The Steps Involved in Protein Synthesis

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Protein Synthesis

- Protein synthesis is simply the "making of proteins." Although the term itself is easy to understand, the multiple steps that a cell in a plant or animal must go through are not. In order to make even one protein, the body must seek the aid of messenger RNA, transfer RNA, DNA, amino acids, ribosomes, and multiple enzymes. So that this process does not become too overwhelming, let's first go over some of the basics.
What is a Protein?

A protein is simply a long chain of amino acids linked together by bonds. The backbone of amino acids form strong covalent bonds and the actual amino acids form temporary weak bonds. These weak bonds allow the amino acids to change shape, remain mobile, and attain flexibility. The most important quality to understand about proteins is that the position of their amino acids determine their function.
Vocabulary Review

- **Nucleotides**: molecules that, when joined together, make up the structural units of RNA and DNA.
- **Amino acids**: A group of 20 different kinds of small molecules that link together in long chains to form proteins; building blocks of protein.
- **RNA**: a nucleic molecule similar to DNA that delivers DNA's genetic message to the cytoplasm of a cell where proteins are made.
- **DNA**: a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses.
The Steps

- Now that we know a little about the basic structure and function of a protein, it will be easier to understand how a protein is made. The three basic steps of protein synthesis are:

1. Transcription
2. Transferal
3. Translation
A Closer Look: Transcription

- In the nucleus, enzymes make a RNA copy using a portion of DNA. The RNA is then transformed into a messenger RNA (mRNA). The mRNA leaves the nucleus through the pores and gets into the cytoplasm. Here, the mRNA mixes with the ribosome, which begins the process of protein synthesis. So basically in this stage, RNA is created, so it can go and make instruct the making of protein.
A Closer Look: Transferal

In this stage, an amino acid activating enzyme attaches an amino acid to one end of transfer RNA (tRNA), also called an adaptor molecule. On the other end of the adaptor is a condon (a specific three-nucleotide code) which will be used when the adaptor reaches the mRNA. Once the condon is retrieved, the mRNA continues to the ribosome. So basically, in this stage, an adaptor is connected to an amino acid so it can be energized and have enough strength to continue its journey.
Transferal: A Even Closer Look

- **Step 1:** An ATP molecule lands on the activating enzyme in a place that is prepared for it (think of this space as a reserved parking place).

- **Step 2:** An amino acid then parks in the next space which was also prepared just for it.

- **Step 3:** The ATP molecule and the amino acid drift closer together until they bond, which releases two phosphates. At this point, the amino acid is energized.

- **Step 4:** The adaptor then comes and parks in its reserved space next to the amino acid.

- **Step 5:** The adaptor comes closer to the amino acid until they bond.

- **Step 6:** Energy from the ATP molecule is transferred into this bond and the ATP molecule is released.

- **Step 7:** The activating enzyme finally releases the adaptor with the amino acid attached to one end.
A Closer Look: Translation

At this point, one amino acid is attached to an adaptor. Remember that it takes many amino acids to make up one protein. Therefore, there must be a way to link these amino acids into a single protein in order to complete protein synthesis. This is where the ribosome comes in which is so good at producing proteins that is often termed a "protein factory." The ribosome "reads" the start codon (AUG) and associates it with the proper amino acid. Once all the amino acids have been linked, mRNA signals STOP. The ribosome releases the mRNA and the amino acid, and a protein has been made.
A Closer Look: Translation

- This stage is divided into three parts: Initiation, Elongation, and Termination.

During the initiation phase, a ribosome attaches to the mRNA and reads the condon (AUG).

During the elongation phase, tRNA bring the corresponding amino acids to each codon, as the ribosome moves down the mRNA strand.

During the last phase, termination, the molecule is read, and the synthesis ends and releases the protein.
The information on DNA is copied onto an mRNA strand, which then leaves the nucleus and heads to the ribosome. Here, a tRNA molecule brings an amino acid that is coded for by codons on the mRNA (codon = three base sequence). Amino acids are bonded together as the mRNA moves through the ribosome. Amino acids joined together make a protein.
1. Transcription

DNA → RNA polymerase → mRNA

2. Translation

mRNA → tRNA → Anticodon → polypeptide chain → proteins

Protein synthesis
Quiz Time

1. On what cell organelle does protein synthesis occur?

A. Nucleus
B. Cell membrane
C. Ribosome
D. Golgi complex
E. Smooth ER
Quiz Time

2. What type of RNA molecule is made in the nucleus and carries the information to the place where proteins are made?

A. rRNA
B. mRNA
C. tRNA
D. DNA
Quiz Time

3. Three bases on a tRNA molecule are called a:

A. Codon
B. Anticodon
C. Oxycontín
D. Trífecta
Quiz Time

4. Which of the following serves as an "adapter" in protein synthesis, and bridges the gap between mRNA and proteins?

A. tRNA
B. mRNA
C. rRNA
D. both a and b
E. both a and c
Quiz Time

5. The process of transferring a gene’s instructions for making a protein is

A. translation
B. replication
C. transcription
D. protein synthesis