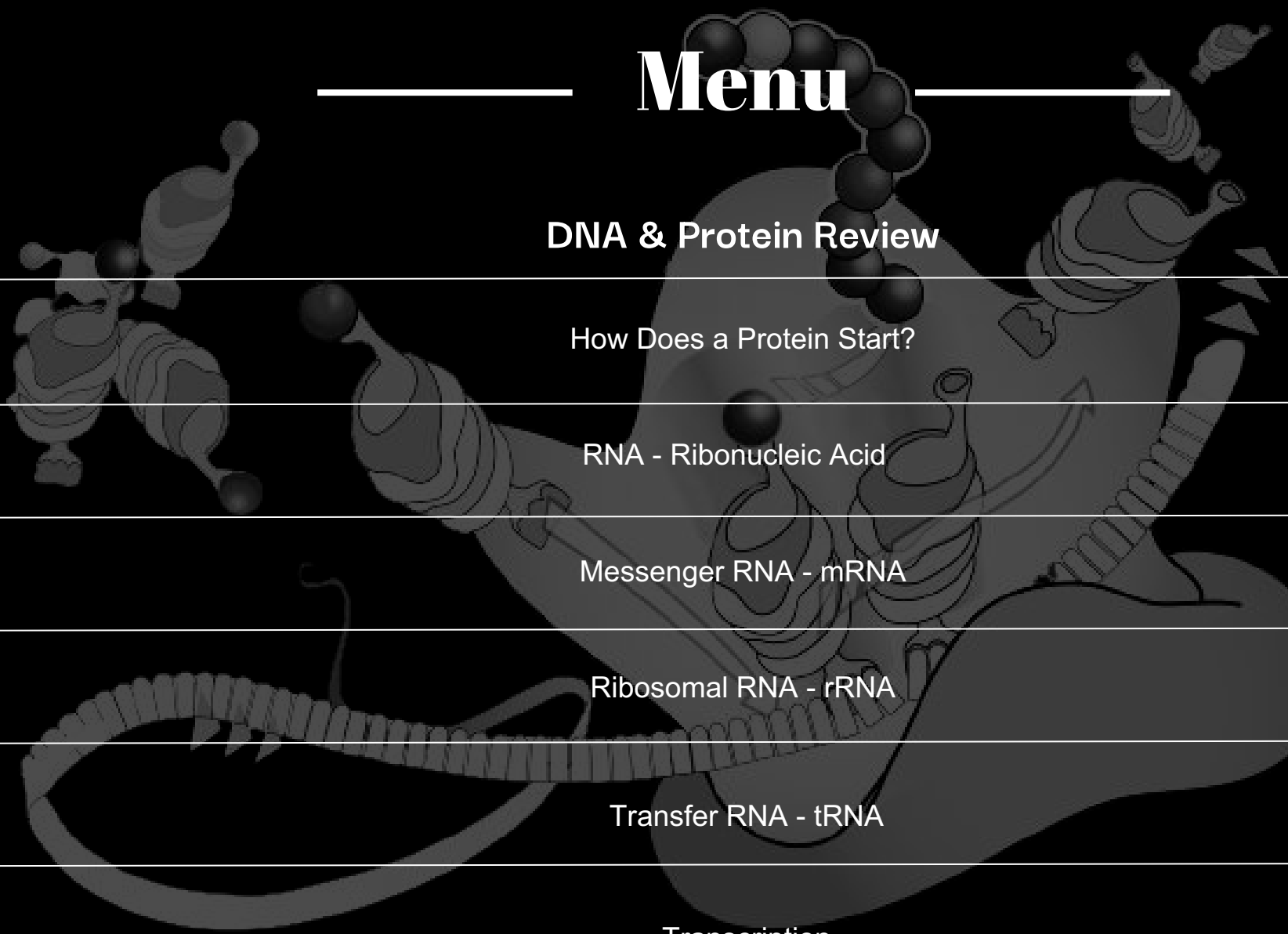
SCIENCE



Unit 10 - Central Dogma & Protein Synthesis

- *Identify that RNA*
- *Explain that the purpose of transcription is to transfer the instructions for making a protein from a gene to an RNA molecule*
- *Using models of DNA and RNA, explain the process of transcription*
- *Explain that the purpose of translation is to read the instructions on the RNA molecule and put together the amino acids that make up the protein*
- *Identify codons as a series of three-nucleotide sequences on mRNA that corresponds to an amino acid*
- *Using models of DNA and RNA, explain the process of translation*

Menu



DNA & Protein Review

How Does a Protein Start?

RNA - Ribonucleic Acid

Messenger RNA - mRNA

Ribosomal RNA - rRNA

Transfer RNA - tRNA

Transcription

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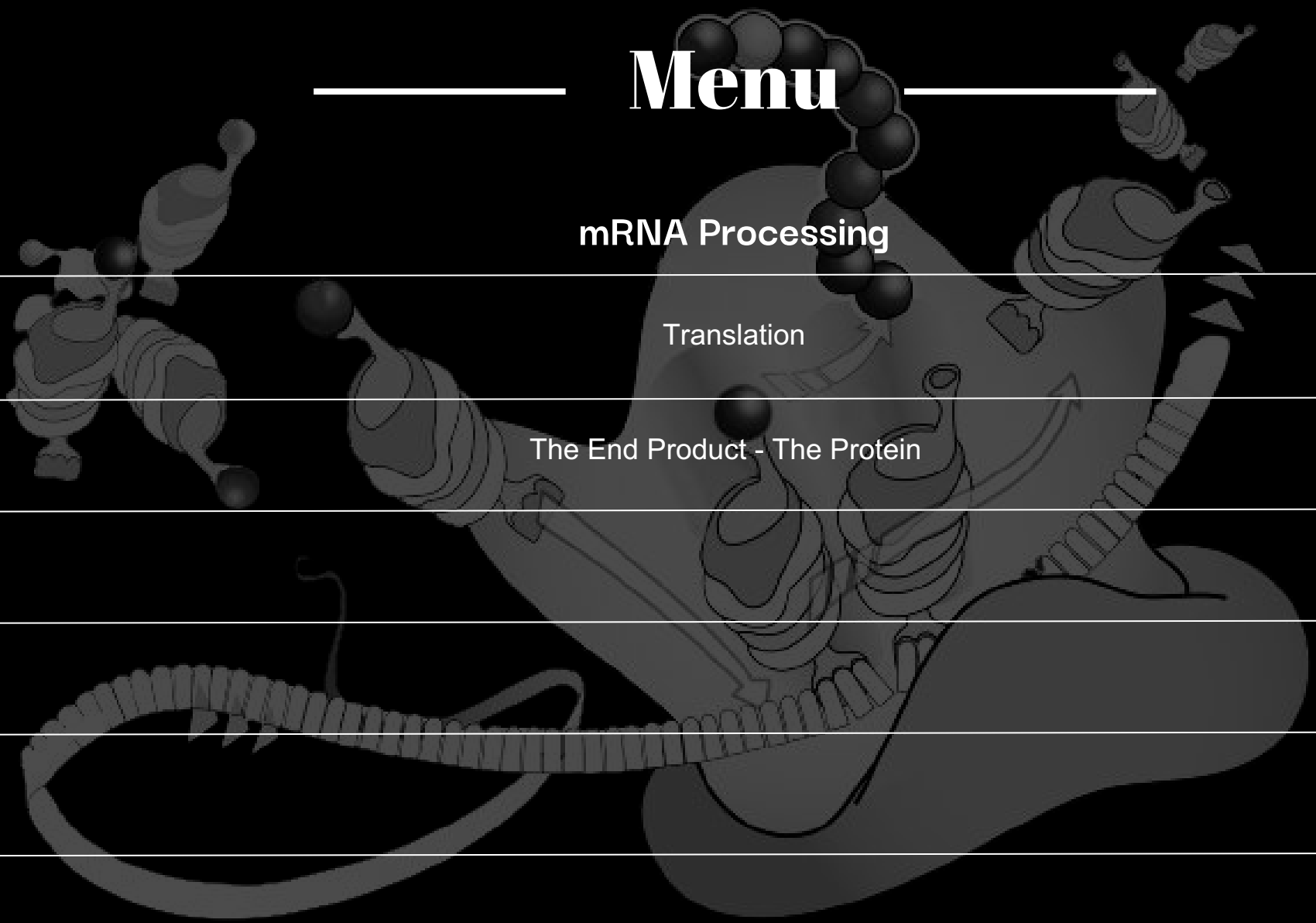
Menu



