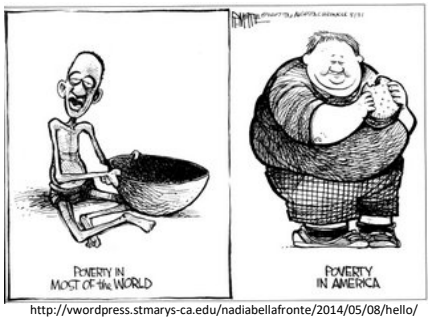
Name(s):	Period:	Date:

Photosynthesis & Respiration

HASPI Medical Chemistry Application Worksheet 6c

Background- Nutrition – An International Energy Crisis

One of the largest issues in global medicine today is nutrition. There is actually enough food in the world. However, it is not evenly distributed, causing some areas to have excess food that often ends up in the landfill while other areas of the world go hungry, because they cannot grow food and cannot afford to import it. There are also political and social issues that limit access to food.



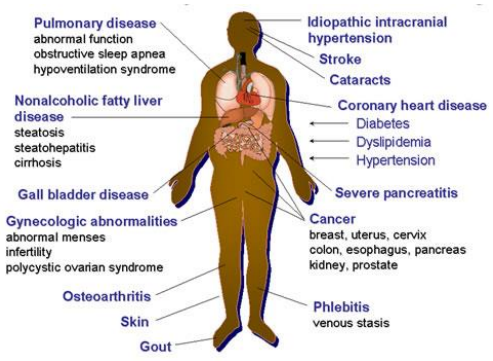
http://vwordpress.stmarys-ca.edu/nadiabellafronte/2014/05/08/hello/

A person who undergoes chronic hunger has a much higher susceptibility to disease, because they are taking in less food than would be sufficient to meet their dietary energy needs. In 2012-2014, the Food and Agriculture Organization of the United Nations reported that 11% of people in the world are undernourished. That's 805 million people who do not get enough energy due to food shortages

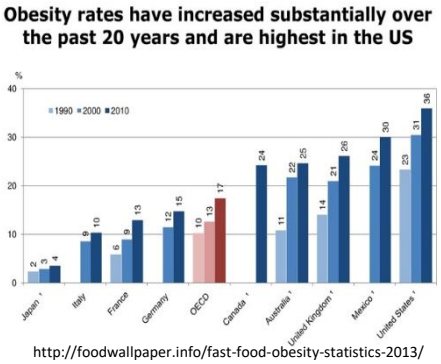
http://www.actionagainsthunger.org/hunger/global-malnutrition

The resulting medical issues from this are significant, and children under 5 years old and pregnant women tend to be the most vulnerable. Malnourishment not only results in children being severely underweight with reduced height, but it also weakens their immune system. When the immune system is weak, these children are are at a heightened risk of illness, because they are prone to any sickness that they are exposed to. In malnourished children, there is a higher chance of dying once they get a disease than children who have access to food. In fact, 61% of deaths from diarrhea, 57% of deaths from malaria, 52% of deaths from pneumonia and 45% of deaths from measles have undernutrition as the underlying cause. In fact, 32.5% of children in developing countries are affected by undernutrition.

If we took the food in the world and divided it equally among all people, there would be at least 2,710 kilocalories per person-per day available, based on a 2002 study. If you look at the suggested caloric intakes listed below, you will see that this is more than enough food. However, distance and cost as well as food waste contribute to this unequal food distribution.



Many Side Effects of Obesity
http://www.surgerytimes.com/about_obesity_medical_complication

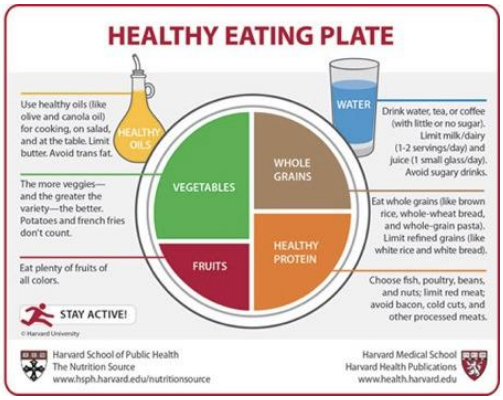


http://foodwallpaper.info/fast-food-obesity-statistics-2013/

The other side to this issue is severe obesity. As more and more high calorie foods are available for low cost, there are a lot of families who forego fresh fruits and vegetables for fast food because it can be easier on the budget and it saves time. Poor nutrition like this has lead to much higher instances of type II diabetes, heart disease, high blood pressure and stroke among many other health issues.

