Chemistry 021

Term Test # 2: Wednesday, February 4, 2004

Short Answer Section

Name *ANSWERS* Student #_____

Answer all questions using the space provided. Mark values are indicated for each question.

1) Iron is a trace mineral that is essential to your well being. [6]

a) What is the main function of iron in the body ?

Iron is an essential component of hemoglobin.

It is responsible for the transportation of O_2 throughout the body, via the blood.

b) What is the condition caused by a deficiency of iron ?

Anemia

c) Name two of the symptoms of this condition.

Fatigue, weakness, poor concentration

d) Name two dietary sources of iron.

Red meat, fish
Spinach and other leafy greens
Whole grains

2) Amylose and cellulose are both polymers formed from glucose monomers.
What is the structural difference between these two polymers and how does this relate to their usefulness in our diets ? [2]

Amylose is a straight chain polymer formed from glucose monomers using an α (1->4) glycosidic linkage.

Cellulose is a straight chain polymer formed from glucose monomers using a β (1->4) glycosidic linkage.

Amylose is digestible by humans, whereas cellulose is not as humans lack the enzyme to break the β (1->4) linkage. However, cellulose is an important source of dietary fibre.

3) There has recently been a lot of press regarding "partially hydrogenated fats".
a) Why would the food industry consider using the process of partial hydrogenation ? (Two reasons) [3]

Partial hydrogenation makes a fat more stable, as there will be less C = C in the molecule.

Partial (as opposed to full) hydrogenation makes a fat softer (somewhere between a solid fat and an oil), so it will be easier to spread.

b) What is a side effect of this process ?

A side effect of this process is that "trans" fatty acids may be produced. These fats act more like saturated fats in the body.

4) a) Briefly describe the process by which a nerve impulse is transmitted between two cells. [2]

A nerve impulse is transmitted via molecules called neurotransmitters. The neurotransmitters are released from the first cell into an area between two cells called the synapse. The neurotransmitters cross the synapse and attach themselves to receptor sites on the second cell. This signals the nerve impulse to travel along the second nerve cell. Once this happens, the neurotransmitters are released from the receptor site and they travel back to the original cell. There they can be released again when another nerve impulse is transmitted between the two cells.

b) Antidepressant drugs interact with this process. What are two different ways that these drugs can act? [2]

Most antidepressant drugs work by increasing the levels of neurotransmitter molecules in the synapse.
One way this is accomplished is by preventing the recapture of the neurotransmitter molecules by the first cell, so the neurotransmitter molecules stay in the synapse longer.
The second way is to inactivate an enzyme which inactivates the neurotransmitter molecules. If the enzyme is not working, the neurotransmitter molecules are not inactivated, so they are able to attach themselves to receptor cells more frequently.

5) Many illegal, mood altering drugs act both as stimulants and depressants. Briefly explain how these compounds can have this dual effect. What is one of the consequences of the dual nature of these drugs ? [2]

These drugs act as stimulants as they cause an increase in the concentration of neurotransmitters in the synapse. This leads to more frequent attachment of the neurotransmitters to receptor sites and causes over stimulation of these sites which results in the "high", or euphoria.
The level of neurotransmitter in the synapse eventually becomes very low as these molecules are eventually destroyed by enzymes. This low level causes depression.
The cycle of euphoria and depression results in addiction to the drug.

6) A certain drug has a half life of 45 minutes. If the initial dose of this drug was 850 mg, how much of the drug would remain after 3 hours ? [3]

3 hours is 180 minutes; which is 4 half life periods.

850 mg is the initial amount.
425 mg is left after 1 half life.
212.5 mg is left after 2 half lives.
106.25 mg is left after 3 half lives.

Therefore; 53.125 mg is left after 4 half lives.

7) DNA has two different, but equally important functions in the body. Name one of them and describe the process used in accomplishing this function. [3]

Replication: making copies of itself prior to cell division

Recipe for protein synthesis with the assistance of mRNA and tRNA

8) How does HDL differ from LDL ? What is the function of each in the body ? [3]

HDL is High Density Lipoprotein. It is a dense molecule containing about 50% protein molecules surrounding a lipid core.
Its function is to transport cholesterol from cells back to the liver.

LDL is Low Density Lipoprotein. It contains less than 50% protein and has a lower mass to volume ratio (density) than HDL.
Its function is to transport cholesterol around the body to cells where it is required.

