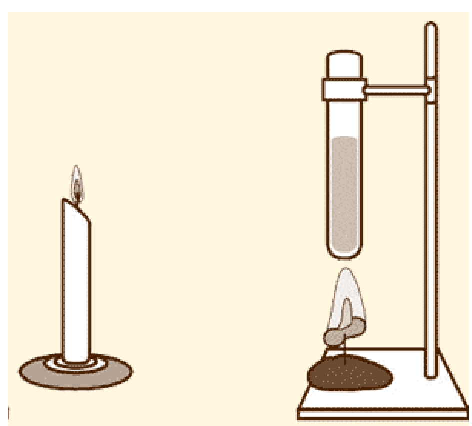
“Burning” Calories Energy Lab; SB3 a; SB4 b; SB1a

As you read the following information, recall our emphasis on a holistic approach to biology… remember the “big picture”. A characteristic of all organisms is that they use energy. Energy comes from lipids, carbohydrates and proteins and is ultimately converted into ATP. A calorie is a unit that has been invented to measure energy. Scientists determine the calories in a particular food by burning the food in a calorimeter. A small calorie or gram calorie is defined as the amount of heat necessary to raise the temperature of one gram of water one degree Celsius. A kilocalorie, or sometimes called a big Calorie (note the capital C) is 1000 calories. The kilocalorie is more commonly used than the small calorie. If you read that a slice of bread contains 100 Calories it is 100 big calories. The energy contained in foods is energy that came from the sun. The autotrophs in ecosystems of the earth (plants, algae, and some bacteria) are able to trap energy by storing it in chemical bonds in the process of photosynthesis. In this process, autotrophic organisms use chlorophyll as a catalyst to break water molecules and combine carbon dioxide with the hydrogen from the broken water molecule to make sugar. These sugars provide energy for all other organic molecules to be formed. This complex process evolved on earth more than a billion years ago. Since its evolution, this conversion process has been making energy available not only to the organisms that have chlorophyll but to organisms that have evolved to metabolize the autotrophic organisms that store the energy. These are the heterotrophs, or consumers. Photosynthesis enables food chains to exist in nature. Calories that are counted in our everyday diet are based upon the same units of heat that measure the potential energy stored within chemical bonds. As substances react, chemical bonds are broken and reformed. During this process, energy is released. The amount of released energy is measured in calories and is dependent upon the original energy content of the reactant bonds. Foods that are high in calories have chemical bonds that when rearranged give off large amounts of energy. When a high-energy bond is broken, a large amount of energy is released. If the body can't use all of this energy, it stores the access within the chemical bonds of lipids. The purpose of this lab is to determine the amount of calories in various foods and to relate this information to the concepts of cellular respiration, photosynthesis and the macromolecules of life. Remember that for this lab, energy is released as heat and is transferred to water. As the water absorbs the heat, its temperature rises. By knowing the mass of burnt food, the volume of water, and the change in the water's temperature, you can determine the calories/gram of the burned food.

Food Item	**Weight (mass) of food (grams)**			**Temperature of water (°C)**			**Calories**	**calories/gram**
	Initial (W_i)	**Final (W_f)**	**Δ mass**	**Initial temp. (T_i)**	**Final temp. (T_i)**	**Δ temp.**	**(volume water)x(Δ temp)**	**(Δ water temp)/(Δ mass)**

MATERIALS

- Large test tube
- Test tube holder
- Graduated cylinder
- Pie pan w/ paperclip
- Candle w/ clay base
- LabQuest2 Digital Probe
- Laboratory balance
- Water (maintained at room temperature)
- Safety goggles



PROCEDURE

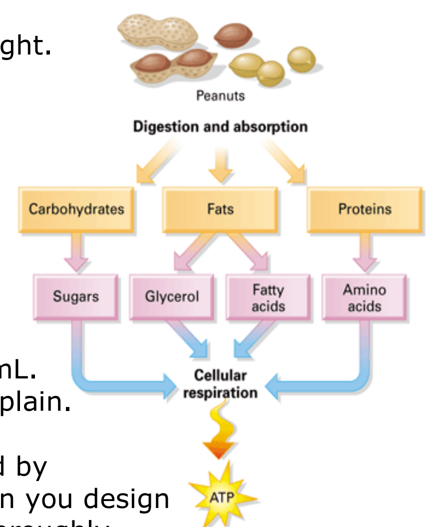
1. Review all safety precautions associated with the use of an open flame with your instructor.
2. Put on your safety goggles. Use a graduated cylinder to pour 10 mls of water into a test tube.
3. Practice using the test tube holder and then secure the tube in the test tube holder.
4. Obtain the initial mass of the three food items you have chosen to test. Record this value.
5. Carefully pierce the item to attach it to the paperclip/pie pan apparatus. You can only test one at a time.
6. Measure the initial temperature of the test tube water in degrees Celsius with a digital probe. Record this value as the initial temperature for all three food items, as they are all the same.
7. With your instructor's approval, light a nearby candle. Once the candle is burning, use it to set the food item on fire. Be smart, productive and safe or I will immediately end the lab.
8. Once the item has started burning, position the water filled test tube slightly above the flame. Move the test slowly back and forth over the open flame. **NOTE:** Hold the test tube so that it points away from everyone as the flame heats the water.
9. When the item has stopped burning, retake the temperature of the water. Record this final value.
10. Carefully place the test tube and holder into the sink to allow it to cool between test burns. The test tube will be black. You can clean them after the third food item has been tested.
11. Place the burnt item on the balance and determine its final mass. Record your data.

QUESTIONS

1. Write a summary of the background information for this lab.

2. Explain how the chemical energy in the food items that you tested is converted into ATP.

3. Thoroughly explain your interpretation of the schematic diagram to the right.



4. Red blood cells do not contain mitochondria. Which stage or stages of sugar breakdown can take place in these cells? Justify your answer.

5. To simplify our calculations, we set the mass of 1 mL equal to 1 gram. How accurate is such an approximation? To find out, use a laboratory balance to obtain the mass of a beaker. Record this value. Use a graduated cylinder to introduce 100 mL of water to this beaker. Determine its new mass. Subtract the initial mass from the final mass to obtain the mass of 100 mL of water. Divide this value by 100 to obtain the mass of 1 mL. Was the approximation you used in the previous experiment acceptable? Explain.

6. The experimental design in this lab was flawed. All of the energy released by each burning food item was not absorbed by the water. Where did it go? Can you design a better set-up in which less heat energy is lost? Think about it and then thoroughly explain your new design.

7. Read standards SB4b, Sb3a and SB1a. Next, write a short essay with the following terms included <u>and underlined</u> explaining how they are all connected. You are trying to make a "big picture" connection between the three state standards and the results of this lab.

Autotroph, food chain, heterotroph, mitochondria, chlorophyll, ecosystem, abiotic, biotic, carbon cycle, oxygen cycle, homeostasis

8. Explain why it is more accurate to define the biosphere as the global ecosystem than as the global community. Justify your answers.