https://foodandhealth.com/flax-milk-review/

Our preference for high-calorie foods stems from the need to survive. To acquire calories in the past, we needed to hunt or gather our food. If it takes a few days to go through the forest in order to find your food, you will expend a large amount of energy. This means we are evolutionarily designed to desire foods with high caloric content, especially fats and carbohydrates. In today's society, we still have the desire for foods with high caloric content, because it historically increased our survival rates. However, we no longer expend a lot of energy to find our food, since it can be purchased at a nearby grocery store. **Fast food yields as many calories as hunting for food but at a very low energy cost.**



The key to maintaining, losing or gaining weight is associated with the energy you take in compared to the energy you use. It also has to do with the type of food you choose to eat. The table at the right outlines the recommended daily caloric intake for someone who is not going out of their way to exercise. If you excersise, you are using up some of your energy, therefore, you can eat more food than shown. To lose weight, you need to use more calories than you eat, so you either need to reduce your caloric intake or increase the calories you burn – meaning you either need to control your diet or exercise!

Review Questions

Directions: Use the reading above to answer the prompt on the left with the appropriate response on the right.

Prompt	Response
1. What percent of people worldwide are undernourished?	
2. What percent of children in developing countries are affected by undernutrition?	
3. Why do people choose high-calorie foods, such fast food, instead of fresh fruit and vegetables?	
4. Why do most people desire high-calorie food?	
5. What is the key to reducing fat-percent in the body?	

6. The data table below indicates the average number kcal/day needed for each age group and gender. Complete the table below by converting kcal/day to kJ/day and highlight the information that pertains to you.

Age (years old)	kcal/day	kJ/day
2- to 3-year-old children	1000	
4- to 8-year-old children	1300	
9- to 13-year-old boys	1800	
14- to 18-year-old boys	2200	
19- to 30-year-old men	2400	
31- to 50-year-old men	2200	
51-year-old+ men	2000	
9- to 13-year-old girls	1600	
14- to18-year-old girls	1800	
19- to 30-year-old women	2000	
31- to 50-year-old women	1800	
51-year-old+ women	1600	

Name(s):	Period:	Date:

Photosynthesis & Respiration

HASPI Medical Chemistry Application Worksheet

Background/Introduction

Photosynthesis & Cell Respiration were a primary focus in Biology and you learned that these two processes can be simplified to 2 chemical reactions that were near mirror images to each other. These reactions are the process through which systems on earth take in light energy from the sun which is utilized by living organisms to eventually produce a source of energy in the form of ATP. By carefully controlling these processes using enzymes, in both the body and the plant cell, we are able to harness the energy we need to continue life on the planet.

Analysis Questions

Directions: Answer the following questions in the space provided about Photosynthesis and Respiration as you apply what you have learned to our most basic energy needs.

1. Photosynthesis occurs when plants take in carbon dioxide (CO_2) and water (H_2O) to make glucose sugar ($C_6H_{12}O_6$) and oxygen gas (O_2) in the presence of light. Write the chemical equation for photosynthesis.

Answer:

2. The ΔH value for this reaction is +2800kJ/mol.
Re-write and balance your equation to include this energy in your thermochemical equation.

Answer:

3. Is this reaction *endothermic* or *exothermic*? How do you know that it is *endothermic* or *exothermic*? Provide evidence.