mRNA Processing

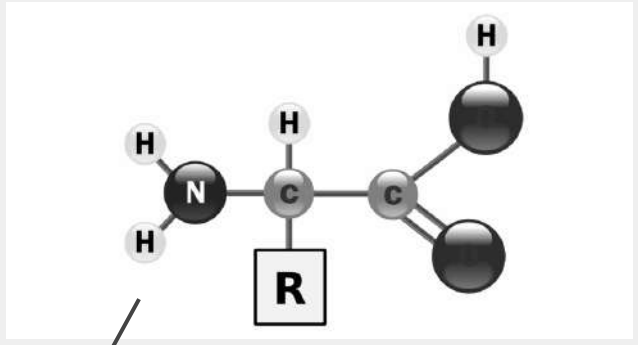
Translation

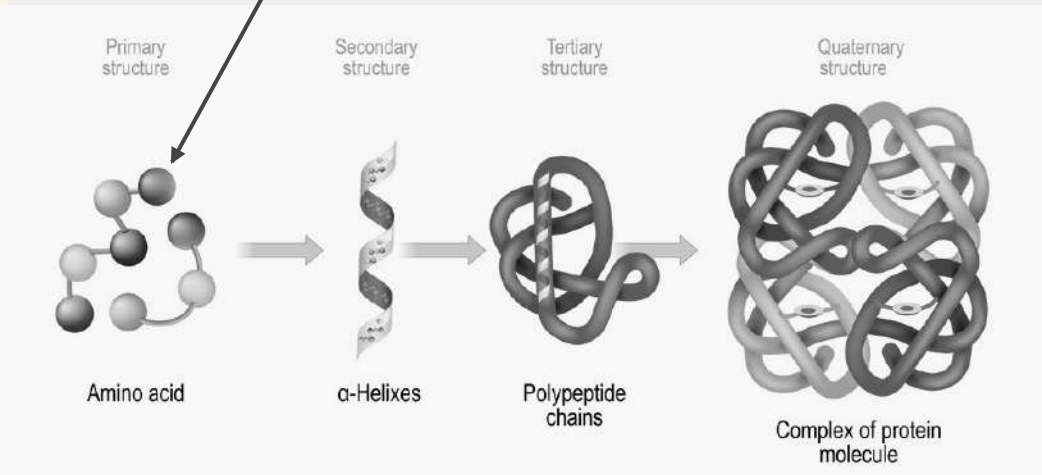
The End Product - The Protein

DNA & Protein Review

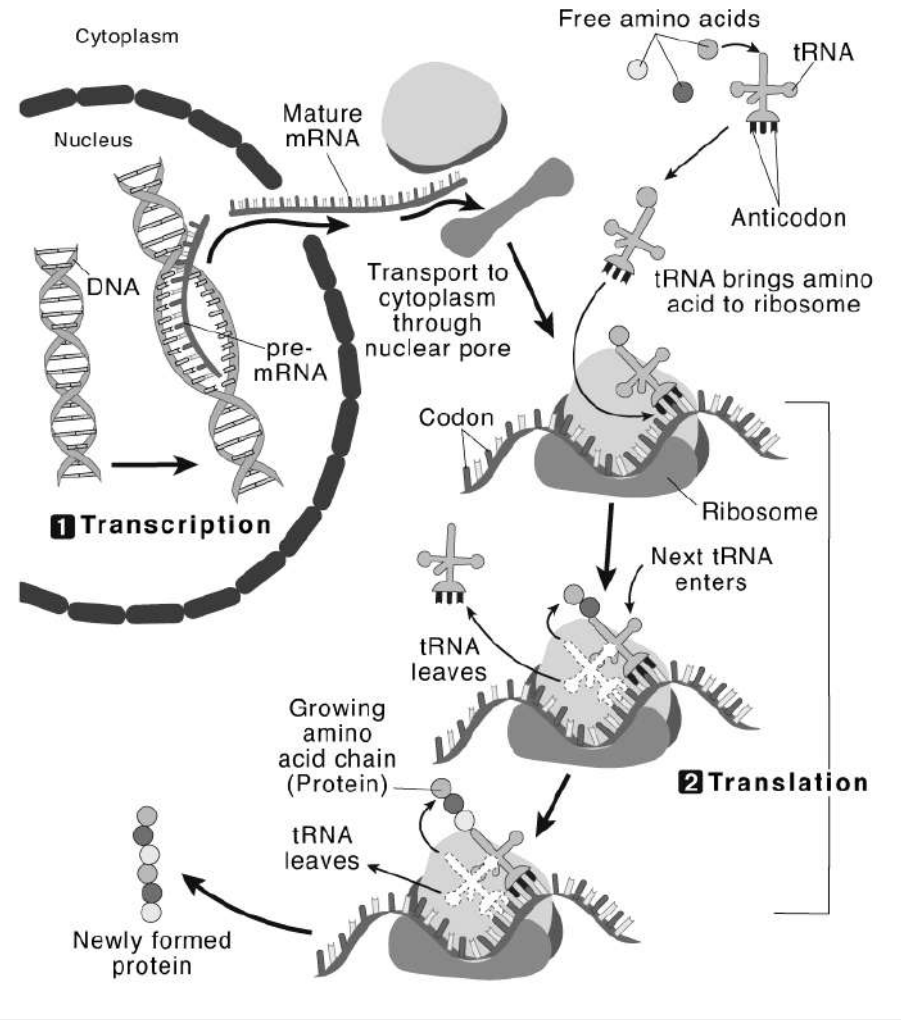
DNA Review

- **DNA** contains **genes**: *sequences of nucleotide bases (Adenine, Guanine, Cytosine, & Thymine) that codes for specific traits*
- These *Genes code* for **polypeptides** (chains of amino acids known as *proteins*)
- *Proteins* are used to *build cells* and *do* much of the *work inside cells*
- Genes and Proteins:
  - **Proteins** are *made* of ***amino acids*** *linked* together *by peptide bonds*
  - ***20*** different *amino acids* exist
- **Amino Acids:**
  - *Amino acid chains* are *called* **polypeptides**





Where do Proteins Start?



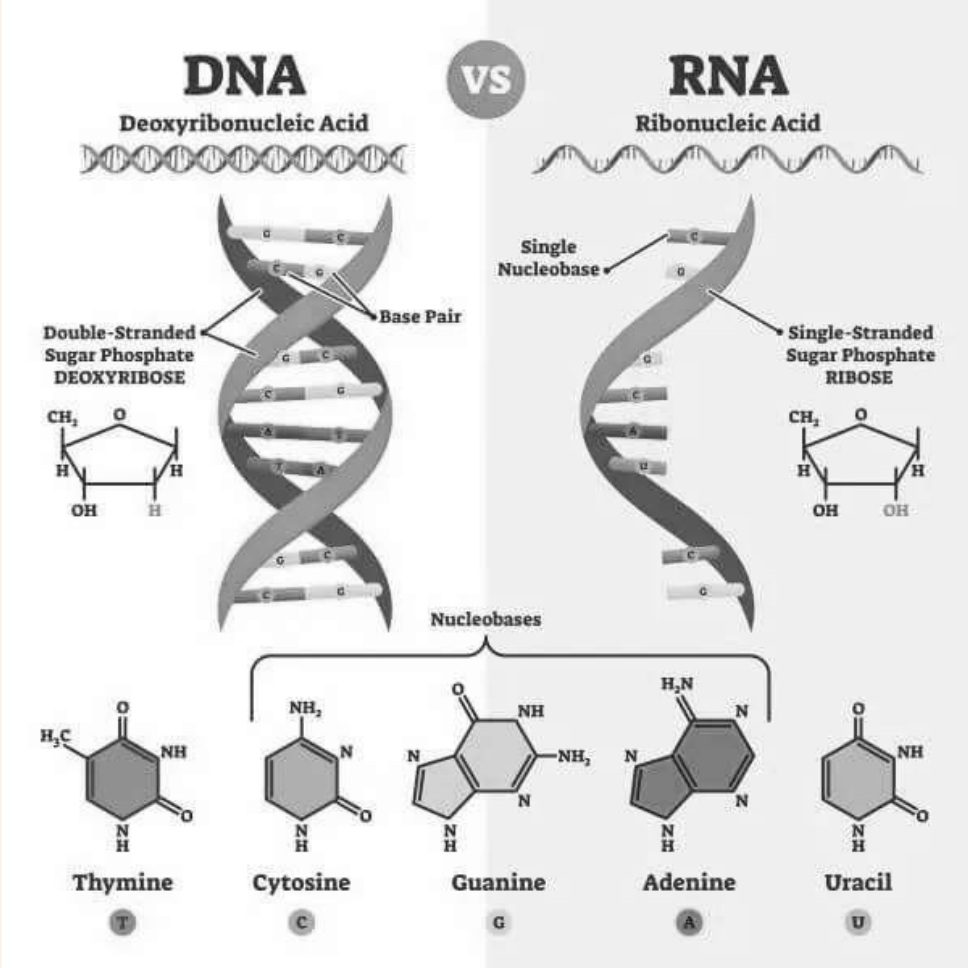
How does Protein Synthesis Start?

- **DNA**
  - **DNA** is found inside the **nucleus**
  - **Proteins**, however, are made in the cytosol of cells by organelles called **ribosomes**
  - Ribosomes may be **free** in the cytosol or attached to the surface of **rough ER**
  - DNA ‘s code must be **copied (S-phase in interphase)** and taken to the cytosol
  - In the cytosol, this **code** must be read so **amino acids** can be assembled to make **polypeptides** (proteins)
- This process is called **Protein Synthesis**

RNA - Ribonucleic Acid

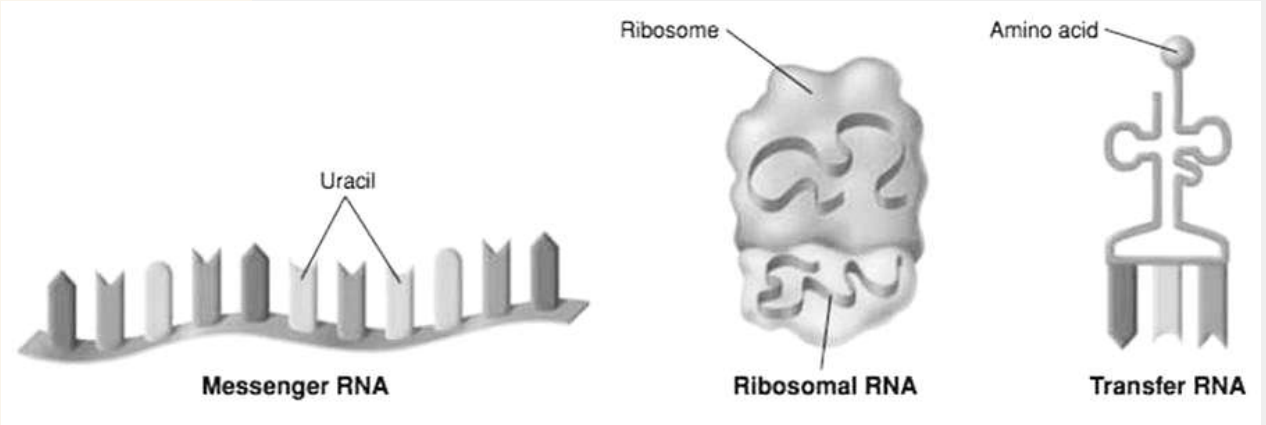
RNA – Ribonucleic Acid

- Roles of **DNA & RNA**
  - **DNA** is the *master plan*, while…
  - **DNA** has a sugar **- Deoxyribose**
  - **DNA** has **thymine** (**T**)
  - **DNA** is double-stranded
  - **RNA** is the blueprint for the Master Plan **RNA** has a sugar **- Ribose**
  - **RNA** contains the base **uracil** (**U**)
  - **RNA** molecule is single-stranded



