Biology 1305 – Modern Concepts in Bioscience – Campbell Textbook Week 14

Hello everyone and welcome back to another resource! Last week, Chapter 17 was covered in pretty extensive detail regarding transcription, translation, mutations, and RNA processing. As most professors are still on Chapter 17, this week's resource will recap translation and focus on how we get proteins from the ribosome to their desired destinations. I hope you guys are excited!

Keywords for this resource are: protein folding, post translational modifications, and signal recognition proteins, translation, EPA sites

Below are some excellent videos covering the whole chapter for you to brush up on where we are at in the story of the central dogma.

Transcription, Translation, and Genetic Code
Molecular Components of Transcription
Stages of Transcription
Molecular Components of Translation
Stages of Translation
Post-translational Modification and Signaling Mechanism

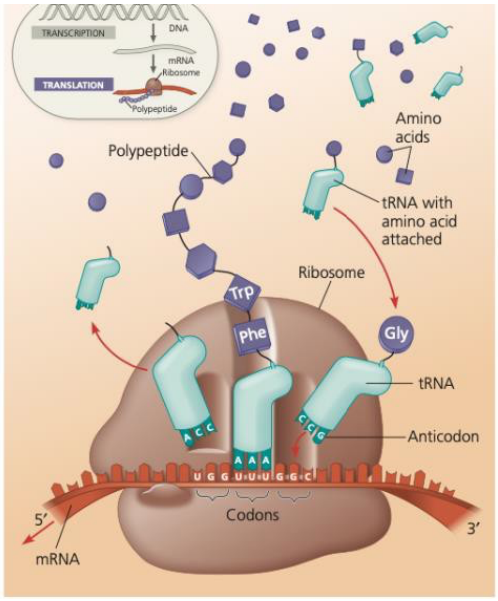
Translation

Translation is the RNA directed synthesis of a polypeptide.

- there are several different types of RNA involved in this process.
- While most of you are familiar with **mRNA**, and **tRNA** in the process, **ribosomal RNA or rRNA** is present within the ribosome to helps with the specific coupling of tRNA anticodons to mRNA codons.

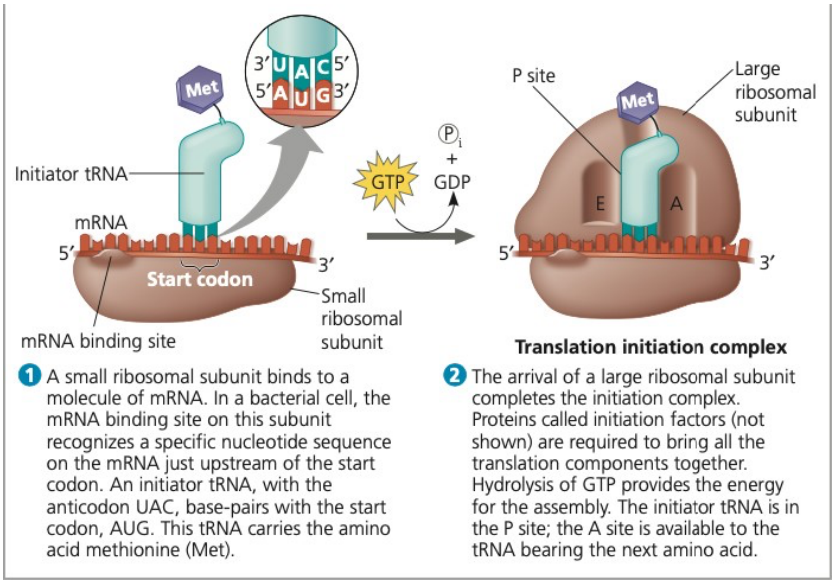
On the right, you see an excellent picture giving an overview of what to expect in the process.

- mRNA will be read by tRNA in coordination with the ribosome
- tRNA carrying amino acids will read the mRNA code, match its **anticodon** to the mRNA **codon**, and synthesize the polypeptide chain.