Answer:

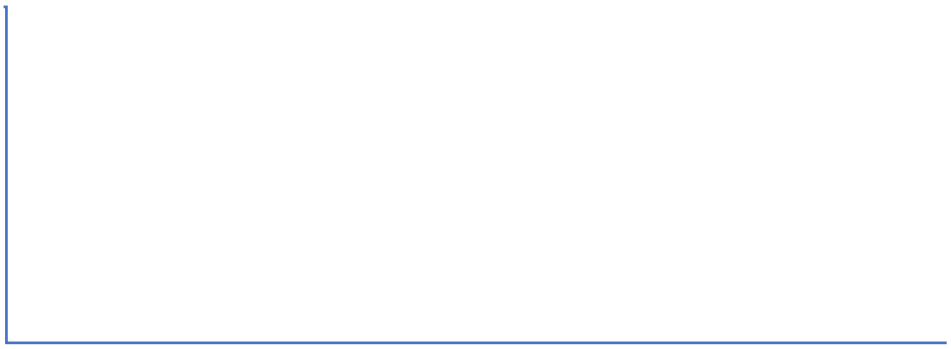
4. Draw an energy diagram including the reactants, the products, and the ΔH value for the reaction of photosynthesis.

Answer:

5. In a banana, there are 14.5 grams of sugar. If we assume that all the sugar is fructose, $C_6H_{12}O_6$, then how much energy does it require to make this much sugar?
a) What is the molar mass of fructose?
b) How many moles of fructose are in 14.5 grams of fructose?
c) Use your ΔH value to calculate the energy required. List in both kJ and kcal.
d) Where did this energy come from to make this banana?
6. If you eat the banana, your body will break down those sugars. Where is energy stored in sugar? What type of energy (potential or kinetic) do you take into your body when you eat sugar?
7. In the process of cellular respiration your body takes the sugar and oxygen in. What are the products of cellular respiration?
8. During respiration, oxygen gas (O_2) and a sugar ($C_6H_{12}O_6$) are used to produce carbon dioxide (CO_2), water (H_2O) and ATP in mitochondria.
a) Write a balanced chemical equation for cellular respiration, using fructose ($C_6H_{12}O_6$) as the sugar.
b) What type of reaction is occurring during cellular respiration?
9. Study the reactions for photosynthesis and respiration. What is the relationship between the photosynthesis reaction and the cell respiration reaction?
Answer:
10. Consider your answer in question 9. How much energy should be released when 1 mole of fructose sugar is consumed and broken down during cellular respiration?
Answer:

11. Draw an energy diagram including the reactants, the products, and the ΔH value for the reaction of cellular respiration. Keep in mind, activation energy is required for this reaction.

Answer:



12. How much energy would you, as a human, intake from eating the banana listed in question 5?

Answer:

13. The body uses released energy to create ATP and NADPH, the energy molecules of our body. Only 38.3% of the energy that was in sugar is stored as ATP.

a) How much energy is lost as heat in this reaction and how much energy becomes stored in ATP?

b) How much energy goes into ATP in kcal?

c) If each ATP requires 7.3 kcal/mol, how many moles of ATP can be formed from eating this banana containing 14.5 grams of sugar?

14. If the molar mass of ATP is 507.18 g/mol, how many grams of ATP can be formed if you eat that banana containing 14.5g sugar?

Answer:

15. What can ATP be used for in the body?

Answer:

16. At the end of this process, what form does most of the energy take on?

Answer:

17. The elements in this process can cycle, because they can be reused by plants and animals over and over. What part of this process is NOT reusable?
Answer:
18. Application: If we limit carbohydrates in our diet, then the FDA recommends that you have only 130 grams of carbohydrates per day. If we got all carbohydrates from fructose in the reaction, how many calories would we consume per day?
Answer:

Application & Research

What do you drink the most? Soda Gatorade Juice	What type of carbohydrate do you eat the most? Bread Rice Pasta
What is a serving size of the drink you have the most of?	What is a serving size of the carbohydrate you eat the most of?
How many calories are in one serving of this drink?	How many calories are in one serving of this carbohydrate?
How many grams of carbohydrates are in that serving?	How many grams of carbohydrates are in that serving?
How many calories from carbohydrates are in that serving?	How many calories from carbohydrates are in that serving?
Consider the questions above. How many carbohydrates do you think you usually eat from these sources per day?	
What other sources of carbohydrates do you consume?	
What changes can you make to limit your intake of carbs to 130 g/day?	

Name(s):	Period:	Date:

Photosynthesis & Respiration KEY

HASPI Medical Chemistry Application Worksheet

Background/Introduction

You probably learned about Photosynthesis & Respiration in your biology classroom, but these two processes can be simplified down to two chemical reactions. These reactions are the process through wich systems on earth take in energy from the sun and pass it along through all organisms as our source of energy. By carefully controlling both processes through enzymes in the body and the plant cell, we are able to harness the energy we need to continue life on the planet.

