

Chem 130: Chemistry for Funeral Services

Problem Set 10

Name: KEY

Date: _____

Each question is worth one point. Show your work wherever calculations are required.

1. Describe in some detail the characteristics of one major class of biomolecules.

Choose either proteins, carbohydrates, fats or nucleic acids and give major functions (structural or otherwise) and use in biological systems.

2. Why is peptide bond formation considered to be a neutralization reaction?

A peptide bond is simply an amide bond. Amide bonds form in the reaction of carboxylic acids with amines. Carboxylic acids are organic acids. Amines are organic bases. So amides—peptide bonds in biological systems—form in acid base reactions. These are neutralization reactions.

3. Show how formaldehyde cross-links protein molecules. How does cross-linking by glutaraldehyde differ?

Formaldehyde forms cross-links wherever the —NH— group is present in proteins. This includes the imide group in some amino acid side chains, the terminal amine group in proteins and the —NH— found in peptide bonds. Formaldehyde reacts with the NH from one of these sources and the NH from another of these sources to insert a methylene group —CH₂— between the two nitrogens. This can happen between each peptide bond in a protein. Glutaraldehyde has three methylene groups between its two aldehyde groups so it cannot crosslink every amide nitrogen. Instead, it can cross-link every other amide nitrogen. See diagrams p. 238 and 340.

4. What is an amphoteric substance? Give an important example related to proteins.

An amphoteric substance can act either as an acid or as a base. Amino acids are amphoteric.

5. Describe what happens when the hemoglobin molecule breaks down. How does this affect embalming?

The heme group is released from the protein structure as the protein breaks down. The heme ring opens up creating a long chain with carbons, nitrogens and alternating double bonds. Biliverdin (green color) is the first important product. It can be further broken down to bilirubin (yellow color). Hemoglobin release to tissues causes postmortem stain. Bilirubin causes the yellow coloring seen in jaundice. Both are cosmetic issues faced in embalming.

6. How does the secondary structure of proteins relate to hydrogen bonding? Describe one of the three we discussed in class and show how hydrogen bonding is important to its structure.

Hydrogen bonding is one of the primary binding forces in the secondary structure of proteins. Depending on which atoms are hydrogen bonded throughout parts of the protein structure, you can get helixes or pleats. Further description of alpha helixes, beta sheets and collagen can be found in class notes and the text.

7. How is denaturation of a protein different from protein breakdown? How does it affect embalming?

When a protein denatures it loses much or all of its secondary and tertiary structure. It usually loses its function (depending on the extent of the disruption to the protein structure.) Protein breakdown results in the formation of amino acids by hydrolysis of the primary structure of the protein – its peptide chain. Disinfecting agents are used in embalming. They often act to denature proteins.

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8. Describe key characteristics of enzymes and their role in biological processes. What is the lock and key model?

Enzymes are biological catalysts. The lock and key model is one way of describing how the substrate fits into an active site. By this model, if the substrate doesn't fit exactly, much like a key, the enzyme won't work on it. The enzyme remains "locked". A more accurate model is to describe the process as "induced fit". The substrate fits into the active site and the enzyme shifts slightly to mold itself to the substrate. This model is more like a hand (substrate) fitting into a glove (enzyme).

9. Describe how enzymes affect the decomposition process.

The decomposition process is governed by the action of a variety of enzymes. Different enzymes are responsible for parts of the putrefaction process—proteolytic enzymes that breakdown proteins and hydrolytic enzymes that govern a wide variety of reactions involving the breakdown of substances through the addition of water to bonds.

10. The chart below includes four of the processes involved in protein breakdown. Complete the chart.

Type of process	What happens?	How it affects embalming:
Digestion	One way of beginning of protein breakdown. Peptide chains are broken into a series of large segments.	More "N terminus" nitrogens are available because of the shorter chains. This causes more amine groups to be available to use formaldehyde.
Hydrolysis	Proteins are broken down into amino acids by the addition of water to the peptide (amide) bonds	There are free amine groups on every amino acid. Formaldehyde demand increases.
Deamination	Amino acids lose their amine group. Ammonia and carboxylic acids are produced.	Ammonia uses up formaldehyde. Formaldehyde demand increases.
Decarboxylation	Amino acids lose their carboxylic acid groups. Carbon dioxide, water and an amine result.	Amine groups can react with formaldehyde. They can also be further broken down to release ammonia. Either way, formaldehyde demand increases.