

MATERIALS

- In your ziplock bag, you should have 1 pipe cleaner and 9 pony beads.
 - Please double check that you have...
 - 1 pipe cleaner
 - 5 yellow beads
 - 2 blue beads
 - 2 red beads
 - **Raise your hand if you are missing any materials.**

LEARNING OBJECTIVE

- 1) Compare and contrast the interactions driving the formation of secondary, tertiary, and quaternary structure of proteins.

PRECONCEPTIONS

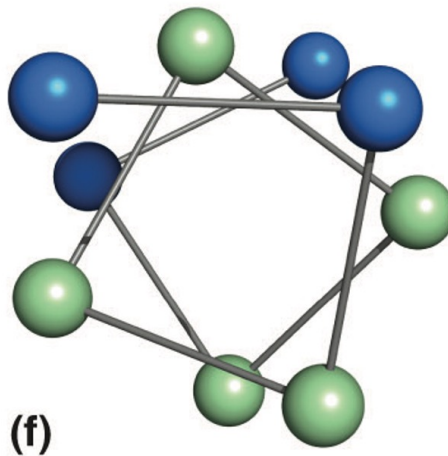
For Preconceptions, Activity 1, and Activity 2, please work individually. You will be able to talk to neighbors during iClickers and Activity 3!

- 1) In the table below, define each level of protein structure and list the primary stabilizing noncovalent interactions involved:

Protein Structure	Definition	Primary stabilizing noncovalent interactions
Primary		
Secondary		
Tertiary		

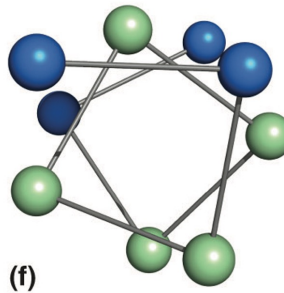
ACTIVITY 1– Protein Synthesis (Primary Protein Structure)

- For this activity, the pipe cleaner represents a protein backbone, and the beads represent amino acids.
 - Each bead color represents an amino acid with the following properties:
 - Yellow = hydrophobic
 - Blue = positively charged
 - Red = negatively charged
- 1) Consider your hand a ribosome that is synthesizing a sequence of amino acids.
- a) By stringing the beads onto the pipe cleaner, synthesize a sequence of amino acids that...
- i) Is 9 amino acids long
 - ii) Allows for the formation of an amphipathic helix.
- b) **Requirements:**
- i) **The first amino acid MUST be hydrophobic**
 - ii) **The third amino acid MUST be negatively charged**
- 2) Hint: The primary protein structure determines the secondary and tertiary structures! Think back to this ball and stick figure, and consider the noncovalent interactions between the amino acids. Think about what kinds of interactions would stabilize the structure to allow for helical formation, and how that would look in the amino acid sequence.



ACTIVITY 2– Alpha helix formation (secondary protein structure)

- Consider this ball and stick figure when answering the iClicker:



- 1) Fold your amino acid sequence into an alpha helix structure by bending the pipe cleaner at each bead in a roughly 45° angle. Your alpha helix should...
 - a) Be stabilized by hydrogen bonds
 - b) Have about 3 (specifically 3.4) amino acids per turn
- 2) **Tip:** Curl the pipe cleaner around your fingers if you are having trouble getting the helix shape. Then, you can try to bend it at each bead, to get more of the box/triangle shape (depicted in the ball and stick figure in Activity 1).

Discuss in groups of four:

- What considerations did you make to ensure your side chains didn't repel? In other words, at what positions did you have to place the negative and positive chargers given the initial requirements?
- For an amphipathic protein (what you modeled), at which positions in the amino acid sequence did you have to put a hydrophobic residue to maintain helical structure?

ACTIVITY 3– Tertiary protein structure

- 1) Get into groups of 4! Using your alpha helices, construct a globular protein.
 - a) Hint: You should all have the same amino acid sequence (and therefore the same alpha helix structure). **Your helices MUST be stable!**

NEW UNDERSTANDINGS:

- In the table below, list the interactions involved for each protein conformation:

Protein Conformation	Primary stabilizing factors/noncovalent interactions
Primary	
Secondary	
Tertiary	

- Discuss with a neighbor: Explain the significance of the hydrophobic effect of R groups. How does the formation of the hydrophobic core stabilize the protein?
- Discuss with a neighbor: How do your answers *before* the activity compare to your answers *after* the activity? Which aspects of the model, if any, helped you understand the differences between those interactions?