Answer the following questions on Photosynthesis and Respiration as you apply what you have learned in this unit to our most basic energy needs.

1. Photosynthesis occurs when plants take in Carbon dioxide and water to make sugar (fructose = $C_6H_{12}O_6$) and oxygen gas. Write the equation for photosynthesis:

$$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$$

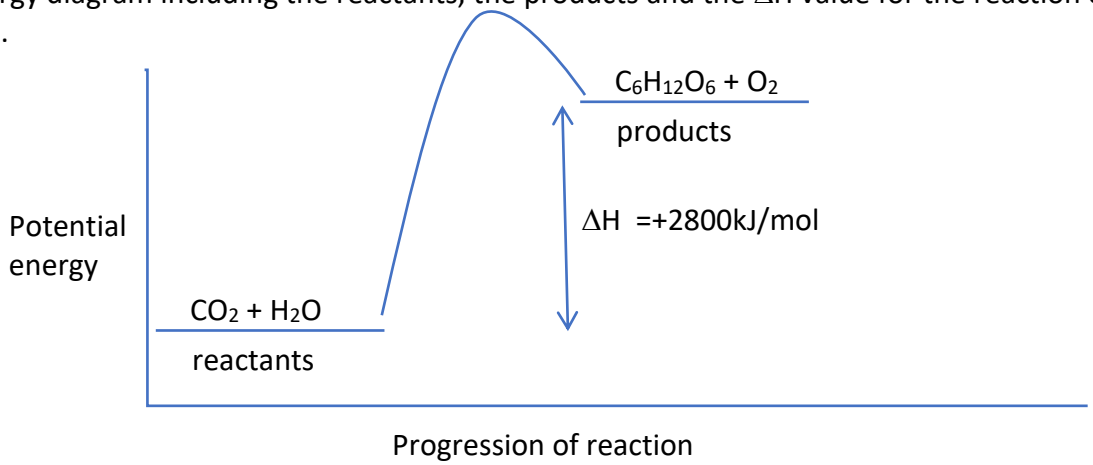
2. The ΔH value for this reaction is +2800kJ/mol.
Re-write and balance your equation and include this energy in your thermochemical equation.

$$6\ CO_2 + 6\ H_2O\ +2800kJ \rightarrow 1\ C_6H_{12}O_6 + 6\ O_2$$

3. Is this reaction endothermic or exothermic? Why?

Endothermic. It has a positive ΔH value which means it requires energy to proceed.

4. Draw an energy diagram including the reactants, the products and the ΔH value for the reaction of photosynthesis.



5. In a banana there are about 14.5 grams of sugar. If we assume that all of that sugar is fructose, $C_6H_{12}O_6$, how much energy does it require to make this much sugar?

a) What is the molar mass of fructose

(6 x 12.01) + (12x1.01) + (6 x 16.00) = 180.18g/mol

b) How many moles of fructose are in 14.5 grams of fructose

$$14.5g \times \frac{1\ mol}{180.18g} = 0.0805\ moles\ of\ fructose$$

c) Use your ΔH value to calculate the energy required. List in both kJ and kcal.
0.0805 moles x 2800kJ/mol = 225 kJ of energy are required x $\frac{1\ kcal}{4.184kJ}$ = 53.7kcal

d) Where did this energy come from in order to make this banana?
The energy came from the sun

6. If you eat the banana, your body will break down those sugars. Where is energy stored in sugar? What type of energy (potential or kinetic) do you take into your body when you eat sugar?
The energy is stored in the bonds which makes it a form of potential energy.

