Translation

Packet #21

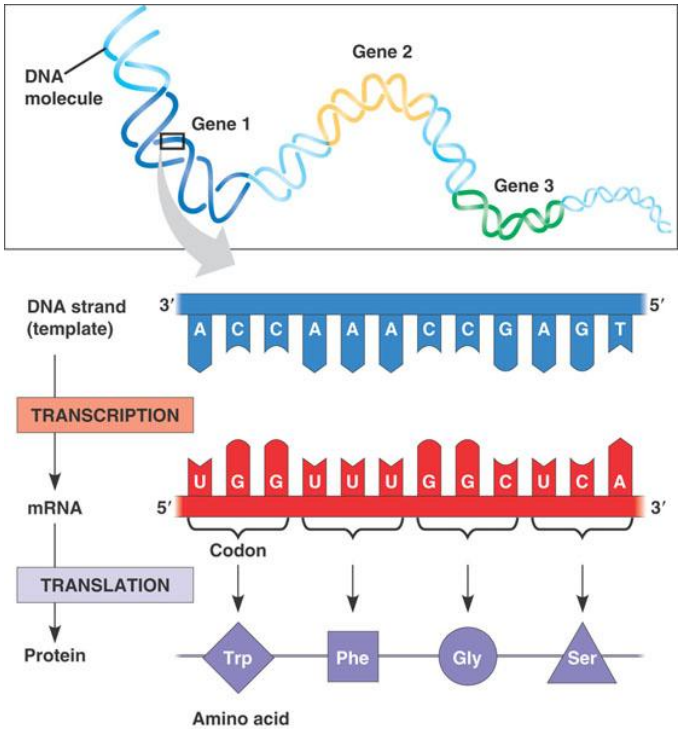
Introduction

* The process of **protein synthesis** where mRNA, produced during transcription, provides the genetic code that specifies an amino acid sequence.
* Proteins are translated from mRNA with the help of ribosomes.

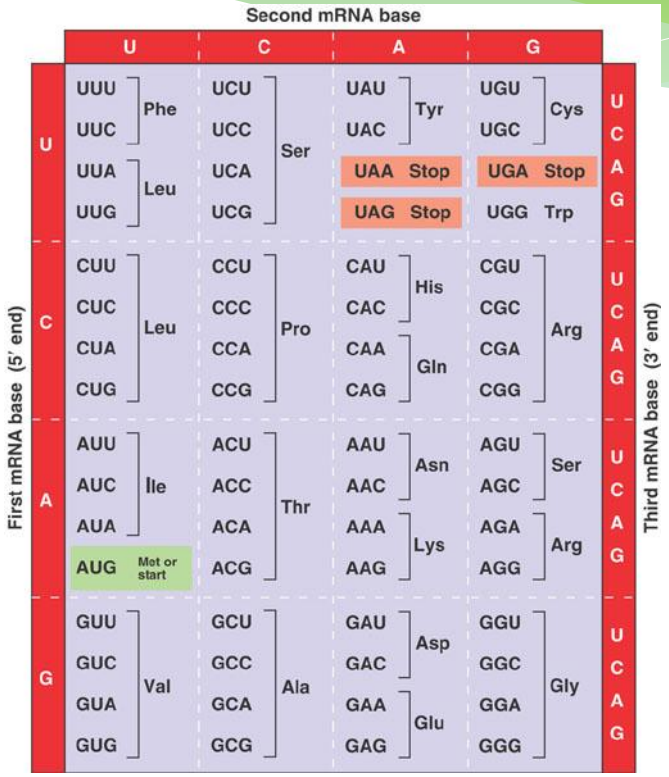
RNA

Messenger RNA

- **Contains the "genetic code" in the form of codons.**
- **Codons**
  - A sequence of three RNA nucleotides
  - Specifies the amino acid
  - There is a **total of 64 codons**
    - 61 code for amino acids
      - 1 of the 61 codons, that code for amino acids, is also used as the start codon
        - AUG
    - 3 serve as stop signals
      - UAA
      - UAG
      - UGA

