Biology, Castle View High School
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Protein Folding Paper Model

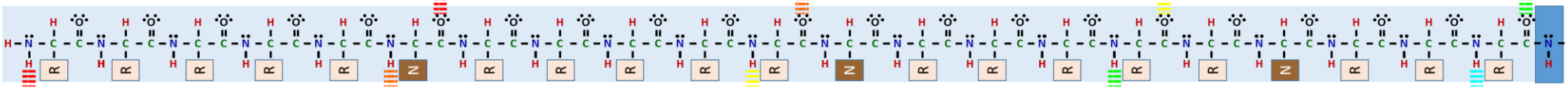
Key:

R	Non Specific Amino Acid	A	Acidic Amino Acid
N	Hydrophobic Amino Acid (Non-Polar)	B	Basic Amino Acid
H	Glycine	P	Hydrophilic Amino Acid (Polar-Covalent)
HS	Cysteine	OH	Serine

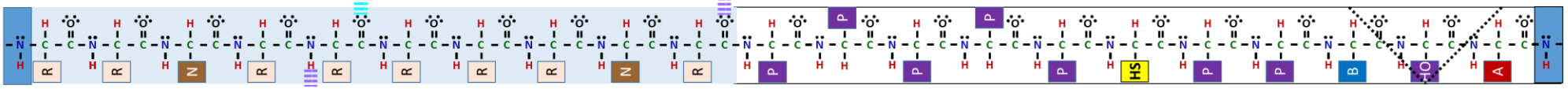
Assembly Instructions:

Cut out each of the four segments of the amino acid chain, one at a time in sequence. After cutting out segments 2-4, tape the left end of the segment to the right end of the previous segment; make sure that the N-H with the dark blue background of each segment overlaps. When you are done you should have one long chain of amino acids.

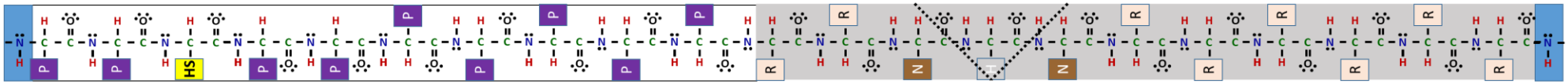
Part 1: ALPHA HELIX



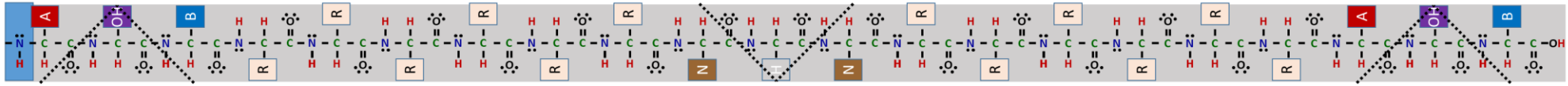
2 Part 2: ALPHA HELIX and HAIRPIN TURN "A"



3 Part 3: HAIRPIN TURN "B" and BETA SHEET "A"



4 Part 4: BETA SHEET "B"



FOLDING INSTRUCTIONS

1. **Primary Structure**
   1.1. Once assembled, the chain of amino acids may at first glance look complicated. Uncomplicate this by noting the repetitive structure of the amino acids. Other marks along the chain are only there to help guide you through the folding process.
   1.2. A protein's primary structure is simply the sequence of amino acids. Instead of naming each amino acid in this sequence, the general properties of each amnio acids have been indicated using symbols. Refer to the key for the meanings of these symbols.
2. **Alpha Helix**
   2.1. Begin at the Amino (NH_2) end of the chain
   2.2. Coil the first part of the chain like an old fashioned phone cord so that the dashed lines under each N-H are matched by color with the dashed lines above each C=O; **What type of bond will form between the H and the O? Place a small piece of tape between these two amino acids to simulate this bond.**

   Notice: This will connect the N-H of one amino acid to the C=O of the 5th amino acid after it. After making one bond, the N-H of the next bond will begin on the N-H before the C=O just connected.

   Hint: begin by placing a small piece of tape hanging down from the N-H, then coil the chain underneath it until the same-colored dashes of the O=H line up with it, then press them together. You will repeat this process until you have made 7 bonds.

3. **Beta Sheet**
   3.1. Move to the Acid end of the amino acid (COOH) end of the chain.
   3.2. Moving down the chain, you will notice four pairs of dotted lines at right angles to each other.
   3.3. At the first set of dotted lines, fold along the dotted lines, with the lines on top of the crease; when folded properly the Acid and Base amino acids next to the fold should be facing each other. **What type of bond will form between the Acid and Base amino acids? Place a small piece of tape between these two amino acids to simulate this bond.**
   3.4. Fold the amino acid chain at the next set of dotted lines as before; this time two Hydrophobic amino acids next to the fold should be facing each other. **What type of bond will form between the Hydrophobic amino acids? Place a small piece of tape between these two amino acids to simulate this bond.**
   3.5. Fold along the next two sets of dotted lines as above.
   3.6. After completing the folds above, the affected part of the amino acid chain should be folded back and forth to create what is known as a beta sheet.
4. **Hydrophobic Core**
   4.1. After creating the alpha helix and the beta sheet, you will notice a line of hydrophobic amino acids on one side of the alpha helix, and a line of hydrophobic amino acids on one end of the beta sheet. Loosely wrap the hydrophobic end of the beta sheet around the alpha helix so that the hydrophobic amino acids are on top of each other. **What type of bond will form between the Hydrophobic amino acids? Place a small piece of tape along these amino acids to simulate their bond.**
5. **Hairpin Turn with a Disulfide Bridge**
   5.1. Hairpin Turn
      5.1.1. When the above folds are complete, there should be a section of the amino acid chain between the alpha helix and the beta sheet loosely surrounding the protein.
      5.1.2. In the middle of this segment you will see another set of dotted lines at a right angle to each; fold the chain along these dotted lines as before to bring an acid and a base amino acid into contact. Place a small piece of tape between these two amino acids to simulate their bond. A single turn such as this is called a hairpin turn.
   5.2. Disulfide Bridge
      5.2.1. Further down from the hairpin turn, you will note that two cysteine amino acids have also been brought into contact.
      5.2.2. These two amino acids can react chemically to form a covalent bond between them called a disulfide bridge. These covalent bridges are often used to stabilize the structure of a folded protein.
      5.2.3. Place a small piece of tape connecting the two cysteine amino acids to simulate the disulfide bridge.