7. In the process of cellular respiration your body takes the sugar and oxygen in. What are the products of cellular respiration?
Carbon dioxide and water

8a) Write a balanced chemical equation for cellular respiration, using fructose ($C_6H_{12}O_6$) as the sugar.

$$1\ C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

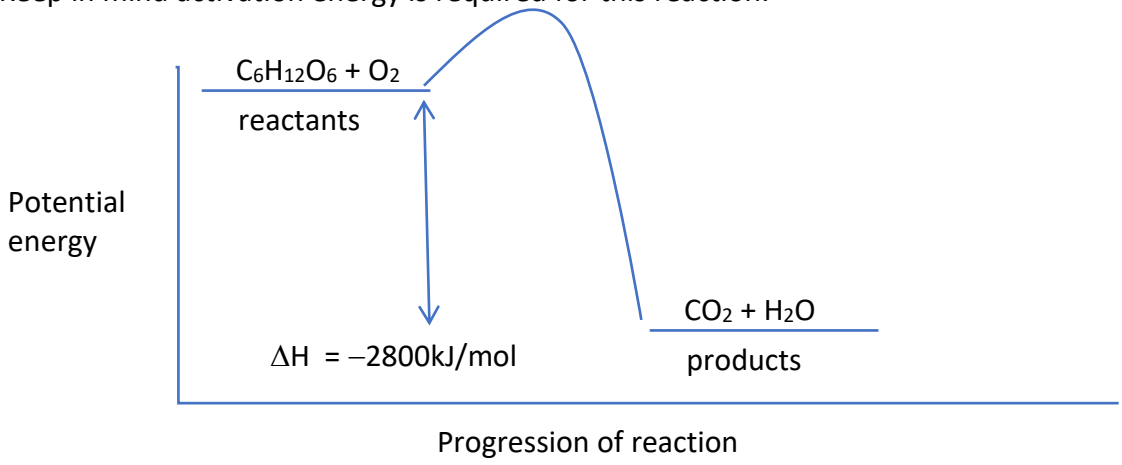
b) What type of reaction is occurring during cellular respiration? Combustion

9. Study the reaction for photosynthesis above. What is the relationship between the photosynthesis reaction and the reaction that occurs during cellular respiration?
The reactions are exactly reversed

10. Considering your answer in question 9, how much energy should be released when 1 mole of fructose sugar is consumed and broken down through cellular respiration?

2800kJ of energy should be released because it's the exact reverse reaction.

11. Draw an energy diagram including the reactants, the products and the ΔH value for the reaction of cellular respiration. Keep in mind activation energy is required for this reaction.



12. How much energy would you, as a human, intake from eating the banana listed in question 5?

I would take in 225 kJ of energy.

13. The body uses this released energy in order to create ATP and NADPH, the energy molecules of our body. Only 38.3 % of the energy that was in sugar is stored as ATP.

a) How much energy is lost as heat in this reaction and how much energy becomes stored in ATP? 225kJ x 0.383 = 86.2kJ go into ATP so 138.8kJ are lost as heat.

b) How much energy goes into ATP in kcal? $86.2\text{kJ} \times \frac{1\text{ kcal}}{4.184\text{kJ}} = 20.6$ kilocalories.

c) If each ATP requires 7.3 kcal/mol, how many moles of ATP can be formed from eating this banana containing 14.5 grams of sugar?

$20.6\text{ kcal} \times \frac{1\text{ mol}}{7.3\text{kcal}} = 2.82\text{ mol ATP}$

14. If the molar mass of ATP is 507.18g/mol, how many grams of ATP can be formed if you eat that banana containing 14.5g sugar?

2.82 moles x 507.18g/mol = 1430 grams of ATP

What can ATP be used for in the body?

Muscle and cell movement, enzyme activity, transport substances across membranes, chemical work such as making and breaking bonds.

15. At the end of this process, what form does most of the energy take on?

Heat

16. The elements in this process are able to cycle because they can be reused by plants and animals over and over again. What part of this process is not reusable?

Energy is not reusable in the cycle because it becomes an unusable type. We need to continually get energy from the sun.

Application Question

If we want to limit ourselves to carbohydrates as we study the cycle of photosynthesis and respiration, the FDA reccomends that you have only 130 grams of carbohydrates per day. If we got all of those carbs from fructose in the reaction above, how many calories would we take in per day?

$130\text{g} \times \frac{1\text{ mol}}{180.18\text{g}} = .722\text{ moles of fructose} \times 2800\text{ kJ/mol} = 2020\text{ kJ} \times \frac{1\text{ kcal}}{4.184\text{kJ}} = 483\text{ calories}$

You should eat just 483 calories from carbs per day.