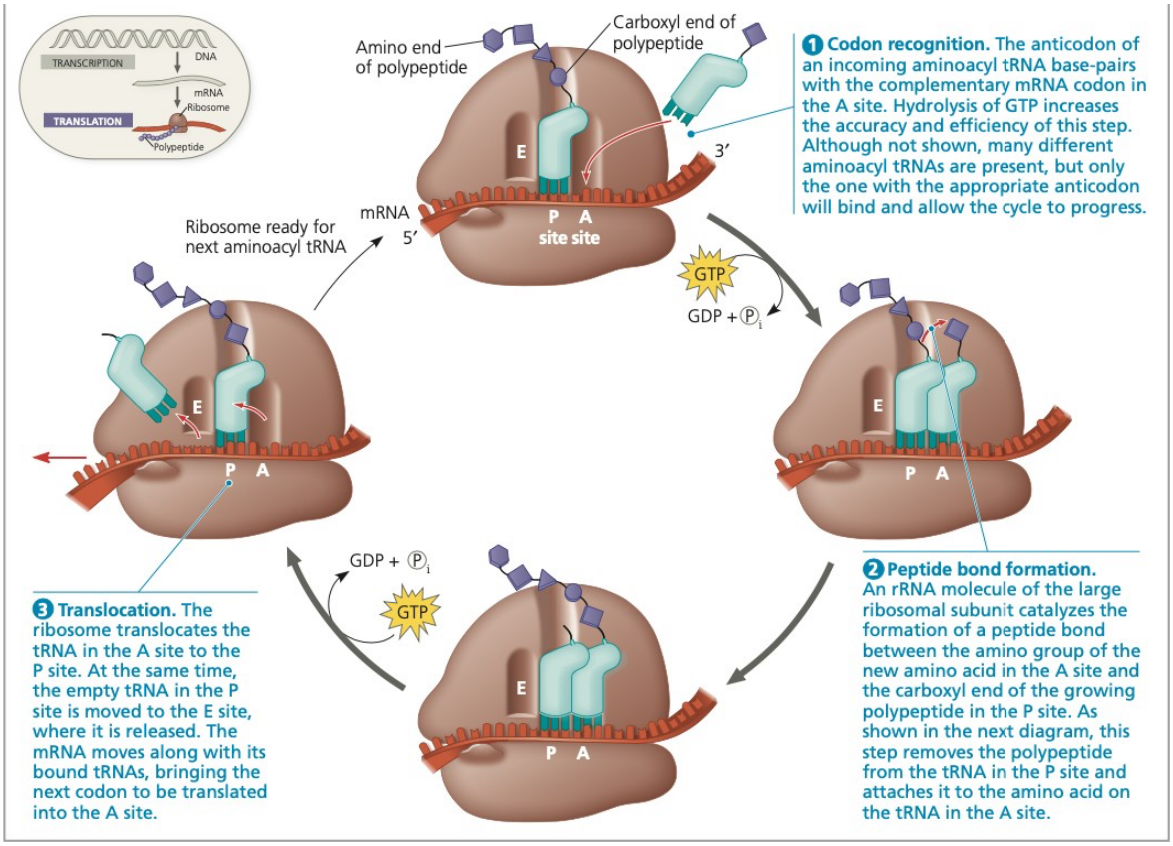


Like transcription, we can split up translation into two parts: the initiation and elongation processes.

In initiation, the **small ribosomal subunit** binds to the mRNA first at the **mRNA binding site**. The initiator tRNAbinds to match the mRNA start codon (universal start codon is AUG).