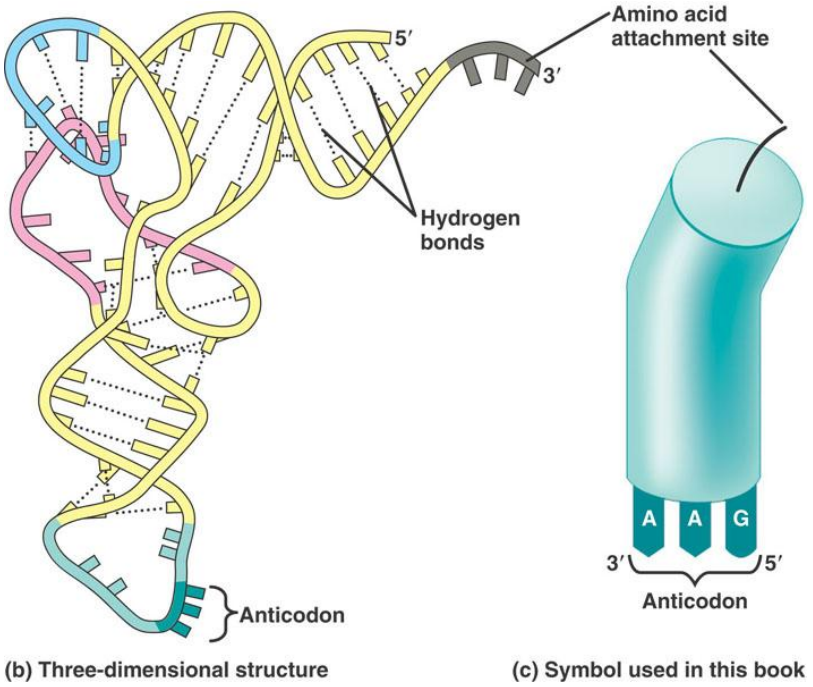


Codons & Amino Acids



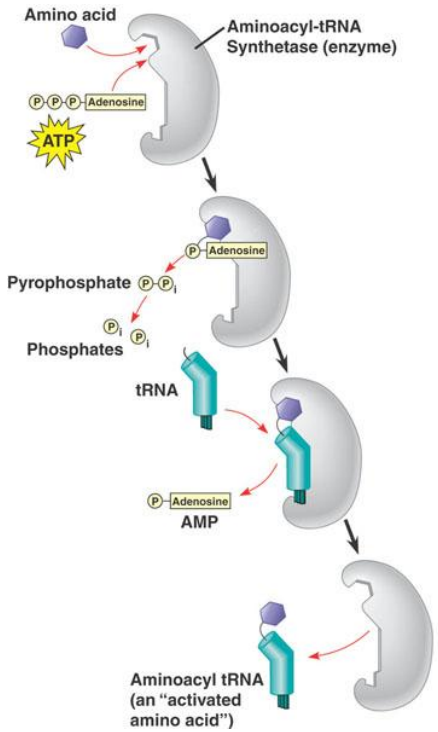
Transfer RNA

* The "transporter"
* Class of small RNA molecules that **bear/carry specific amino acids,** to the ribosome, during translation
* Structure formed by use of hydrogen bonds



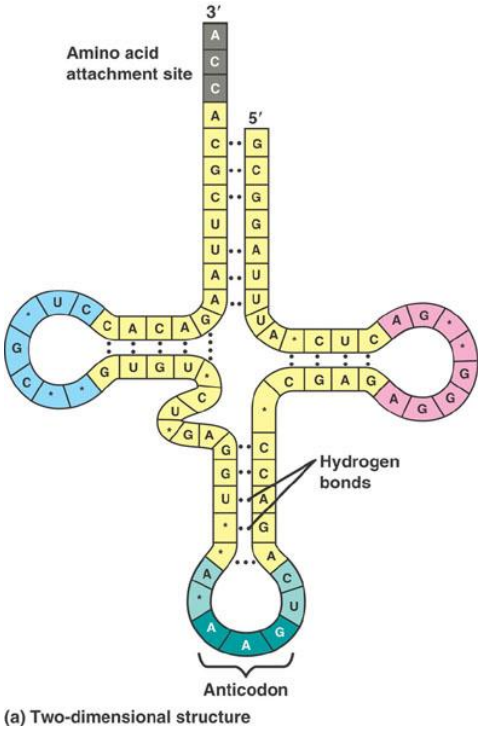
Transfer RNA II

* How does the amino acid attach to the tRNA?
  * Amino acids are covalently bound to tRNA by ***aminoacyl-trna synthetase.***