RNA Types

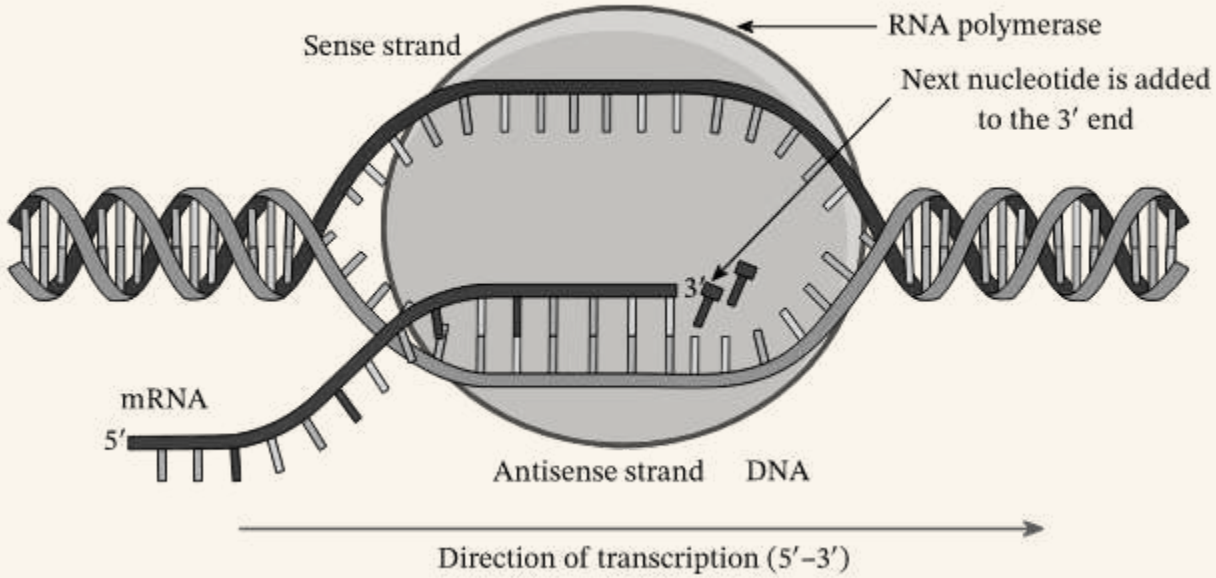
- **Three Types of RNA:**
  - **Messenger RNA (mRNA):** *copies DNA's code* & *carries* the genetic *information* to the *ribosomes*
  - **Ribosomal RNA (rRNA):** along with *protein*, *makes* up the *ribosomes*
  - **Transfer RNA (tRNA):** *transfers amino acids to* the *ribosomes* where *proteins* are *synthesized*

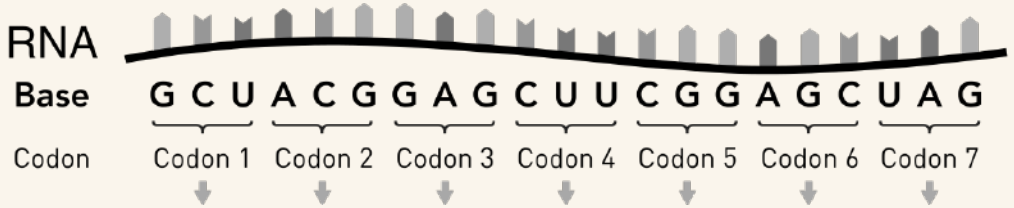


Messenger RNA - mRNA

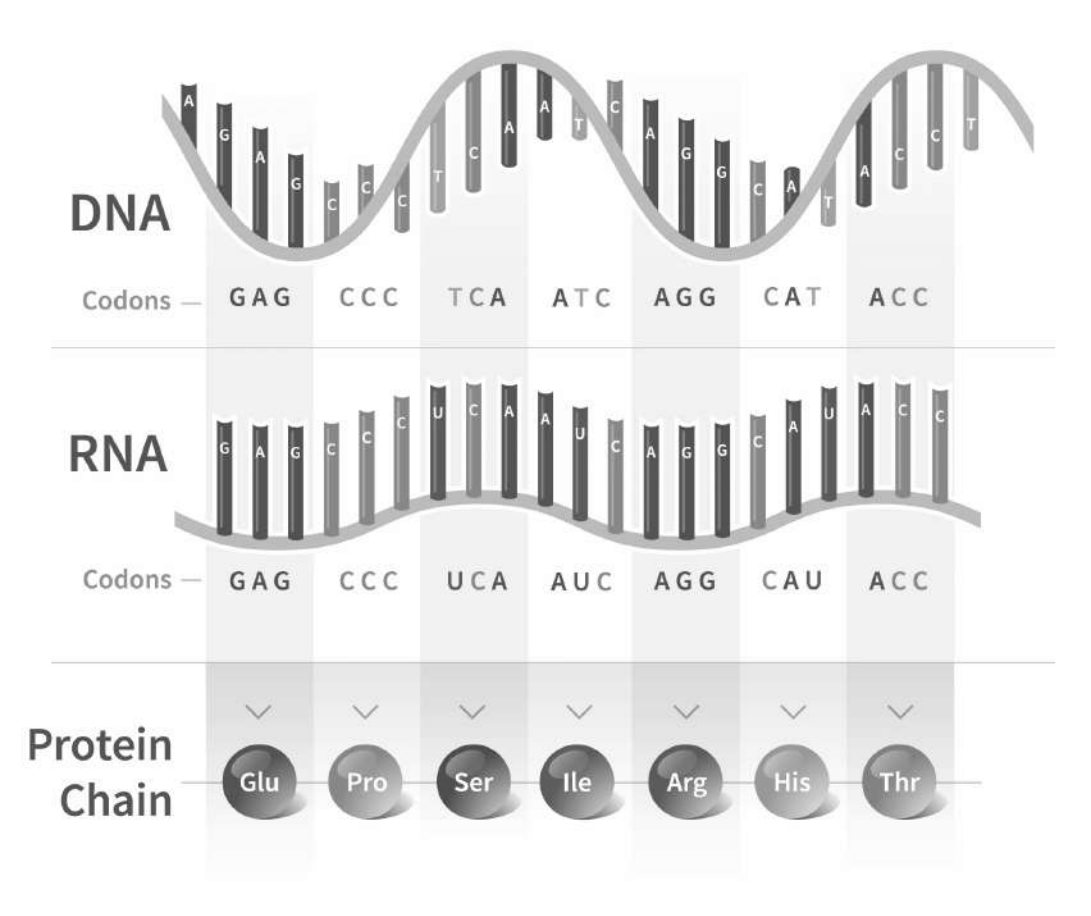
Messenger RNA (mRNA) in Detail:

- Long Straight chain of Nucleotides
- Made in the Nucleus
- Copies DNA & leaves through nuclear pores
- Contains the Nitrogen Bases A, G, C, U (no T)
- Carries the information for a specific protein
- Made up of 500 to 1000 nucleotides long
- Sequence of 3 bases called **codon**
  - **AUG – methionine or start codon**
  - **UAA, UAG, or UGA – stop codons**





Your Genetic Code

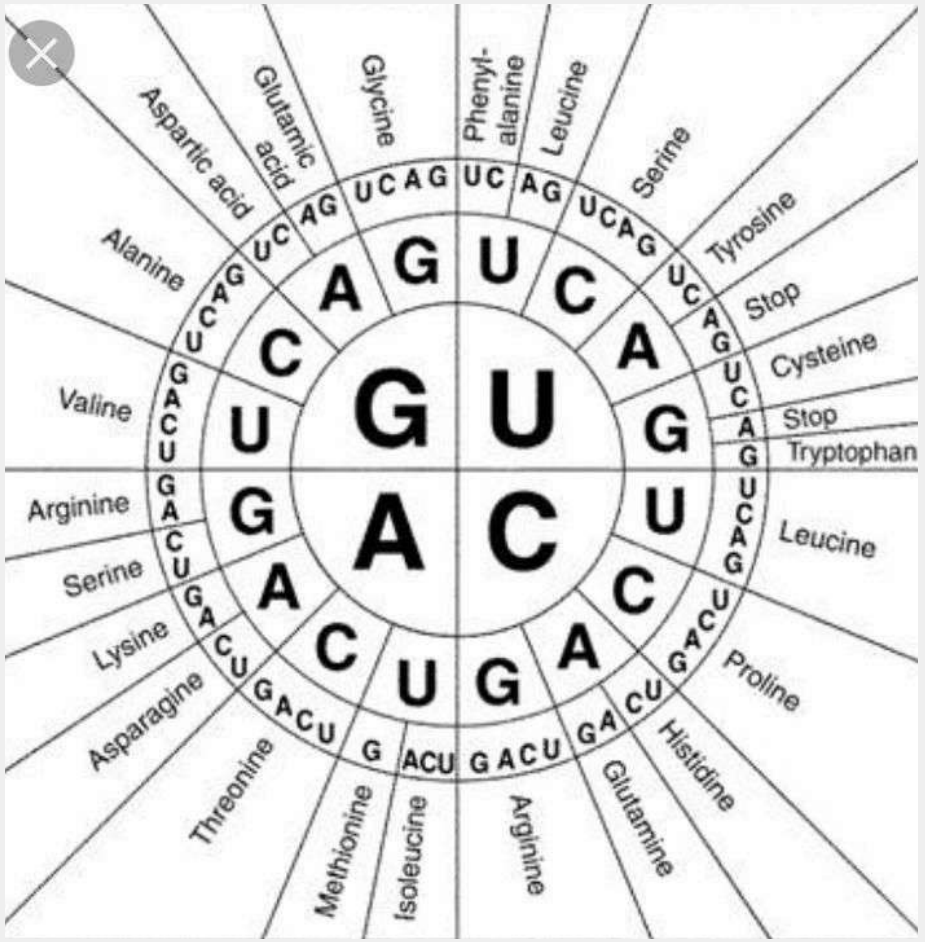


The Genetic Code:

- The **Sequence of Nucleotides** in **DNA**, makes a specific sequence of nucleotides in **mRNA**. Every **3** nucleotides constitute a **Codon**
  - A **codon** designates an amino acid
  - An **amino acid** may have **more** than **one** codon
  - There are **20 amino acids**, but **64 possible codons**
  - Some **codons** tell the ribosome to **stop** translating
  - Use the code by reading from the inside toward the outside ring
  - **Example**: **AUG** codes for **Methionine**

