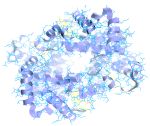


StarBiochem

Name_____

Lysozyme Exercise

Background

In this exercise, you will use StarBiochem, a protein 3-D viewer, to explore the structure of the protein lysozyme. Lysozyme degrades the cell walls of bacteria, and is found in human tears.

Getting started with StarBiochem

- To get to StarBiochem, please navigate to: **http://web.mit.edu/star/biochem**.
- Click on the **Start** button to launch the application.
- Click **Trust** when a prompt appears asking if you trust the certificate.
- In the top menu under **File** click on **Open/Import** and select "1GXX" and click on **Open**.

You are now viewing the structure of lysozyme, with each bond in the protein drawn as a line.

Practice changing the viewpoint of this protein in the view window:

	Mac	PC
TO ROTATE	**click** and **drag** the mouse	**left-click** and **drag** the mouse
TO MOVE UP/DOWN RIGHT/LEFT	**apple-click** and **drag** the mouse	**right-click** and **drag** the mouse
TO ZOOM	**option-click** and **drag** the mouse	**Alt-left-click** and **drag** the mouse

Take a moment to look at the structure of lysozyme (1GXX) from various angles in this "bonds only" view. Before proceeding to answer the questions, review the basic structures and terms on the next page which you can refer to during this exercise.

PROTEIN STRUCTURE BASICS

Each protein has the following three levels of protein structure:

Primary structure
Lists the amino acids that make up a protein's sequence, but does not describe its shape.

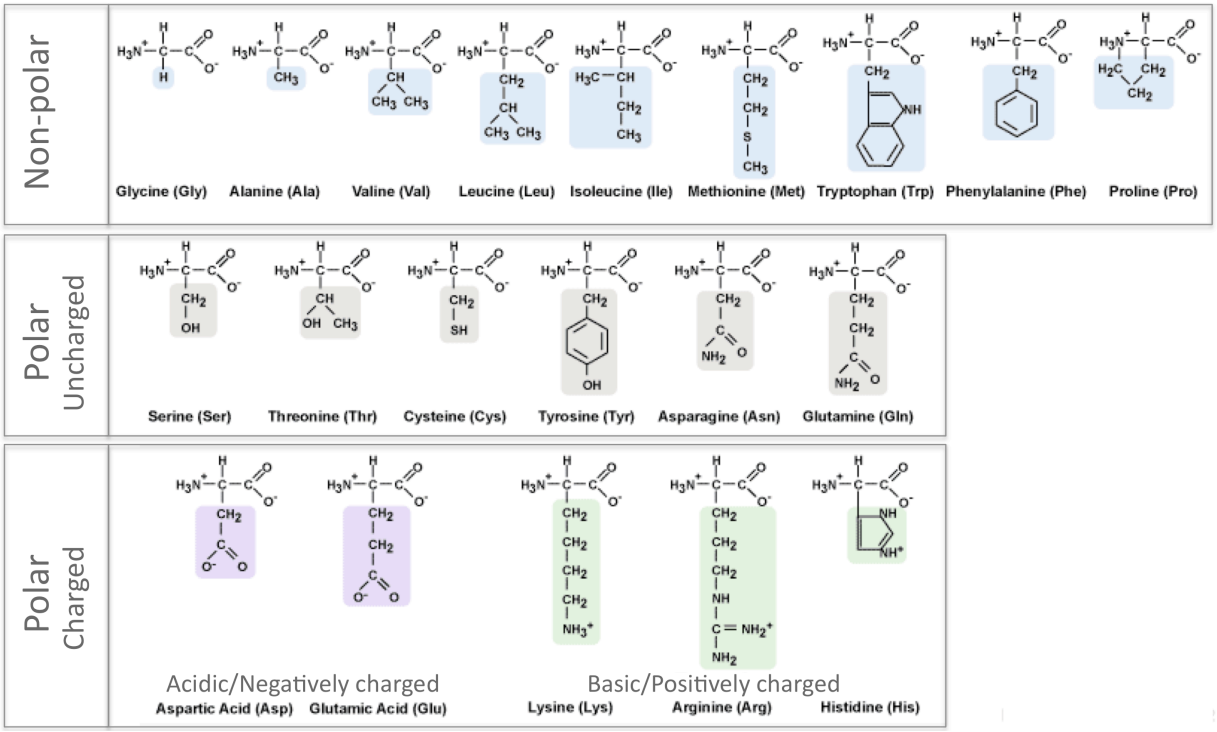
Secondary structure
Describes regions of local folding that form a specific shape, like a helix, a sheet, or a coil.