Transfer RNA III

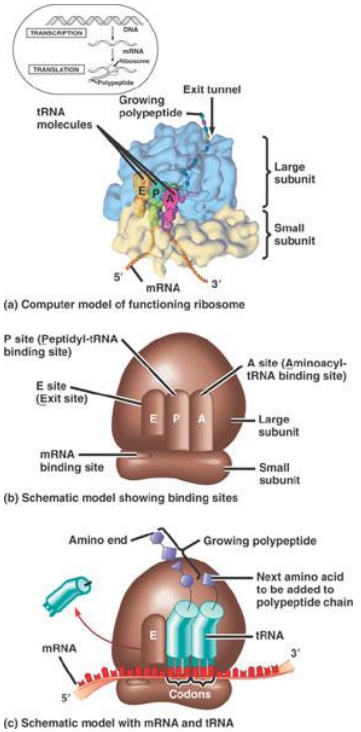
* Along with carrying amino acids, they must also **carry the anti-codon to pair with the codon** found on the messenger RNA



Ribosomes

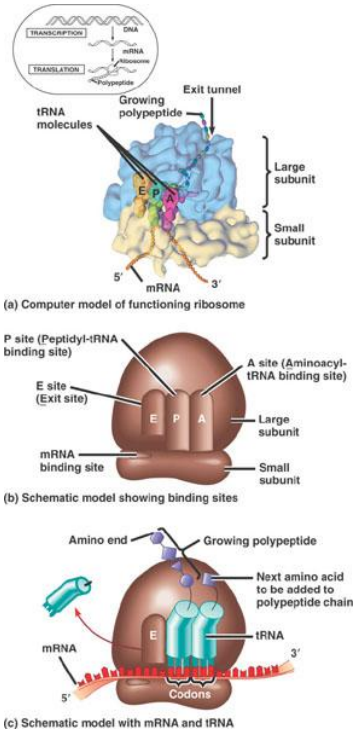
Ribosomes

- Acts as the **site of protein synthesis** in the cell
  - The factory of proteins
- May be either in the form of **large subunits** or **small subunits**



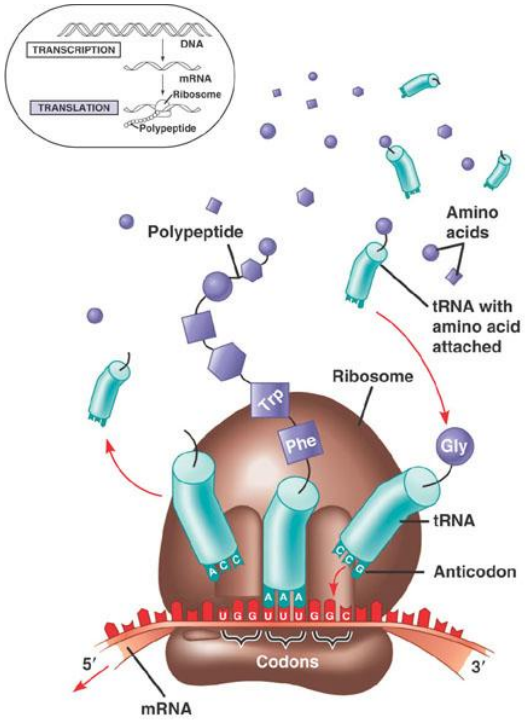
Ribosomes II

- **Large subunits**
  - Contains 30S
    - rRNA subunits
  - Will also have three sites
    - A site
      - Amino acid attachment site
    - P site
      - "Polypeptide" site"
    - E site
      - Exit site
        - Exiting of tRNA
- **Small subunits**
  - Contains 15S