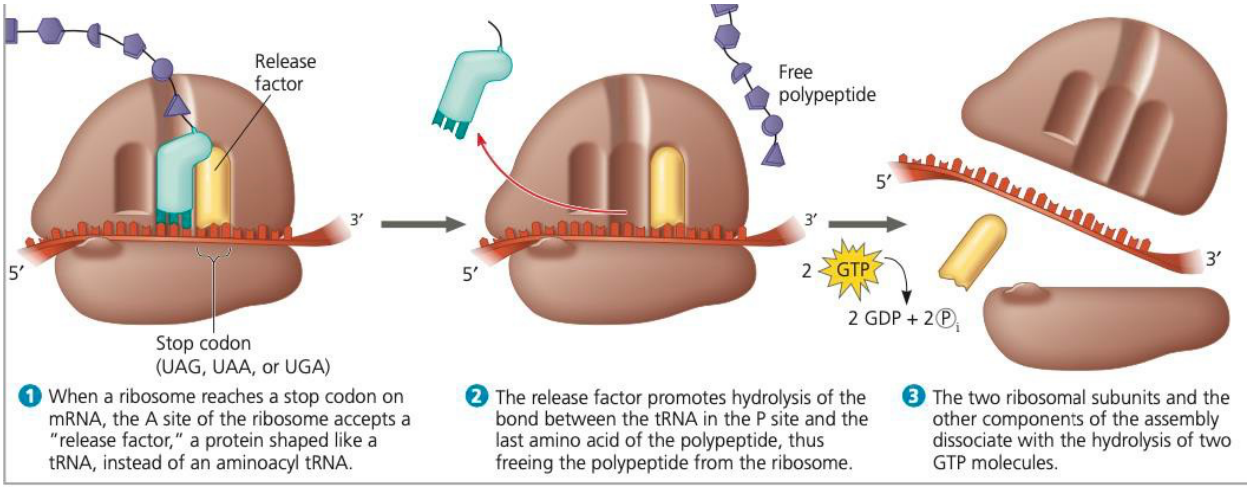
Through the use of energy in the form of GTP hydrolysis to GDP and inorganic phosphate, the large ribosomal subunit is able to bind and complete the initiation complex. You will notice 3 distinct areas in the ribosome **E, P, and A**. Think of them as **E-exit, P-peptide, and A-arrive** and watch how tRNA will move through these sites depending on the stage of elongation.



As you can see above, protein synthesis is as **energetically costly process**!

- After the initiation complex has been formed, the next codon from the start codon is read, bringing in the complementary tRNA to the A site with its corresponding amino acid attached to it.
- Upon entering the A site, a rRNA molecule will catalyze the formation of a peptide bond between the polypeptide on the P-site tRNA and move it to the A-site tRNA. The P-site tRNA isnow empty.
- The ribosome will then shift over, and the tRNA's will shift to the site on their left. The P-site tRNA has now exited via the E-site, and the A-site tRNA has now refilled the P-site.

The ribosome is now ready to receive the next amino acid determined by the next codon to be read.This process continues upon recognition of the **stop codon** (UAA, UAG, UGA)



Protein Folding and Post Translational Modifications

Much like with RNA, our proteins need to be modified to be fully functional for whatever target they are about to arrive at. Without this, proteins would stay at the ribosome, or freely floating in the cytosol with nowhere to go, and that would be **bad news bears (**hehe sic' em)

- Proteins begin to **spontaneously fold and coil** as they are being synthesized due to the amino acid sequence it contains (primary structure)
- This in turn leads to a protein with a specific shape. A **three-dimensional molecule with secondary AND tertiary structure**.
- This is really huge, as this means that a **gene determines primary structure, which then determines secondary, tertiary, and even quaternary structure of proteins**. It's all due to our DNA!!

Some steps may occur called **post translational modifications** before the protein goes and does its duty