Codon Charts

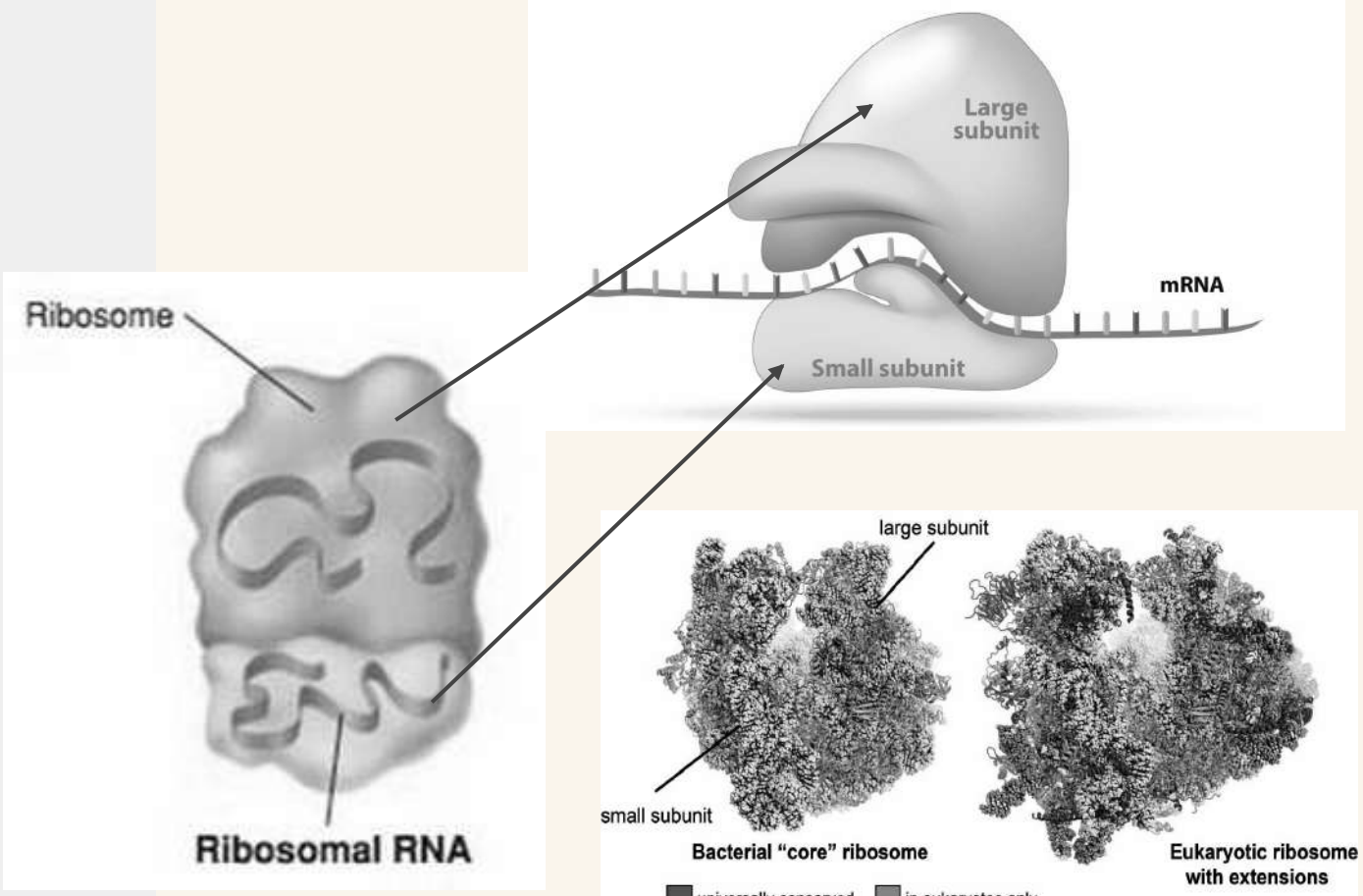
First Base	Second Base: U	Second Base: C	Second Base: A	Second Base: G	Third Base
U	UUU, UUC – Phenylalanine (Phe/F) UUA, UUG – Leucine (Leu/L)	CUU, CCU, CAU, CGU – Serine (Ser/S)	AUU, ACU – Tyrosine (Tyr/Y) AAU – STOP AGU – STOP	GUU, GCU – Cysteine (Cys/C) GAU – STOP GGU – Tryptophan (Trp/W)	U C A G
C	CUU, CUC, CUA, CUG – Leucine (Leu/L)	CUC, CCC, CAC, CGC – Proline (Pro/P)	AUC, ACC – Histidine (His/H) AAC, AGC – Glutamine (Gln/Q)	GUC, GCC, GAC, GGC – Arginine (Arg/R)	U C A G
A	AUU, AUC, AUA – Isoleucine (Ile/I) AUG – Methionine (Met/M)	CUA, CCA, CAA, CGA – Threonine (Thr/T)	AUA, ACA – Asparagine (Asn/N) AAA, AGA – Lysine (Lys/K)	GUA, GCA – Serine (Ser/S) GAA, GGA – Arginine (Arg/R)	U C A G
G	GUU, GUC, GUA, GUG – Valine (Val/V)	CUG, CCG, CAG, CGG – Alanine (Ala/A)	AUG, ACG – Aspartic acid (Asp/D) AAG, AGG – Glutamic acid (Glu/E)	GUG, GCG, GAG, GGG – Glycine (Gly/G)	U C A G



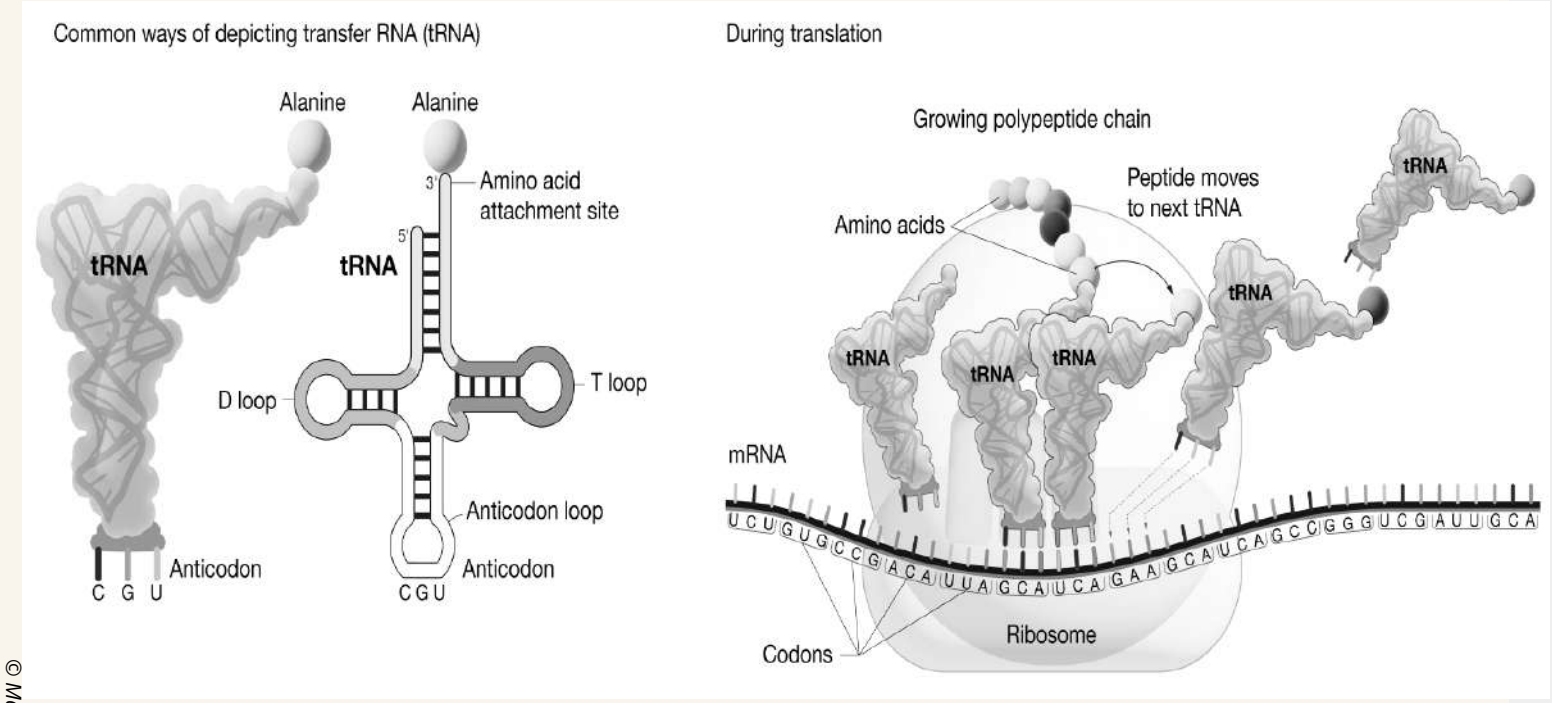
Ribosomal RNA - rRNA

Ribosomal RNA (rRNA) in Detail:

- **rRNA** is a single strand 100 to 3000 nucleotides long
- Globular in shape
- Made inside the nucleus of a cell
- Associates with proteins to form ribosomes
- **Site of Protein Synthesis**



Transfer RNA - tRNA



Transfer RNA (tRNA) in Detail:

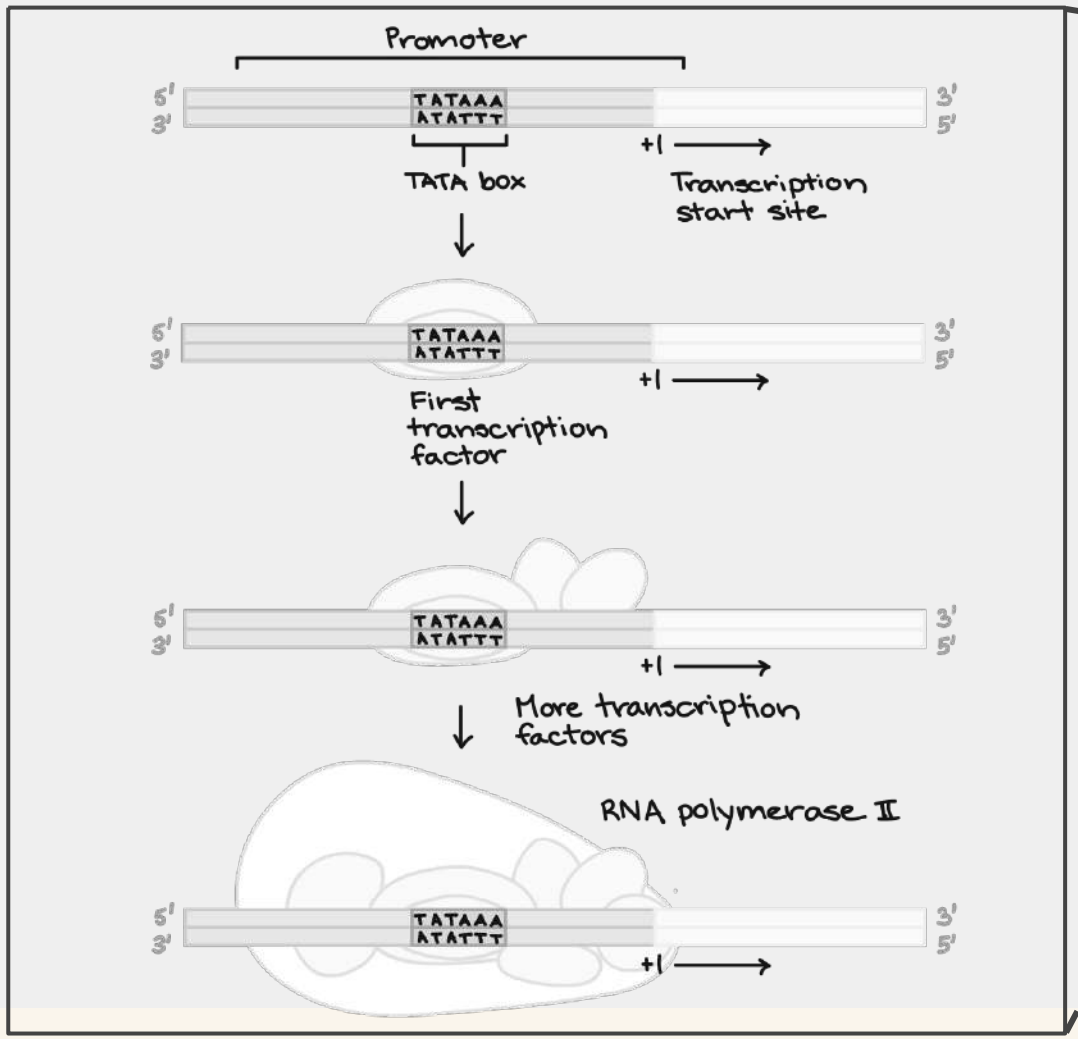
- Clover-leaf shape
- Single stranded molecule with attachment site at one end for an amino acid
- Opposite end has three nucleotide bases called the **anticodon**
- Comes from the **Nucleus**

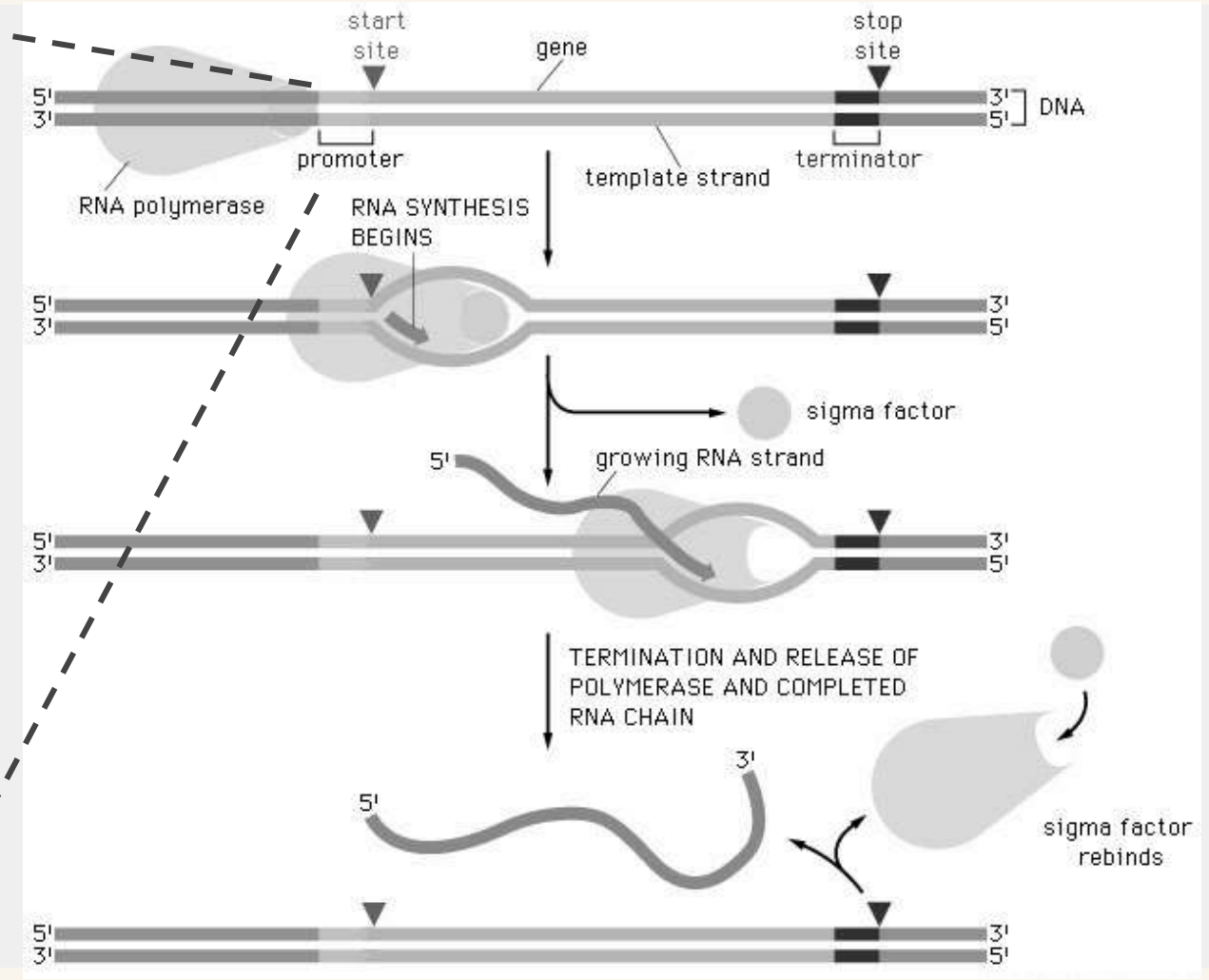
Transcription

Transcription

- The process of copying the sequence of one strand of DNA, the template strand
- **mRNA** copies the **template** strand
- Requires the enzyme **RNA Polymerase**
- During **transcription**, RNA polymerase binds to **DNA** and **separates** the DNA strands
  - **RNA Polymerase** then uses one strand of **DNA** as a **template** to assemble nucleotides into **mRNA**
  - **Promoters** are regions on **DNA** that show where RNA Polymerase must bind to begin the **Transcription** of RNA
  - Called the **TATA** box
  - The **termination signal** are specific base sequences act as signals to **stop**
  - Only **one** of the two DNA strands is **transcribed**. This strand is called the **template** strand, because it provides the template for ordering the sequence of nucleotides in an **RNA transcript**. The other strand is called the **coding strand**.
  - The DNA template strand is **read 3' → 5'** direction by RNA polymerase and the **new mRNA strand** is **synthesized** in the **5'→ 3' direction**.

Transcription - Cont

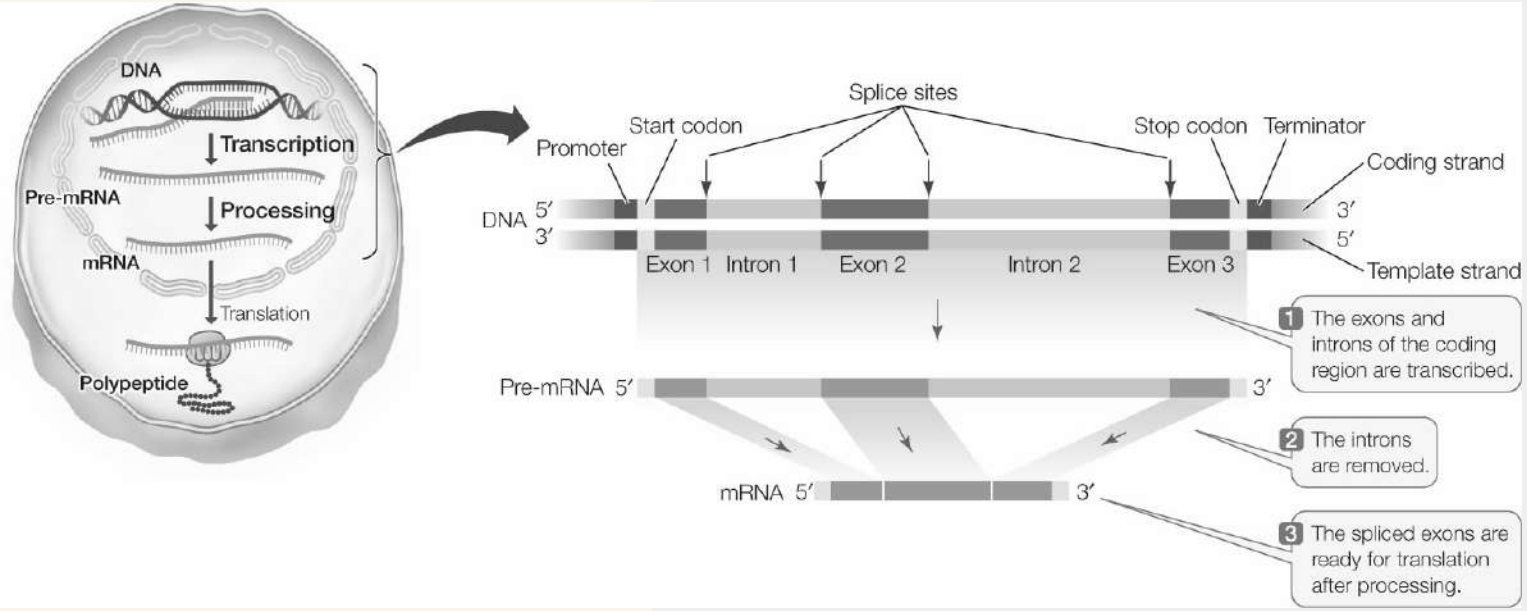




mRNA - Processing

New mRNA Processing:

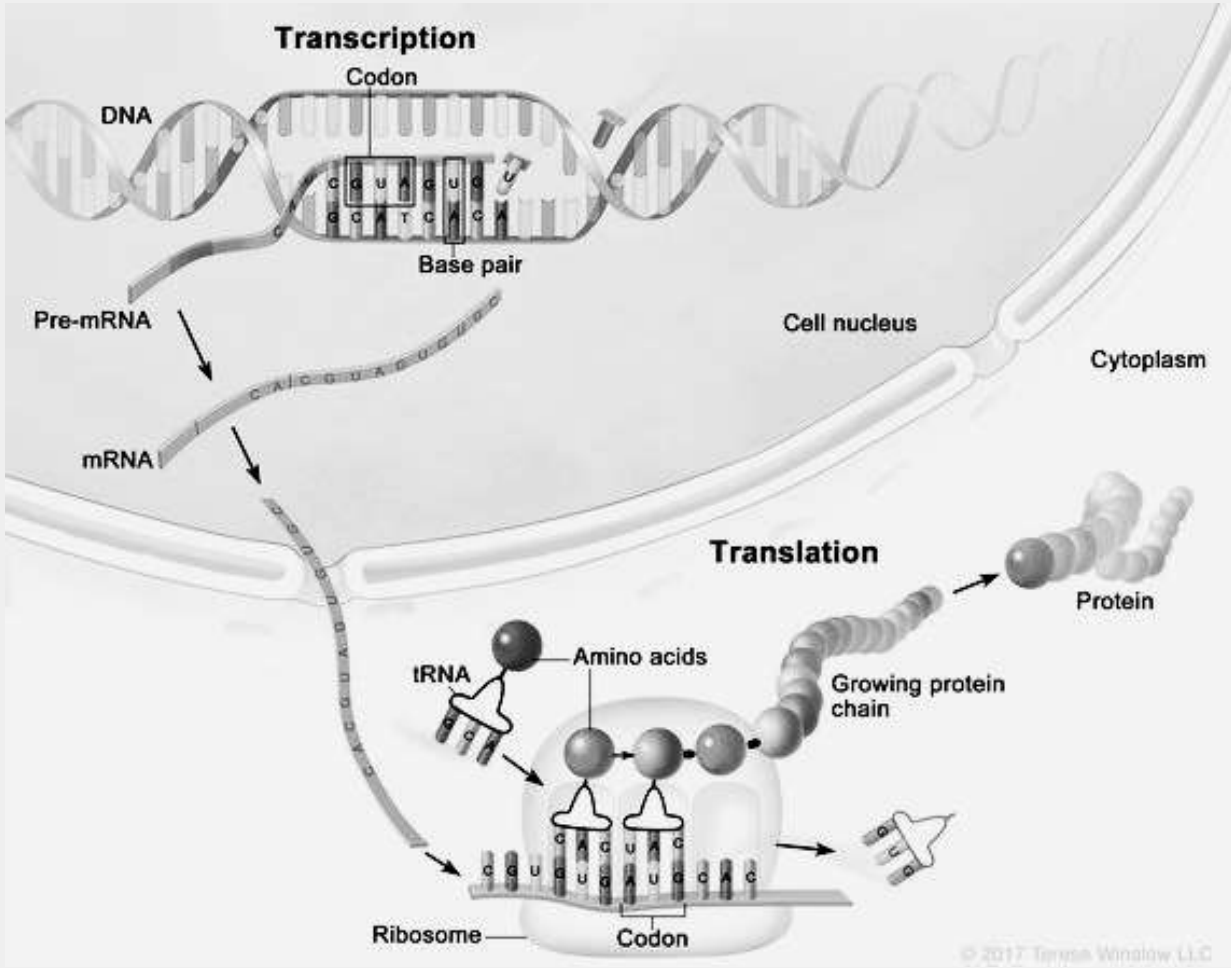
- **After** the **DNA** is **transcribed** into **mRNA**, editing must be done to the nucleotide chain to make the mRNA functional
  1. **Introns**, non-functional segments of DNA are snipped out of the chain
  2. **Exons**, segments of DNA that code for proteins, are then rejoined by the enzyme ligase
  3. A **guanosine triphosphate cap** is added to the **5" end** of the newly copied mRNA
  4. A **poly A** tail is added to the **3' end** of the RNA
  5. The newly processed **mRNA** can then **leave** the **nucleus**
  6. mRNA leaves the nucleus through its **pores** and goes to the **ribosomes**



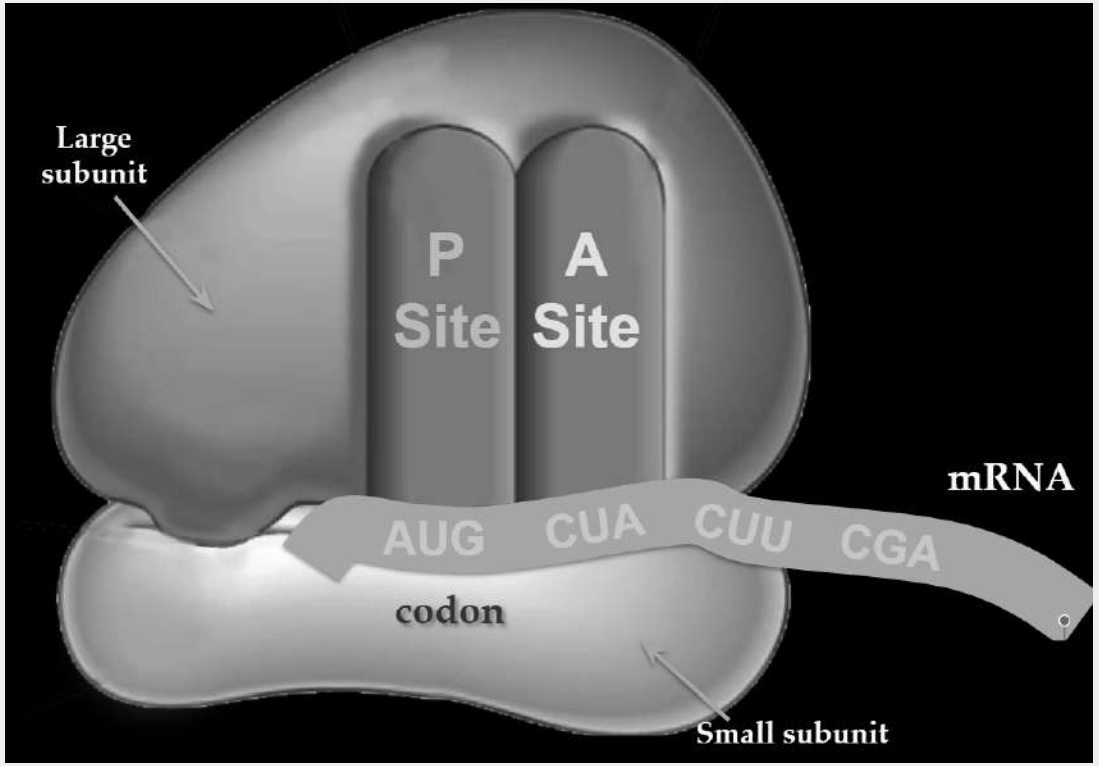
Translation

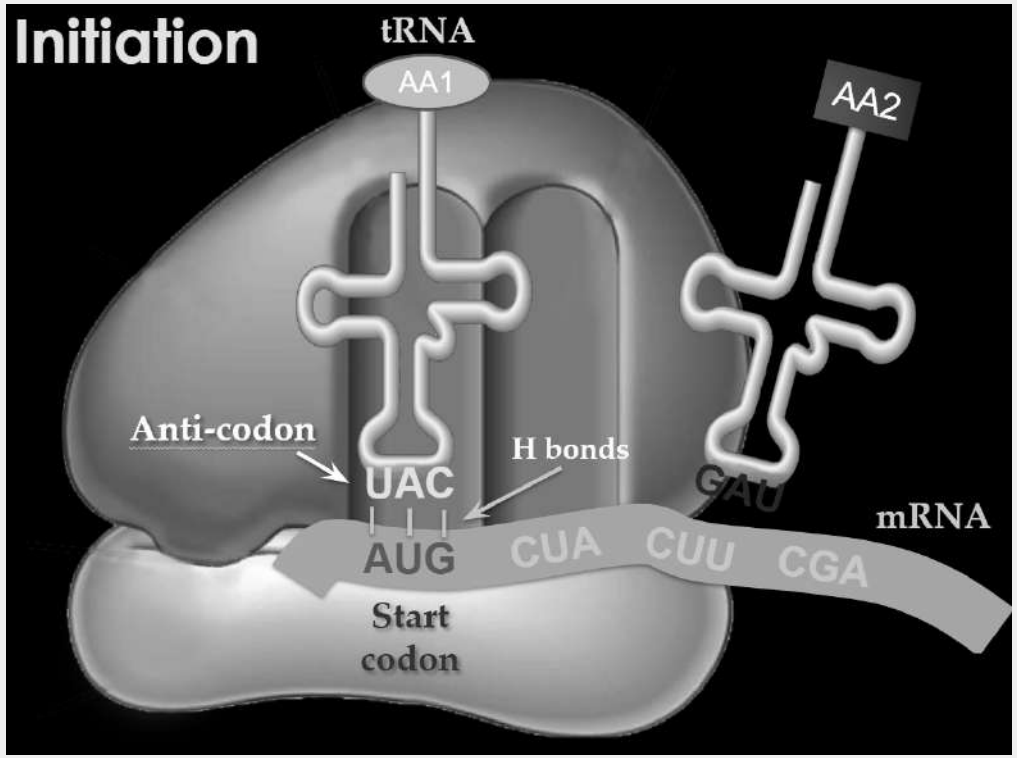
Translation

- **Translation** is the process of **decoding** the **mRNA** into a **polypeptide** chain (**protein**)
- **Ribosomes** read **mRNA three bases** or **1 codon** at a time and construct the proteins
  - Made of a **large and small subunit**
  - Composed of **rRNA** (40%) and proteins (60%)
  - Have two sites for **tRNA attachment**: **P site** and **A site**
  - **Stage 1: Initiation**
    - ❑ **mRNA** transcript **start codon AUG** attaches to the small ribosomal subunit
    - ❑ Small subunit attaches to large ribosomal subunit