Ribosomes, mRNA & tRNA

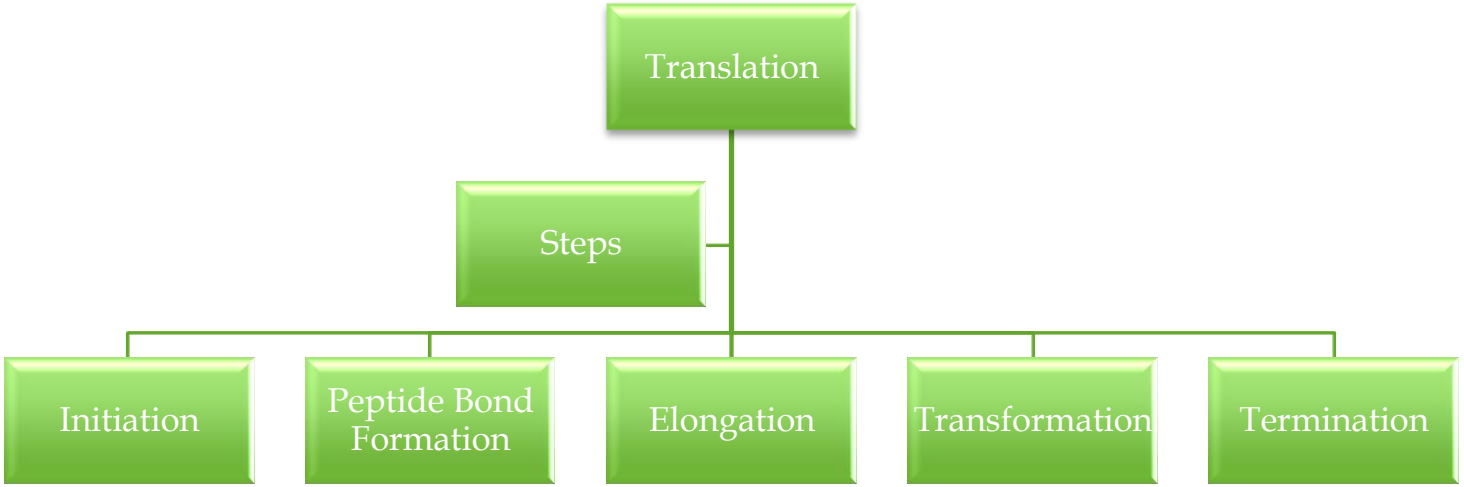
* These are all pieces involved in the process of making a protein.



Steps of Translation

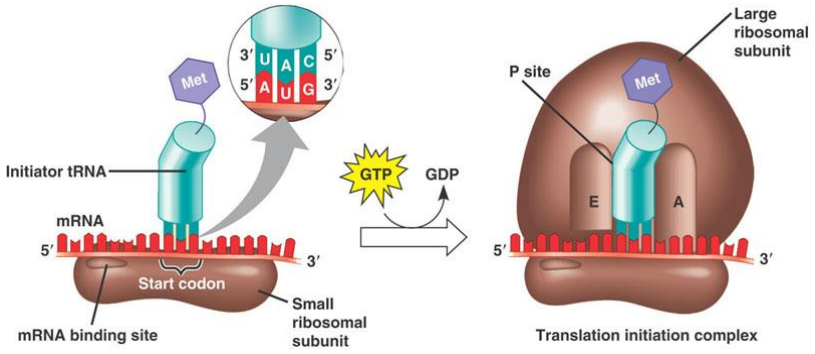
Introduction

* There are five basic steps during the process of translation.



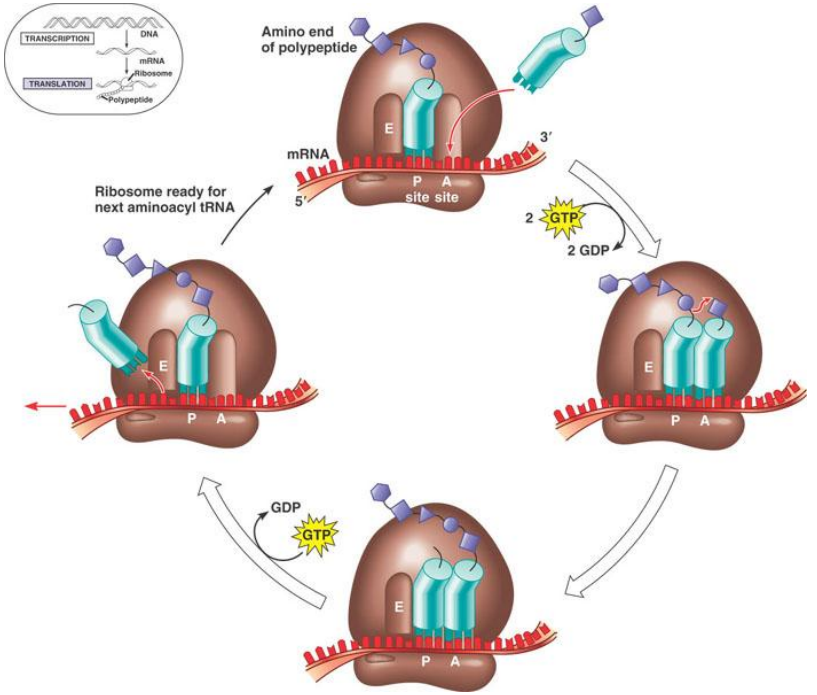
Translation Initiation

* Small subunit binds to mRNA
* **Initiator tRNA** binds at start codon
  * Start codon = AUG
  * tRNA carries anti-codon UAC
  * Initiator tRNA **carries amino acid MET**
* Large subunit binds to mRNA
  * 1 molecule of GTP is used
* Initiator tRNA will be located at the P site of large subunit



