

# Free-response Questions for Topic 1: Chemistry of Life: Teacher's Manual

### 1. Ten points are possible on this question.

Proteins are complex molecules with very advanced folding patterns directed by the chaperone proteins in the cell. The folding is due to the interactions between the amino acids and the R groups of the amino acids. Proteins have many diverse functions in cells.

- a. Describe FOUR functions of proteins in a cell.
- b. Describe the FOUR levels of folding in protein structure.
- c. List TWO examples of proteins and provide the function for that protein in a cell.

Part A is worth four points. Part B is worth four points. Part C is worth two points.

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#### Part A

Award one point per function up to four. Select any four from the list. Accept any valid protein function.

### **Protein Functions:**

- They can act as enzymes.
- They can act as motor proteins.
- They can act as transport proteins that move materials across the membrane.
- They can act as structural support.
- They can act in defense.
- They can be hormones.
- They can act as recognition proteins.
- They can act in signal transduction.

# Part B

Award one point for each level of structure. One bullet per level of structure is needed.

### **Primary Structure**

- Peptide bonds form between amino acids.
- There is a chain of amino acids.
- Covalent bonds form between amino acids.



# **Secondary Structure**

- Hydrogen bonding occurs.
- It forms alpha helices.
- It forms pleated sheets.

### **Tertiary Structure**

- It is the final three dimensional shape of most proteins.
- Many different kinds of bonding are present.
- Hydrogen bonding is responsible for some bonds.
- Van der Waals interactions are responsible for some bonds.
- Covalent bonds with disulfide bridges occurs between sulfhydryl groups.
- Ionic bonds are present between ionic side chains.
- It is determined by properties of the R group.

# **Quaternary Structure**

- It is the final shape in large subunit proteins.
- Interactions between subunits are present.
- Mostly additional hydrogen bonding supports this structure.

#### Part C

Award one point per protein up to two points total. Give any accurate protein example.



# 2. Four points are possible on this question.

Hydrogen bonding is very important biologically.

- a. Explain how hydrogen bonds are responsible for ice being less dense than liquid water.
- b. Explain how hydrogen bonding is responsible for the high specific heat of water.

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### Part A Two point maximum

Award one point for each correct statement up to two points.

- Hydrogen bonds are very prevalent in both liquid and solid water.
- Hydrogen bonds break and reform in liquid water.
- Hydrogen bonds freeze in place in solid water.
- In ice, water molecules are held further apart than in liquid water.

# Part B Two point maximum

- Award one point for each correct statement up to two points.
- Hydrogen bonds break and reform in liquid water.
- Much energy goes to breaking hydrogen bonds.
- Temperature increases are very slow.
- Hydrogen bonds immediately reform following being broken.



# 3. Four points are possible in this question.

Dehydration synthesis is very important in forming large macromolecules. Select two molecules from the list and explain how dehydration synthesis is involved in its formation. What kind of bonds form in this process?

- a. Collagen
- b. Chitin
- c. Sucrose
- d. Phospholipid

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Select two from list. Two point maximum per molecule selected. Award one point per bullet in table.

Molecule from List	<b>Bulleted Statements</b>
Collagen	It is a structural support protein.
	Covalent bonds are formed.
	It is composed of amino acid monomers.
	Peptide Bonds are present.
Chitin	It is a structural polysaccharide.
	Monosaccharides are the monomer.
	Covalent bonds are present.
	It forms a glycosidic linkage.
Sucrose	It is a disaccharide.
	Monosaccharides are the monomer.
	Covalent bonds form.
	Glycosidic linkage forms.
Phospholipid	It has a glycerol backbone.
	It has two fatty acids and a phosphate group.
	Covalent bonds form between a fatty acid and glycerol.
	Ester linkage forms.



# 4. Four points are possible in this question.

Carbon is the central atom in organic molecules.

- a. Explain how carbon allows for much variation in molecule shapes.
- b. Explain how carbon adds strength to organic molecules.

Part A has a two point maximum.

Award one point per bulleted statement up to two points.

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#### Part A Bullets

- Straight chains are possible.
- Ring-shapes are possible.
- Single, double, or triple bonds are possible.
- Several bond angles are possible.

Part B has a two point maximum. Award one point per bulleted statement up to two points.

#### Part B Bullets

- No ionic bonds are present.
- Only covalent bonds develop.
- Covalent bonds are strong.
- It can support large molecules.
- It has four valence electrons.