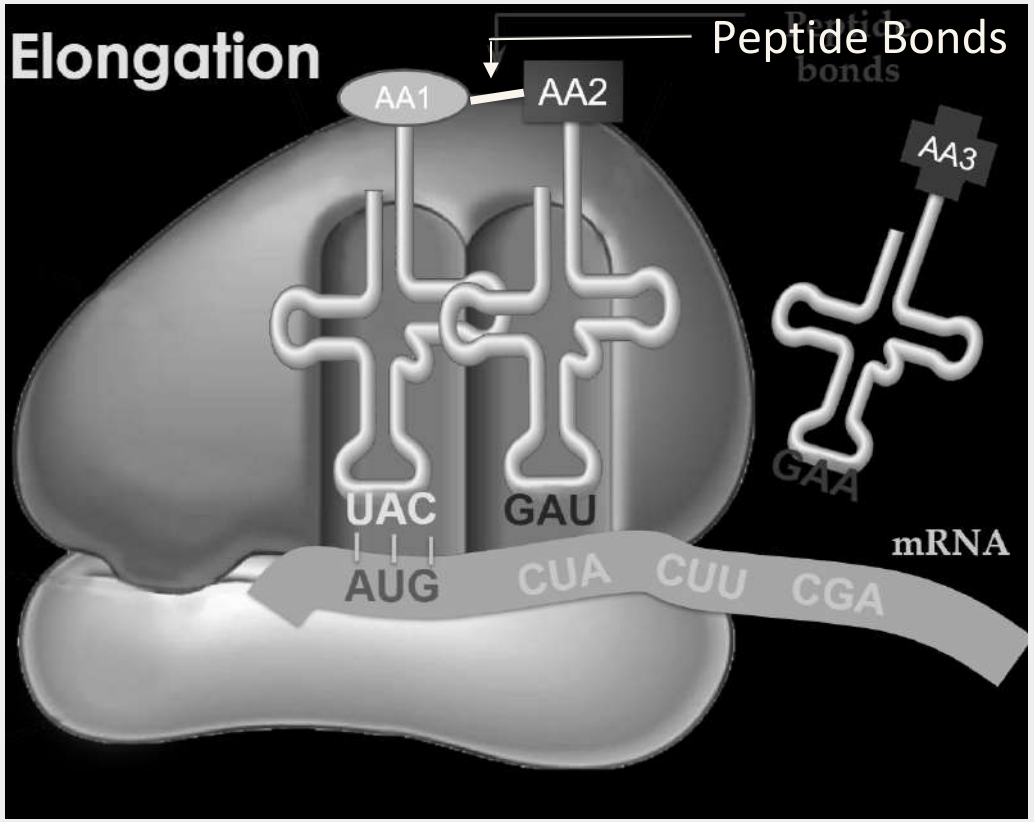


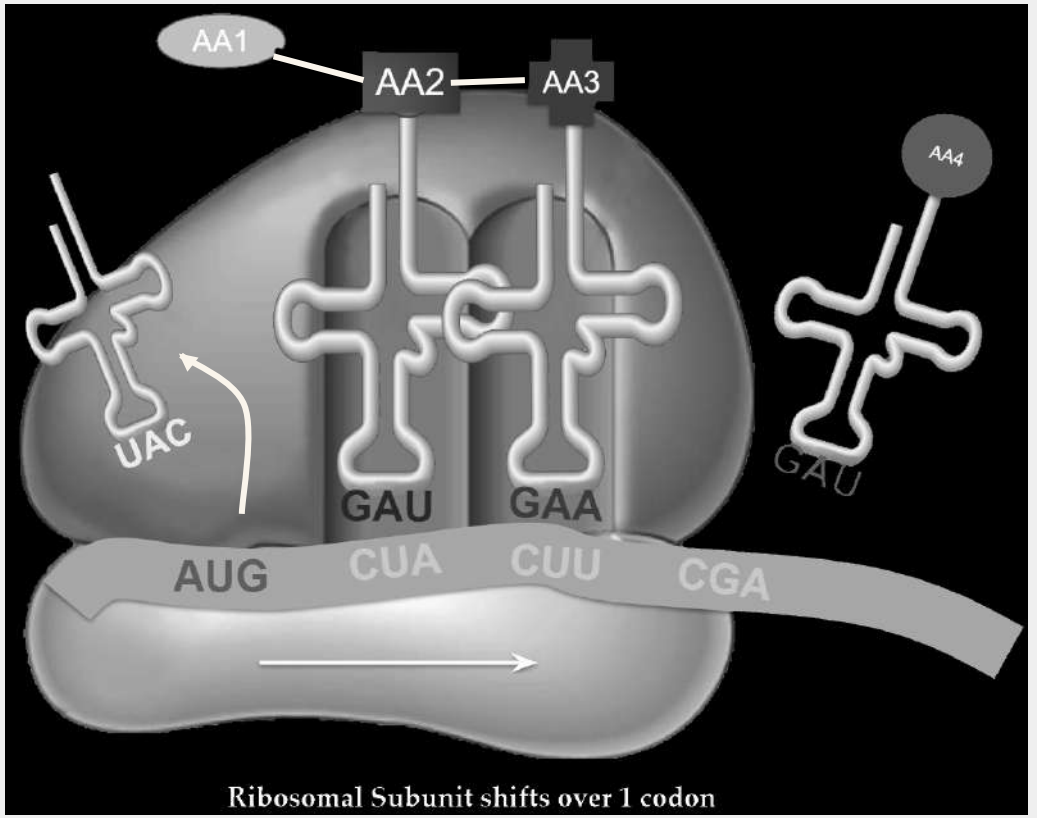
Transcription - Initiation



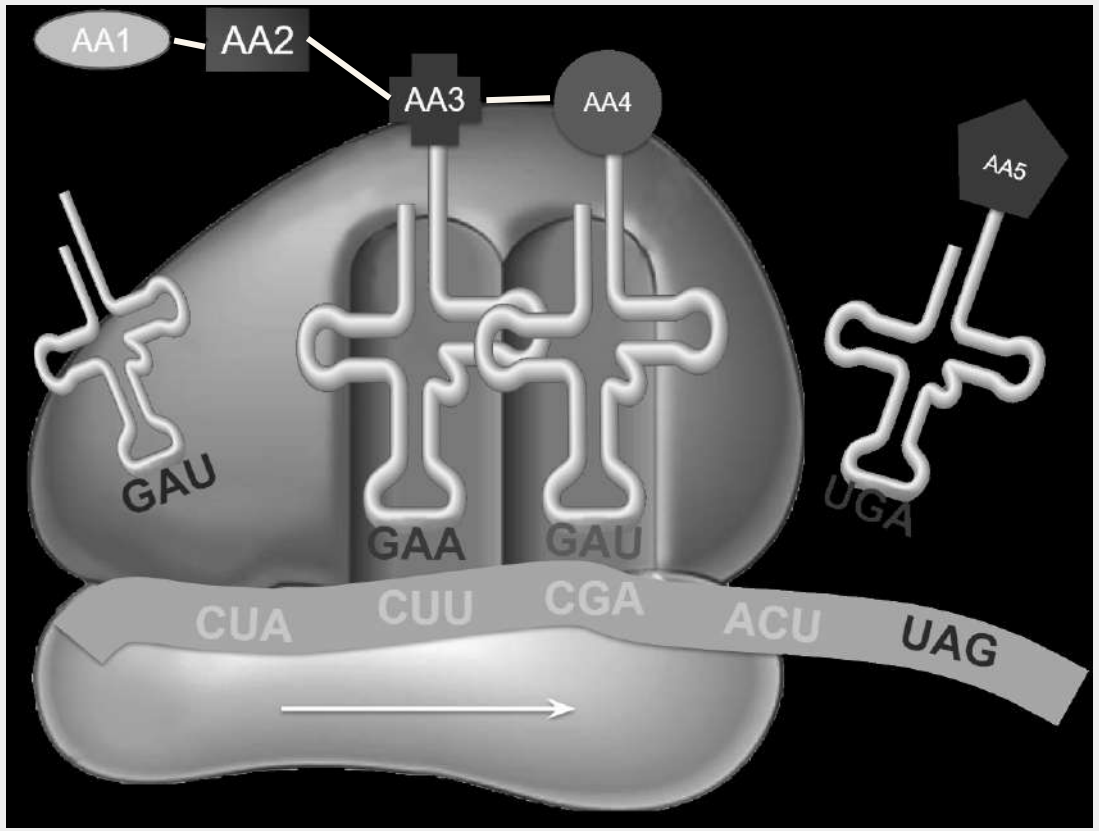


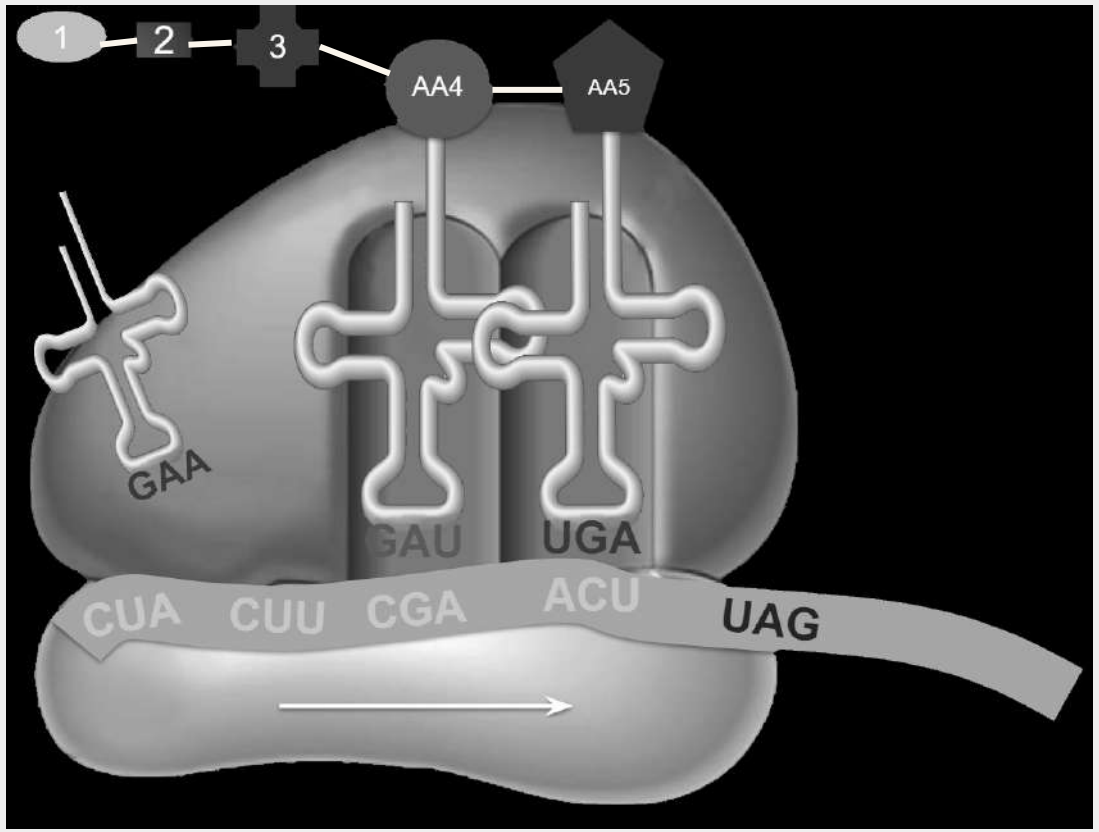
Transcription - Elongation



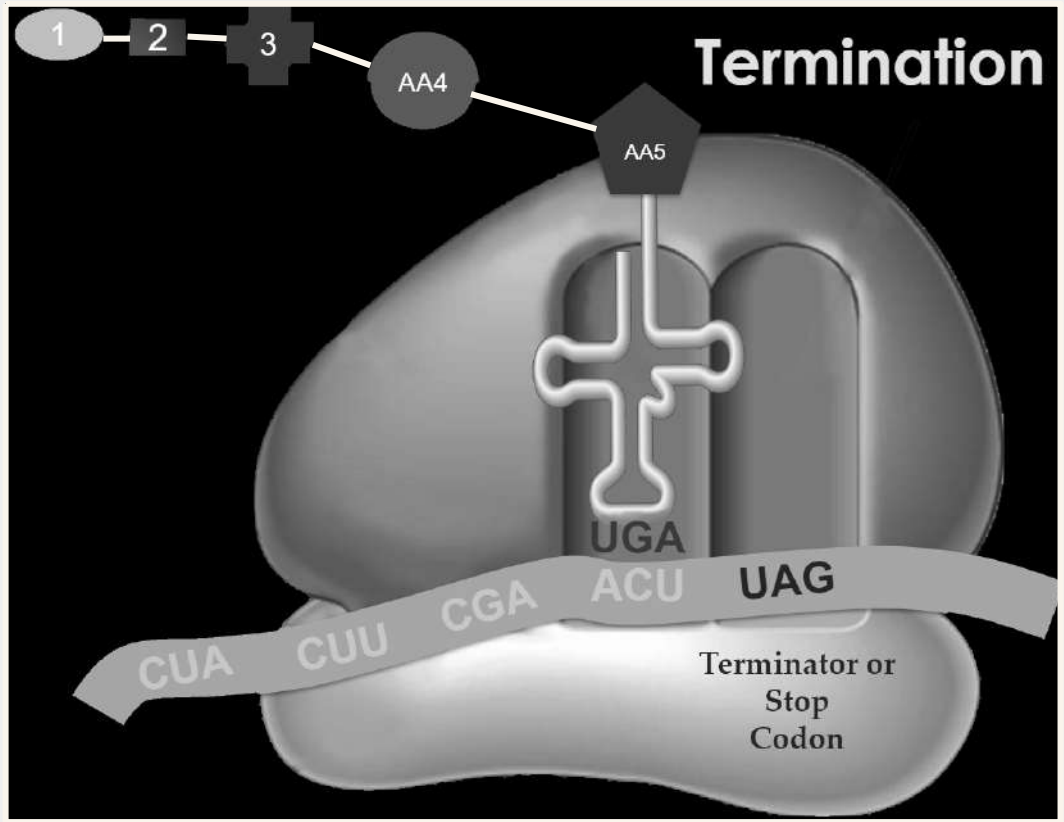


Transcription - Continued



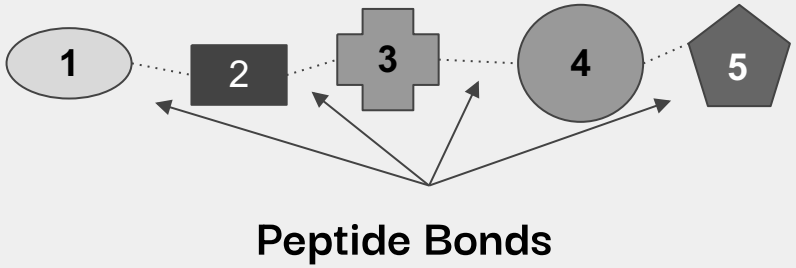


Transcription - Termination