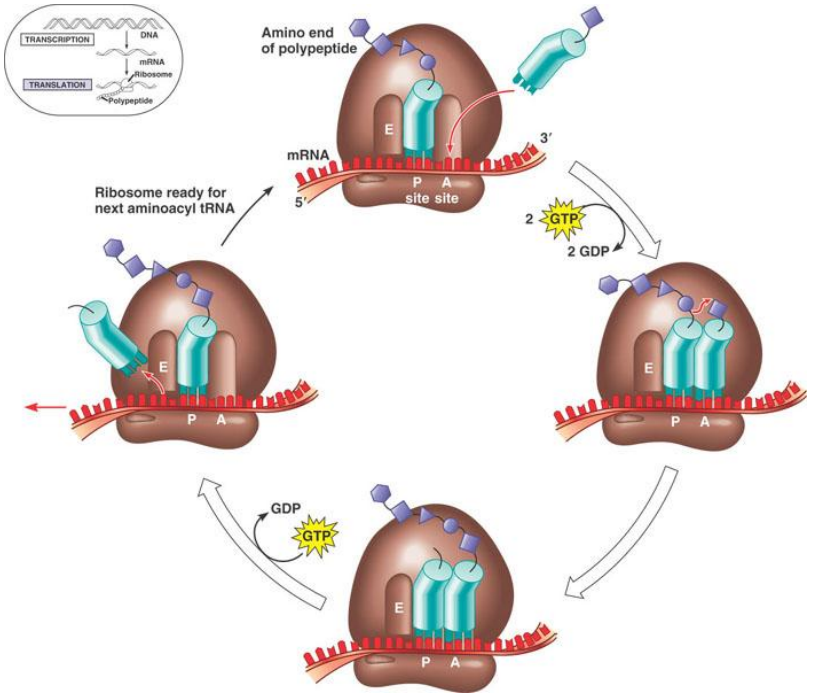
Translation
Peptide Bond Formation & Elongation

* Ribosome (rRNA) catalyzes the formation of a peptide bond between the new amino acid and the carboxyl end of the growing polypeptide.
  * Complete with ***the use of 2 GTP's and the enzyme peptidyl transferase .***



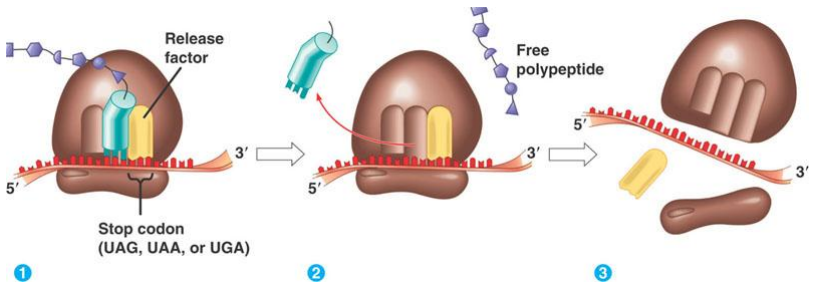
Translation Translocation

* The movement of the ribosome down the mRNA allowing tRNA to change ribosome sites
  * Moves from A site to P site
  * Moves from P site to E site



Translation Termination

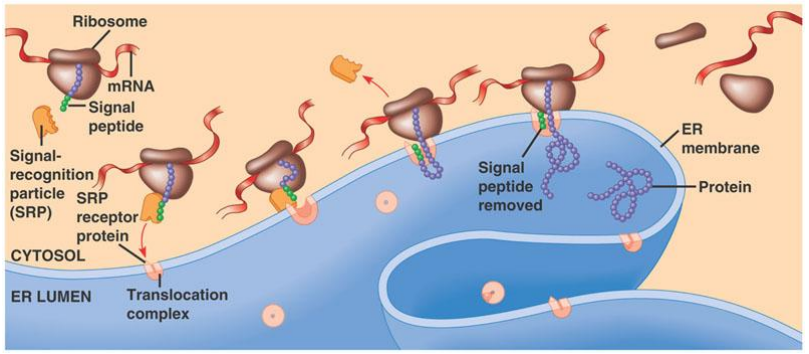
* Ribosome reaches stop codon and release factor binds
* Release factor initiates process causing tRNA and polypeptide chain to be released
* Large subunit, small unit break apart releasing its bond to the mRNA.