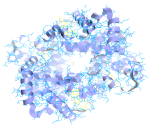
Tertiary structure
Describes the entire folded shape of a whole protein chain.

In addition, some proteins interact with themselves or with other proteins to form larger protein structures. How these proteins interact and fold to form a larger protein complex is termed **Quaternary structure**.

CHEMICAL STRUCTURES OF THE AMINO ACIDS

The 20 amino acids share a common backbone and are distinguished by different 'R' groups, highlighted in various colors below.





StarBiochem

Name_____

Protein Structure Questions

1 Other than hydrogen, proteins contain four additional atoms, Carbon, Nitrogen, Oxygen, and Sulfur. ***Which of these four atoms is most <u>rarely</u> found in proteins?***

- Click on **View Controls**.
- Under **Atoms**, click on **Draw**. Under this view, each atom in the protein is shown. Carbon is grey, Nitrogen is blue, Oxygen is red, and Sulfur is yellow. *Note: hydrogen is not shown.*

Answer

2 ***How many of the sulfurs in the protein are clearly exposed on the surface of this protein?***

- Click on **View Controls**.
- Within **Atoms** box click on **Fill Space**. This shows a space-filling view of the protein so that you can see how much space is taken up by each atom.

Answer

3 Now explore lysozyme's secondary structure.

a) ***How many helices are in one lysozyme protein?***

- Click on **View** and choose **Reset Molecule**.
- Go to **Structure** and click on **Secondary**.
- Click on **Helices**.

Answer

b) ***Which structure predominates in the lysozyme protein, helical shapes or sheet-like shapes?***

- Under **Secondary**, click on **Sheets** and compare this with your answer to part a).

Answer

4 ***Which are more common in lysozyme, acidic amino acids or uncharged polar amino acids?***

- Click on **View** and choose **Reset Molecule**.
- Go to **Structure** and click on **Tertiary**.
- Click on both **Acidic** and **Polar** to highlight the acidic and the polar amino acids within the protein.

Answer

5 Lysozyme consists of 129 amino acids. **List in order the 12 amino acids numbered 4 through 15 in lysozyme.**

- Click on **View** and choose **Reset Molecule**.
- Go to **Structure** and click on **Primary**.

Answer

6 These 12 amino acids make up a helix in lysozyme. ***How many full turns of the helix (i.e. 360° turns) do you see in this one helix?***

- Click on **View** and choose **Reset Molecule**.
- Go to **Structure** and click on **Secondary**.
- Under **Helix Selection** click on the box next to "1". This will select all the amino acids in the first helix in lysozyme, which turns out to be the 12 amino acids you listed above.
- Close the **Structure** panel and open the **View Controls** panel. In the **View Controls** panel, move the **Unselected** transparency slider to zero. This makes all the amino acids you have not selected disappear.
- Set the **Sidechain** transparency slider to zero.
- Under **Atoms** click on the **Draw**. Rotate the helix to look at it from a variety of viewpoints.

Answer

7 Every amino acid is made up of two parts, the backbone (which is shared by all amino acids, and consists of an amino group bound to a central carbon bound to a carboxyl group) and a side chain (which is different for each of the 20 amino acids). ***Do the side chains of the amino acids in a helix point INTO or OUT of the center of the helix?***

- Rotate the helix so that you look down the center axis of the helix.
- Click on **View Controls** and move the slider labeled **Sidechain** back and forth, to turn the side chains on and off.

Answer

8 ***How many prolines are in one lysozyme protein?***

- Click on **View** and choose **Reset Molecule**..
- Go to **Selection Controls** and click on **Select residue by type**. This allows you to see where each of the twenty amino acids/residues are in the protein.
- Click on **Proline**.

Answer