

## **Answers to the Analyze the Data, Apply the Concept, and Working with Data Questions**

### *Chapter 3: Nucleic Acids, Proteins, and Enzymes*

#### **Analyze the Data**

##### **Figure 3.10 Primary Structure Specifies Tertiary Structure**

- A. Disulfide bonds began forming almost immediately after oxidation began.
- B. Enzyme activity began appearing 100 minutes after oxidation began.
- C. Disulfide bonds are necessary for protein tertiary structure and must form before the enzyme active site can reappear, but there are other chemical interactions, such as hydrogen bonding and hydrophobic interactions, that occur after the protein has initially folded due to disulfide bond formation and which are also necessary for enzyme activity. In addition there may be multiple disulfide bonds within the enzyme, all of which must re-form before activity is restored. In other words, the first disulfide bonds to form aren't sufficient to restore activity, so there is a lag before activity reappears.

#### **Apply the Concept**

##### **Concept 3.1 Proteins Are Polymers with Important Structural and Metabolic Roles, p. 45**

Three-dimensional structure:

Both have this feature.

Protein: due to hydrogen bonding, hydrophobic interactions, and disulfide bonds between amino acids.

RNA: due to hydrogen bonding and hydrophobic interactions between bases.

3-D structure destroyed by heat:

Both have this feature.

Protein: Heat disrupts hydrogen bonding between amino acids, and the protein unfolds.

RNA: Heat disrupts hydrogen bonding between bases, and the chain unfolds.

Monomers connected by N—C bonds:

Only proteins have this feature.

Protein: This occurs between amino acids in the C—N direction.

RNA: Monomers are connected by P—O bonds.

Contains sulfur atoms:

Only proteins have this feature

Protein: The amino acids methionine and cysteine contain S.

RNA: No S atoms.

Contains phosphorus atoms:

Only RNA has this feature

Protein: Amino acids connected within proteins do not contain P; some may be added as phosphate after the protein is made, especially in eukaryotes.

RNA: contains P in all nucleotides.

### **Concept 3.2 Regulation of Metabolism Occurs by Regulation of Enzymes, p. 53**

1. No enzyme: The very low rate of hydrolysis indicates that the reaction can occur spontaneously but at a low rate, due to high activation energy.

Enzyme: The catalyst lowers the activation energy and so the reaction can occur much faster.

Enzyme pre-boiled: Heat denatures the enzyme protein so that the active site is not intact and cannot bind the substrate; there is very low activity.

Enzyme + RNA: RNA has no effect on enzyme activity, and the reaction can occur much faster (as with enzyme alone).

Enzyme + dipeptide: The dipeptide has a  $-C-C-CO-N-C-$  structure that is similar to that of the substrate. The dipeptide inhibits the enzyme from acting on the substrate.

2. The dipeptide may be a competitive inhibitor. To show this, add excess concentration of substrate in the presence of the inhibitor and the inhibition will be much less because the substrate out-competes the inhibitor at the active site. The dipeptide may also be a substrate for the enzyme; in this case, examine hydrolysis of the dipeptide by the enzyme in the absence of its normal polymer substrate.

## **Working with Data**

### **3.1 Primary Structure Specifies Tertiary Structure (Figure 3.10)**

1. (See *Analyze the Data* for Figure 3.10 above.)

2. A. Native peak was at about 2740 Å; Reduced (denatured) peak was at about 2720 Å.

B. Reoxidation resulted in a return to the native spectrum.

C. Under the denaturation conditions of these experiments, as long as the primary structure of RNase A is retained, the proper environmental conditions will result in a return to the native structure and a fully functional molecule.