The ER Connection

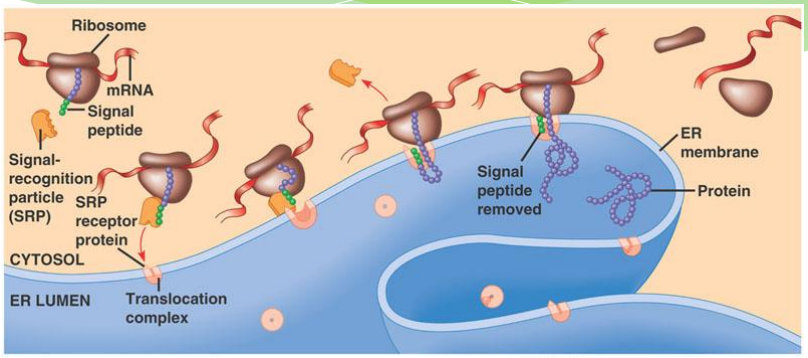
The ER Connection

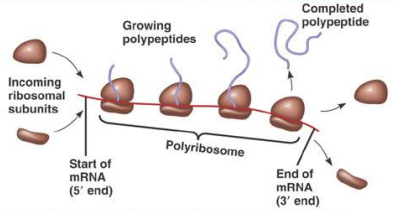
- A signal sequence, at the beginning of the polypeptide chain, indicates that the chain will be imported into the ER
- Most of the proteins that enter the ER begin to be threaded across the ER membrane before the polypeptide chain is completely synthesized
- This requires that the ribosome synthesizing the protein is attached to the ER membrane.
  - Allows the formation of the Rough ER



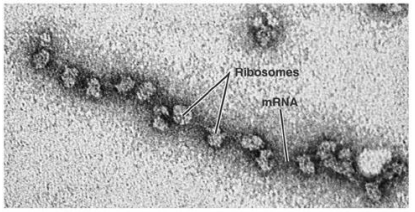
The ER Connection II

* The proteins produced may be destined for other organelles such as the Golgi Apparatus, endosomes and lysosomes, or even the cell surface
  * Recall that once inside the ER, the proteins will have to be ferried via transport vesicles.





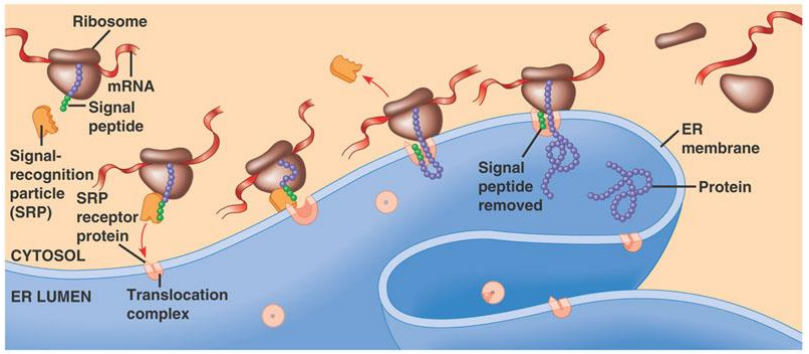
(a) An mRNA molecule is generally translated simultaneously by several ribosomes in clusters called polyribosomes.



(b) This micrograph shows a large polyribosome in a prokaryotic cell (TEM).

The ER Connection III

- The SRP (signal recognition particle) binds to the exposed ER signal sequence and to the ribosome
- Protein synthesis is slowed
- SRP-ribosome complex binds to an SRP receptor in the ER membrane
- SRP is released leaving the ribosome on the ER membrane
- A protein translocation channel in the ER membrane inserts the polypeptide chain into the membrane and starts to transfer it across the lipid bi-layer.



