Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Making a Paper Model: Insulin**

Insulin is a peptide hormone that plays a key role in glucose metabolism. Read the Molecule of the Month feature on Insulin (<http://pdb101.rcsb.org/motm/14>). This could be assigned reading, in preparation for the class. Complete the following sentences:

1. Each insulin molecule /monomer is composed of \_\_\_\_\_\_\_\_\_\_\_\_(include #) protein chains.
2. There are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_disulfide linkages in each insulin molecule.
3. Disulfide linkages are formed between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Insulin is synthesized as a precursor molecule, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Overview:**

In this activity you will make a paper model of the Insulin hormone.

**Learning Goals:**

1. Make a 3D model of insulin using the template(s) provided.
2. Study the 3D model of insulin to understand its structure and functions.

**Steps for Modeling**:

1. Print out the insulin model page (preferably using a color printer) <https://cdn.rcsb.org/pdb101/learn/resources/insulin-activity-assets/insulin-activity.pdf>
2. You will also need clear tape and scissors to make the model
3. Cut out the strips of paper as per instructions on the page that you printed

Note: Insulin has two chains - chain A (colored green), and chain B (colored blue). Three disulfide-bridges (colored yellow, green and orange) hold these chains together. As you build the model, pay attention to the primary, secondary, tertiary and quaternary structures of Insulin.

1. Make the chains A and B separately before connecting them with the disulfide bonds. You may view a short video to guide the modeling

<http://pdb101.rcsb.org/learn/resource/insulin-paper-model-tutorial-video>

1. Examine your model and complete the following sentences about it:
2. The chain A in insulin has \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ amino acids, while chain B has \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Hint: include the numbers of amino acids in these chains
3. The alpha helices are stabilized by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_bonds formed. For example, such a bond is formed between CO of residue 16 of chain A and NH of residue \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. There are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_inter-chain and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ intra-chain disulfide bonds in the insulin structure.
5. The active and storage form of insulin have different oligomerization states – the storage form is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(# of oligomers), while the active form is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(# of oligomers).
6. Read a learn about insulin and its synthesis at <http://pdb101.rcsb.org/learn/resource/insulin-activity-page> and answer the following questions:
   1. What is the functional role of the disulfides in this structure? Are they in a good place to perform this role?
   2. Structurally, what is the primary difference between the T and R states of insulin? What form of insulin did you make in the paper model above?

**Homework:**

1. If you wanted to make a long-lasting formulation of insulin, would you try to stabilize the hexamer or the monomer? How about a fast-acting insulin formulation, would that be more monomeric or hexameric?
2. Research – find example each of short acting and long acting insulins. List the names, and discuss at a molecular level, how they were engineered.

**Extension and Enrichment:**

1. Based on what you know about insulin synthesis – how would you determine if an individual is currently making insulin or not? Describe a situation when it would be important to figure this out.