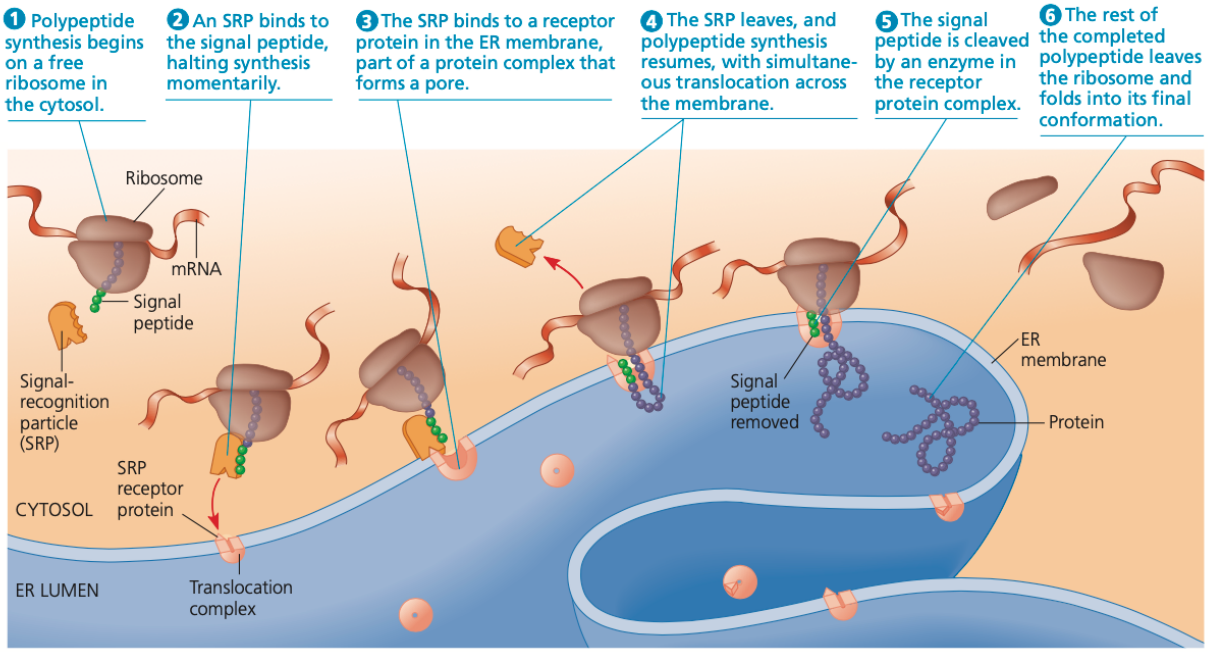
- Certain amino acids can be chemically modified through the additions of sugars, lipids, phosphate groups, or even simple chemical compounds. Each one offers a unique property to the amino acid for its desired duty (for example, sugars are excellent labeling molecules that essentially let the cell know that a specific protein is meant to go to a specific location)
- Enzymes can even remove amino acids or cleave a protein
- Multiple polypeptides can come together to make a protein with **quaternary structure**! Hemoglobin is a great example of this.

Targeting Polypeptides to their Specific Locations

So how does this all relate to sending proteins to their specific locations? First we need to make a few quick things:

- There are 2 types of ribosomes:
  - **free ribosomes**, which are in the cytosol and make proteins that stay and work in the cytosol
  - **bound ribosomes**, which are bound to the **rough endoplasmic reticulum** and make proteins that are destined for the endomembrane system and secretion (insulin).
- One really important thing to note is that the ribosomes are the **exact same** and they can alternate between being bound at one point and free at the next

Figure 17.22 The signal mechanism for targeting proteins to the ER.



These ribosomes are going to going to create these proteins as normal in the cytosol, but our proteins created by the bound ribosome do something a little different

- These proteins are marked by a **signal peptide** which targets the protein to the ER
- This signal peptide is recognized by a protein-RNA complex called **the signal recognition particle** which escorts the ribosome to a receptor protein on the ER membrane
    - The ribsome started off free and became bound!
- The protein will continue being synthesized in the ribosome and make its way into the ER via a pore

Now the protein has two options, depending on what it is destined to do

- If the protein is to be secreted, like insulin
    - The protein is released into the ER lumen where it will be modified to be packaged and sent to the plasma membrane. This typically involves moving through the Golgi apparatus.
- If it is a membrane protein
    - The protein stays embedded in the ER membrane and will be transported to its location whenever it is ready.

Take note that both of these proteins will require a **transport vesicle** to get to their locations.

So this resource was short and sweet, but like I said that's because your professors are still covering chapter 17. As we approach finals, be looking toward your old notes and exam performance and start to identify where you need to study if your exam is cumulative. Finals are extremely important, and you want to be prepared for anything they throw at you!