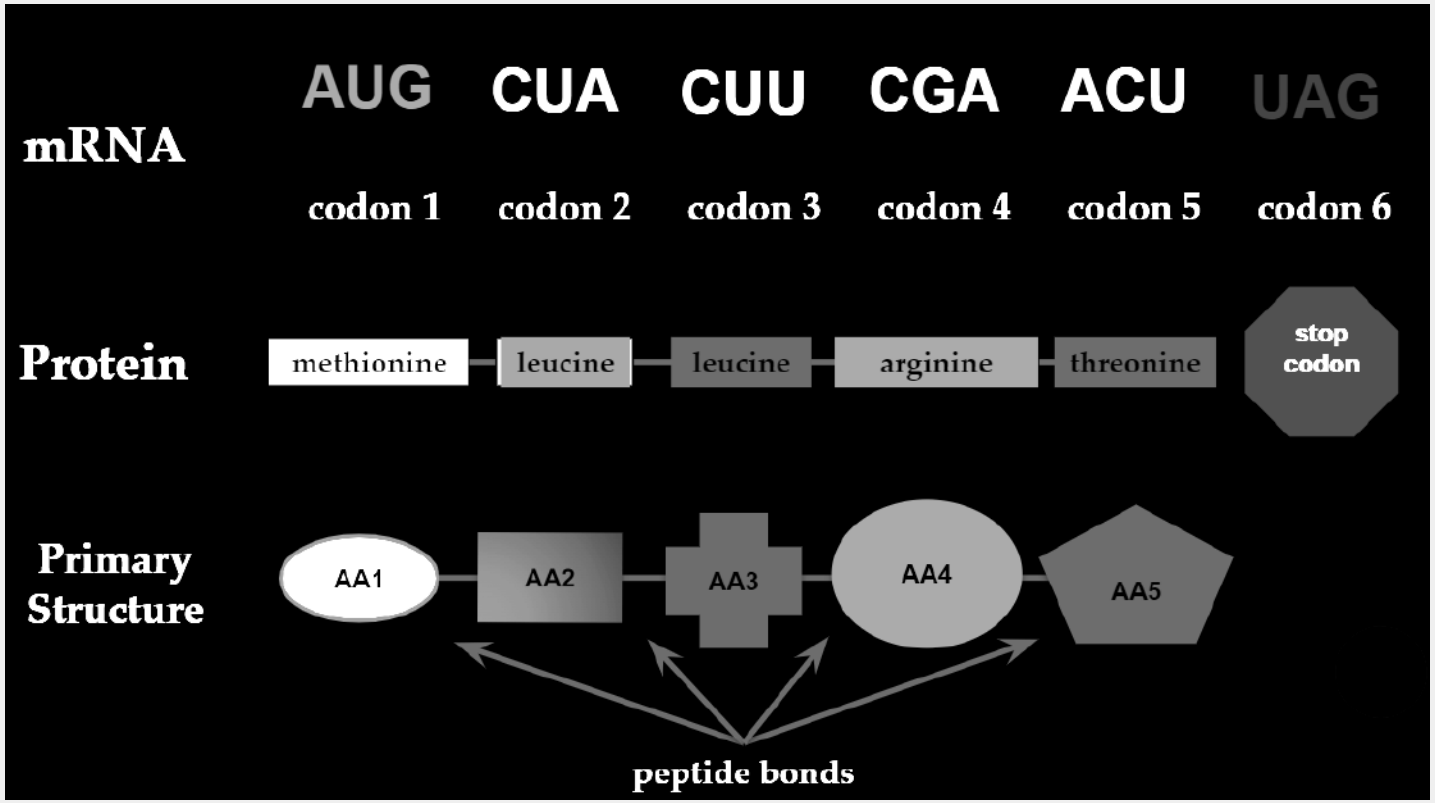


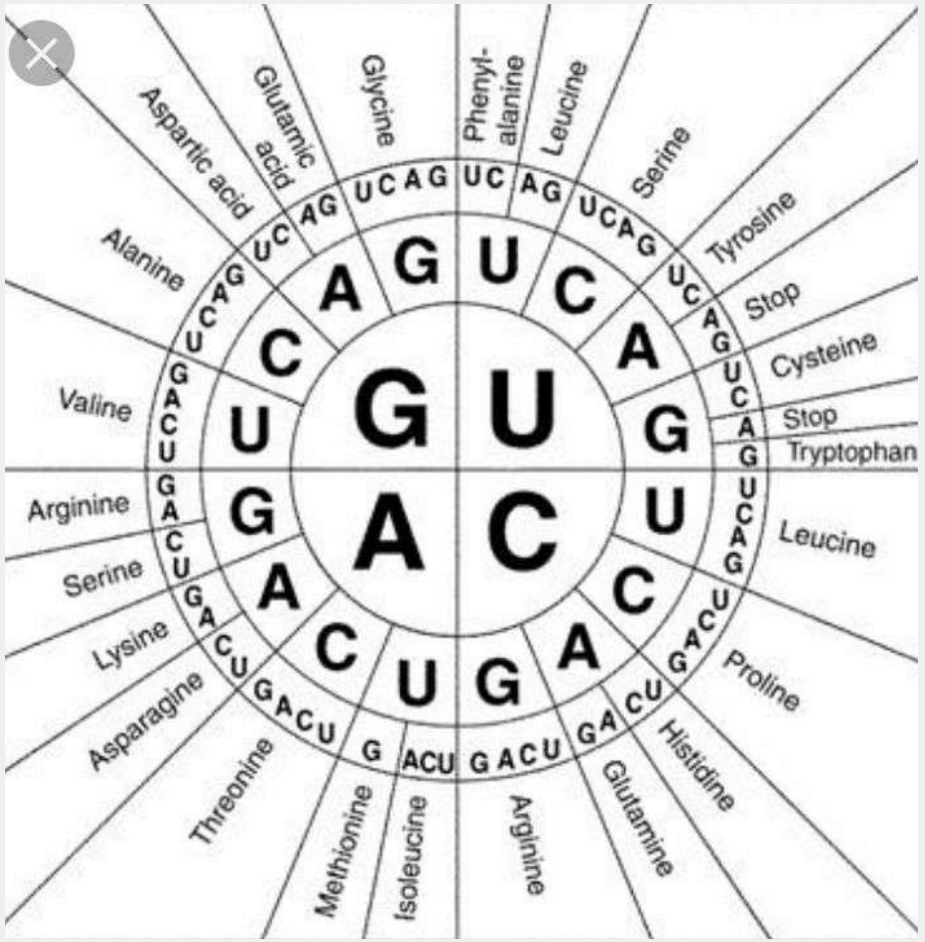
The End Product – The Protein:

- The end products of protein synthesis is a primary structure of a protein
- A sequence of amino acid bonded together by peptide bonds



Transcription - Summary





Thank you!

Do you have any questions?

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xxx-xxx-xxxx