9) a) What is meant by the term "protein complementary" ? [2]

Protein complementary is a term which refers to the combining of different protein foods to obtain all the essential amino acids.
Animal proteins are usually "complete" proteins, containing all the essential amino acids, but non animal sources are not always complete.
By combining two sources of non animal protein, all the essential amino acids may be obtained.

b) Give two examples of this concept could be used in the diet. [2]

Rice and beans
Corn and beans
Wheat and dairy products
Seeds and legumes

10) A vitamin deficiency can have a major impact on our health. Consider Vitamin A and Vitamin C. Would it be easier to develop a deficiency of Vitamin A or of Vitamin C ? Explain. [2]

Vitamin A is a fat soluble vitamin, and as such, is stored in the body. It does not have to be ingested every day.

Vitamin C is a water soluble vitamin. It is not stored in the body; any excess is excreted. It is therefore important to take in some of this vitamin every day.

As Vitamin C is not stored in the body, if it is not ingested regularly, a deficiency can develop. As Vitamin A is stored, the body can call upon the stored amount if necessary before a deficiency develops.

Therefore, it would be easier to develop a deficiency of Vitamin C.

11) Name two methods of food preservation and briefly describe why each is effective. [4]

Drying: effective because water is necessary for almost all reactions (including those which contribute to food spoilage).

Pickling or Preserving: these methods involve a solution containing either lots of salt or lots of sugar. These concentrated solutions will draw water out of the food in a process called osmosis. This leaves less water in the food product. Water could also be drawn out of any microorganisms present.

Cooking: the high heat required kills many microorganisms which might be present in the food.

12) Environmental estrogens and phytoestrogens are both mimics of the hormone estrogen. [4]

a) Why are these "estrogens" able to affect hormone activity ?

These "estrogens" bind to estrogen receptors in the body, thereby blocking the action of natural estrogens.
This may speed of the breakdown of the natural hormones, as they are not able to perform their intended function.

b) How do these two "estrogens" differ ?

Environmental estrogens are very stable, so do not decompose.

Phytoestrogens are readily metabolized in the body, so have no long lasting effects.

c) How do these "estrogens" affect health ?

Environmental estrogens can be transferred from a mother to her developing fetus, which may result in decreased fertility in the fetus.

This effect is not seen with phytoestrogens.

13) Briefly describe how the compounds that we call "salts" dissolve in water. [2]

Water is a polar molecule, with the Oxygen bearing a partial negative charge and the Hydrogen bearing a partial positive charge.

Salts are compounds which are ionic in nature; they consist of a cation (+ve) and an anion (-ve).

When a salt is placed in water, the cation of the salt is attracted to the Oxygen of the water, forming a hydrogen bond. The anion of the salt is attracted to the Hydrogen of the water, also forming a hydrogen bond.

These attractions compensate for the loss of the cation - anion attraction in the salt and as a result, the salt dissolves.

14) Both calcium carbonate, $CaCO_3$, and sodium bicarbonate, $NaHCO_3$, can be used as antacids.

a) Write a balanced equation for the reaction of each of these compounds with hydrochloric, or stomach acid, HCl. [2]

$CaCO_3 \rightarrow Ca^{2+} + CO_3^{2-}$ then: $CO_3^{2-} + 2\,H^+ \rightarrow H_2O + CO_2\,(g)$

$NaHCO_3 \rightarrow Na^+ + HCO_3^-$ then: $HCO_3^- + H^+ \rightarrow H_2O + CO_2\,(g)$

b) Supposing you had an equal amount (meaning equal numbers of molecules) of each of these antacids, and a very bad case of acid indigestion, which one would you use to get relief ? Explain. [2]

Each molecule of $CaCO_3$ will react with 2 molecules of hydrogen ion (from the stomach acid), whereas each molecule of $NaHCO_3$ will only react with 1 molecule of hydrogen ion.

So each $CaCO_3$ will react with twice as much stomach acid as $NaHCO_3$; it would be the best one to use.

15) Buffer solutions are based on mixtures of weak acid or bases and their conjugate species. For each of the following weak acids or bases, give the conjugate species and state whether a buffer solution formed from each pair would be acidic or basic. [4]

Weak acid: $HClO_2$ *ClO_2^- is the conjugate base; buffer would be acidic*

Weak base: $(CH_3)_2NH$ *$(CH_3)_2NH_2^+$ is the conjugate acid; buffer would be basic*

Weak acid: H_2SO_3 *HSO_3^- is the conjugate base; buffer would be acidic*

Weak base: $C_6H_5NH_2$ *$C_6H_5NH_3^+$ is the conjugate acid; buffer would be basic*