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Building a Protein

Purpose

- Assemble a protein from its base parts while considering what is happening with matter and energy in the process.
- Explore ideas about the diversity of proteins, their sequences and shapes.
- Discuss connections between the form and function of these molecules.

Background Information

We've been studying three types of molecules that are fundamental components of food—carbohydrates, fats, and proteins. We've learned a little about what each is made from, and that proteins are unique among the three in that they contain nitrogen (N) in addition to carbon (C), hydrogen (H), and oxygen (O).

We have recognized that we take these molecules in because they make up our own bodies and the bodies of all living things. But since we don't directly incorporate them into our bodies (eating a piece of corn doesn't put corn in our muscles, for example), we must have some way of breaking down and building these molecules in our cells.

In this activity, we begin to explore how to build proteins. Proteins provide the structure for much of our body and the diversity of proteins in our body also carry out all of the important functions our cells, tissues and organs need to keep us going. Proteins are also the fundamental molecule that actually determine our traits (with the help of something called DNA).

Materials:

— Paper Amino Acid Molecules (variety, PDFs provided in unit zip file)
— Clear Tape for connecting paper
— Masking Tape for taping to the wall
— Scissors

Procedure—Part A: Assembling Your Protein

1. Get together with your group and read over any information your teacher has given you about the protein your team is going to assemble.
2. Decide which amino acid templates and how many of each you will need to ask for. Then ask your teacher for the needed supplies and make sure you have the materials in the list above ready or nearby.
3. Look over the individual amino acid molecules and the atoms that make them up. What do they have in common? Do you notice any patterns? (Discuss as a team for a minute.)
4. How will you connect them? Decide as a group. Then talk to a neighboring group in the presence of your teacher.

   ➔ *While you are waiting, you may begin to cut out your amino acids, being careful to NOT cut off any of the parts (the atoms).*

5. Once you've decided on how to assemble the protein and have checked in with your teacher, you can begin the process of linking the amino acids to one another. Be sure to save any scraps that may be removed in the process. (Just place them aside for now.) Begin by cutting on the dotted lines.

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6. Next connect the molecules together with clear tape where the other elements where removed. Keep connecting all the molecules until you have a long chain of amino acid molecules.
7. Pause here to answer the reflection questions below. Answer them to the best of your ability, discussing your ideas with your group and other classmates. We're trying to figure some things out and may not always have complete answers during the activity.

What did your group notice about the differences among the amino acids in your chain?

How many amino acids did you assemble? _____

How many amino acids does your protein actually contain? _____

When you put your amino acids together, which atoms were left over (the scraps)?

Was this assembly of amino acids into a protein a chemical reaction? (circle one) Yes / No

If so, what were the reactants? What were the products? Was energy released as we saw in cellular respiration? What do you think? Could you draw a diagram for this reaction? (Discuss with your group and record some of your thoughts here or make a drawing.)

Procedure—Part B: Considering Protein Diversity, Form and Function

1. Look over this summary information table for all of the proteins in your class below, plus any extra information your group was given on your particular protein. Reminder: you were given only the first 10 amino acids of a much longer chain needed to make your protein.

Protein Name	Function	Length (# of amino acids)
Rhodopsin	detects light in the eye	348
Pepsin	breaks down other proteins in the stomach	388
Insulin*	helps cells pull glucose from the blood	110*
Keratin*	builds skin, nails, and hair	505*
Hemoglobin*	transports oxygen in the blood	142*

*each of these individual protein chains combines with others before it can function

What is your protein's function?

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2. Next, take a tour of what other groups have been working on as instructed by your teacher.

Are there any patterns you notice when looking at the starter sequence of amino acids that your classmates have assembled? Discuss briefly with your group and record any ideas in the space provided below.

3. Follow your teacher's instructions for finding the 3-D structure of your completed protein.
4. Then look at other the shapes of the other proteins your classmates are studying.
5. Pause to answer the questions below before having a class discussion.

How do you think a protein figures out how to fold into a 3-D shape considering your starter sequence seems more like a chain?

Why do you think proteins have complex forms? How might their form and function be related?

Be sure to follow any further instructions from your teacher about folding and displaying your group's amino acid chain / starter protein sequence. Clean up your work stations and return supplies before ending the activity.