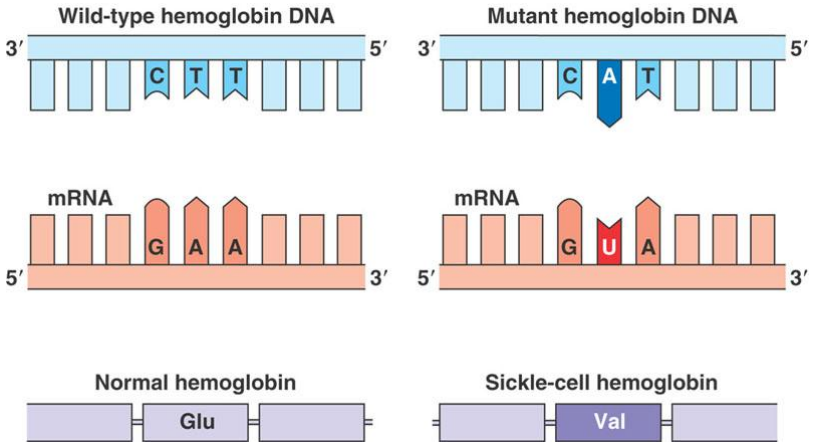
Mutations

Introduction

* When the base sequence of a molecule of DNA is altered, the amino acid sequence of the polypeptide for which it codes will likewise be altered.
  * Hence, this affects the operation of enzymes
    * Recall some genetic disorders previously covered

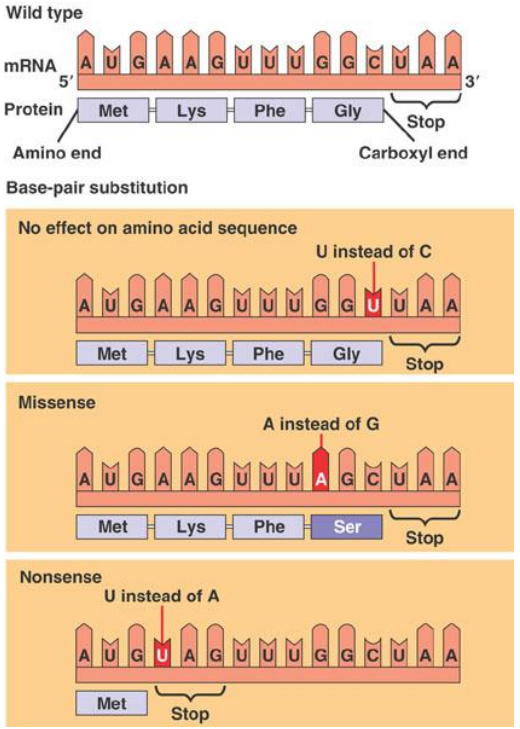
Types of Mutations

* **Point Mutation**
  * Change a single nucleotide of a gene.
  * Sickle Cell Anemia



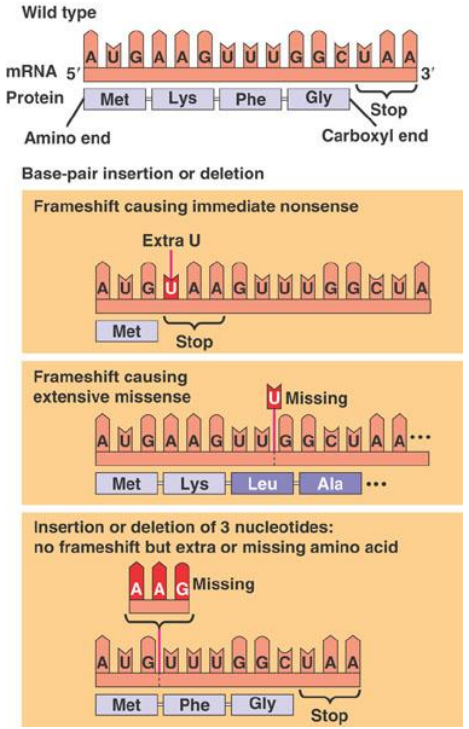
Types of Mutations

- **Point Missense Mutation**
  - The most common type of mutation where the new codon still codes for AN amino acid
    - But not necessarily the same amino acid
- **Point Nonsense Mutation**
  - A mutation that changes an amino acid codon to an amino acid codon that is a stop codon--usually resulting in a shorter, and non-functional form, of a protein



Types of Mutations

* **Frameshift**
  * The insertion, or deletion, of one/three nucleotides resulting in the incorrect sequence of amino acids.
    * Results in a ***frameshift missense mutation or a frameshift nonsense mutation***
  * Huntington Disease
  * Cystic Fibrosis



Review