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

**Short Acting Insulin: Aspart**

Before starting on this activity review the Molecule of the Month feature on “Designer Insulins” at <http://pdb101.rcsb.org/motm/194>.

*Q1. Use the following words to complete the sentences written below*:

fast

protamine

long

asparagine

lysine

hexamer

proline

arginine

1. Insulin is stored in the pancreas as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ complex.
2. Adding a fish protein, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, can slow the dissolution of the storage form of insulin.
3. Glargine is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acting insulin molecule that has two extra \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(amino acids).
4. Lispro is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-acting insulin, designed by reversing the order of two residues \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ near the C-terminus of the B-chain.

 This activity will follow the following steps in order to answer a question and tell a molecular story.

1. Ask a question – this is the theme for the molecular storytelling
2. Build model based on literature review – what will you explore in the PDB
3. Investigate - Query/Browse PDB; Select PDB entries; Visualize
4. Analyze - Explore interactions; Compare Structures
5. Construct molecular explanations for original question
6. Develop argument - relate structure to bioinformatics information (go back to the literature to see if the molecular explanation makes sense)
7. Communicate - Tell a Molecular Story with Illustrations

**Overview:**

This activity focuses on the design of an insulin molecule called Aspart. It provides an opportunity to explore and understand a molecular basis for how this molecule fulfills its therapeutic role.

**Learning Goals:**

1. Define a question/topic for exploration at a molecular level
2. Explore the literature to find out about the topic
3. Query the RCSB PDB website to find specific structure(s) for exploration.
4. Explore relevant molecular structures to develop a molecular story explaining the topic.

**Guided Molecular Storytelling**:

In 2001, the US Food and Drug Administration approved Insulin Aspart for treatment of Diabetes Mellitus. This molecule was designed by replacing a key residue at position 28 in the Chain B with Aspartic acid.

1. Ask a question:

The question: Why does changing the amino acid 28 in “Chain B” to Aspartate make the insulin molecule a special therapeutic molecule? What does this molecule do? Explain this function at a molecular level.

1. Build a model:

Search for information about insulin Aspart. For your initial explorations you may search:

1. Online – using your favorite search engine (Google, Bing etc.)
2. In text books – that you or your library owns; or check the NCBI bookshelf (online) at <http://www.ncbi.nlm.nih.gov/books>
3. Review articles – you can search for these using the NCBI PubMed (online) at <http://www.ncbi.nlm.nih.gov/pubmed>

*Q2. Based on your knowledge of insulin aspart, summarize what is the unique property of this molecule. What is the amino acid that is engineered (mutated) in this molecule?*

1. Investigate:

Search for your molecule(s) of interest in the PDB using known properties – e.g. molecule name, mutation, presence of ligand etc.

*Q3. List the PDB ID and Structure titles for at least 1 structure in the PDB for insulin Aspart and 1 structure for native human insulin (without any mutations).*

*Q4. How did you perform the search on the RCSB PDB website? List your search options and any logic that you used to refine your search results.*

Visualize the PDB entries that you identified, separately first. If necessary and appropriate, superpose the structures to explore any changes in the structure-function relationships resulting from the mutation. Save suitable images and include them in your answers below.

*Q5. What do your molecule(s) of interest look like? Is there anything unusual in the structure of the molecule(s) you are exploring?*

1. Analyze:

Insulin Aspart has an engineered mutation in the C-terminus of “Chain B”. In the structure(s) that you have selected, focus on this area (i.e. residue 28) and its vicinity to explore its structure.

*Q6. Aspart insulin has an engineered residue - what is special about the residue and molecular interactions? Illustrate your answer with 1-2 illustrations based on your structural explorations.*

1. Molecular explanations:

Based on the images included above and your explorations of the molecular structures and interactions explain the functional properties of Insulin Aspart.

*Q7. Explain the molecular basis for the function of insulin Aspart.*

1. Argument:

*Q8. On September 25, 2015 FDA approved a new drug formulation called Ryzodeg or 70/30 (insulin degludec/insulin aspart injection) to improve blood sugar (glucose) control in adults with diabetes mellitus. Based on your understanding of insulins aspart and degludec, explain how this formulation works.*

**Complete the following questions for HW:**

1. Communicate:

*Q9. Describe the molecular basis for insulin Aspart’s therapeutic functions. Include an introduction, molecular explanation for clinical circumstances for using this form of insulin (based on your explorations of the molecule and the literature).*

**Extension and Enrichment:**

*Q11. Using the approaches that you used to explore insulin aspart, discuss the molecular basis for insulin degludec’s function. Draw 1-2 images to support your discussions.*