The DNA of every living organism tells the ribosomes how to join the amino acids together to make all of the protein that is required by the cell.

Upon successful completion of this unit, you should be able to do the following:

1. Explain and describe protein synthesis.
2. List and explain the 4 steps of protein synthesis.
3. Describe the location of protein synthesis.
4. Explain the reason(s) for protein synthesis.
5. Be able to use the following terms in their correct context:

<table>
<thead>
<tr>
<th>protein</th>
<th>Ribosome</th>
</tr>
</thead>
<tbody>
<tr>
<td>protein synthesis</td>
<td>Gene</td>
</tr>
<tr>
<td>DNA</td>
<td>nucleus</td>
</tr>
<tr>
<td>Amino acid</td>
<td></td>
</tr>
</tbody>
</table>
Protein Synthesis
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Why are proteins so important? Proteins are found throughout all cells. They act as chemical messengers to keep your body functioning correctly, they help to determine how tall you will become, and they form the structure for building your body. Proteins are found almost everywhere in a living organism. The human body contains about 50,000 different kinds of protein. Proteins are the reason for the many different types, shapes, colors, and textures found in all living things such as teeth, claws, antlers, and skin.
Protein synthesis describes how proteins are made in the cells. It is an easy process if you know the following steps.

First, the gene on the DNA strand (found in the nucleus) must be copied into messenger RNA (mRNA). (Remember DNA is the blueprint).

Next, the copy of the DNA (mRNA) is moved out of the nucleus of the cell and to the ribosomes, which reside in the cytoplasm of the same cell. The ribosomes read the copy of the DNA (mRNA).

Then, transfer RNA (tRNA) deliver the correct amino acids to the ribosomes. Ribosomes assemble amino acids together in the manner described by the DNA. When the amino acids are joined in the correct manner, they form a protein.

It is important to know the 4 steps in protein synthesis:
1. The individual gene on the DNA strand is copied into mRNA
2. This DNA copy (mRNA) is transported out of the nucleus and into the ribosomes found in the cytoplasm.
3. Ribosomes read the mRNA so that the tRNA knows which amino acid to bring to the ribosome.
4. The ribosomes join amino acids together as required by the DNA
5. When complete, the amino acid chain forms a protein

The ribosomes play a very important part in the creation of protein. They are the assembly location. The ribosomes put together the amino acids in the correct order to create the correct protein that was called for by the DNA.

Different proteins perform different functions. Many different types of protein are made as required by the DNA. The protein to be made depends on what the cell is making. The ribosomes are able to make all of the different proteins by assembling the amino acids together in the correct order as told by the DNA.

REMEMBER THIS!!!

The DNA tells the ribosomes how to join the amino acids together to make the specific protein required by the cell.
**Interesting Scientific Fact:** Mutations happen when a different protein is made by the ribosome than what was intended by the DNA. This creates a *slightly different feature in the living organism*. Mutations are common. Most of the time, they are small changes. Usually the living organism does not even know that they have a mutation in their body. Some are more obvious, like the 2-headed snake that was found in the Southwest last year. Mutations can actually help a species, like camouflage in certain insects. Mutations also form the basis for natural selection which you will learn more about in a later unit.

**Question 1.** How would you define protein synthesis?

**Question 2.** Explain how protein synthesis occurs.

**Question 3.** What is the function of the ribosomes? Explain how they perform their function.

**Question 4.** What are amino acids and why are they important in protein synthesis?

**Putting it all Together**

This process of building proteins requires energy. There are two special organelles that help provide that energy. They are called chloroplasts and mitochondria. Only green plants including algae have chloroplasts. Chloroplasts have the ability to trap the sun’s energy and use it to make glucose. This process is called photosynthesis.

The mitochondrion is another organelle that is important in providing energy in a cell. All cells have mitochondria. Once glucose is made by the chloroplasts, the mitochondria take in glucose and break it apart. The stored energy in the glucose is released and stored in smaller molecules called ATP. The process of breaking apart glucose for its energy is called cellular respiration. If a cell does not have chloroplasts, it must get its glucose by eating food, digesting it and transporting it to the cell.

The energy created as a result of photosynthesis and respiration is needed by the ribosomes to create protein. Protein synthesis does not occur unless energy is available to make it work.
To make its proteins, a cell uses the information stored in its DNA and uses an organelle called a ribosome located outside the nucleus to actually hook together the amino acids in the proper sequence. The ribosome is the location where the proteins are made. There are often hundreds or thousands of ribosomes in cells. All cells have ribosomes, so all cells make proteins.

The process of building proteins is extremely important to a cell. Proteins serve as enzymes and make up very important components of the cell's structure. Therefore, a cell must have its nucleus, ribosomes, and mitochondrion for each plays an important role in the making of proteins.

To make a specific protein, the gene located on the DNA is copied. The copy is then moved to the ribosome. The ribosome connects amino acids together according to the model described by the DNA of the gene. When finished, the amino acid chain is the protein.
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Self Test

Matching

_____ 1. ribosome  a. amino acids joined together as described by the DNA
_____ 2. amino acid  b. where the DNA is located
_____ 3. protein synthesis  c. where the amino acids are made into protein
_____ 4. gene  d. the code that tells the ribosome what protein to make
_____ 5. DNA  e. the making of a protein
_____ 6. nucleus  f. these make up the DNA
_____ 7. protein  g. correctly combined together, these make protein in the ribosomes

True or False

_____ 1. Amino acids are made of protein.
_____ 3. Ribosomes are located in the nucleus of a cell.
_____ 4. Ribosomes assemble amino acids into proteins
_____ 5. Ribosomes are capable of making different kinds of proteins.
_____ 6. Protein synthesis tells how amino acids are made.
_____ 7. Protein synthesis explains how proteins are made.
_____ 8. DNA is found in the nucleus.
_____ 9. DNA is found in the ribosomes.
_____ 10. DNA copies (mRNA) are found in the ribosomes.
_____ 11. DNA tells the ribosomes which proteins to make.
_____ 12. DNA tells the nucleus which amino acids to make.
_____ 13. DNA tells the ribosomes to create genes.
_____ 14. Genes are located on the DNA strands.
_____ 15. Genes are found in the ribosomes.
_____ 16. The nucleus is the only place to find DNA.
_____ 17. The nucleus is the only place to find ribosomes.
18. Proteins are made in the process of protein synthesis.

19. Proteins are made in the process of respiration.

20. The exact protein to be made is determined by the DNA.

21. The exact protein to be made is determined by the ribosomes.

22. Proteins are made of amino acids.

23. Proteins are made of amino acids and DNA.

24. Proteins are made in the ribosomes based on information provided by the DNA.

25. Proteins are made according to instructions provided to the ribosomes by the DNA.

**Fill In the Blank**

**Ribosomes DNA Protein Amino Acids**

1. In the process of protein synthesis, ____________ is made in the ____________.

2. _______ tells the ____________ what type of protein to make.

3. ____________ ____________ are joined together to make ____________.

4. Ribosomes assemble _______ ____________ to make ____________.
Question 1. How would you define protein synthesis?

Question 2. Explain how protein synthesis occurs.

Question 3. What is the function of the ribosomes? Explain how they perform their function.

Question 4. What are amino acids and why are they important in protein synthesis?