Human Body Systems: Calorimetry

SC Academic Standards: 5.L.4B; 7.L.3B; 7.EC.5B; H.B.2A; H.B.3A.

NGSS DCI: 5-LS2.A; MS-LS1.C; MS-PS3.D; MS-LS2.B; HS-LS1.C; HS-LS2.B.

Science and Engineering Practices: S.1A.1; S.1A.2; S.1A.3; S.1A.4; S.1A.5; S.1A.6; S.1A.7, S.1A.8.

Crosscutting Concepts: Patterns; Cause and Effect: Mechanism and Explanation; Scale, Proportion, and Quantity; Energy and Matter: Flows, Cycles, and Conservation; and Systems Models.

Focus Question(s): Which food has more stored energy, or a greater caloric content: protein, carbohydrate, or fat?

Conceptual Understanding: All organisms need energy to live and grow. Energy is obtained from food. The role an organism serves in an ecosystem can be described by the way in which it gets its energy. Energy is transferred within an ecosystem as organisms produce, consume, or decompose food. A healthy ecosystem is one in which a diversity of life forms are able to meet their needs in a relatively stable web of life.

Multicellular organisms (including humans) are complex systems with specialized cells that perform specific functions. Organs and organ systems are composed of cells that function to serve the needs of cells which in turn serve the needs of the organism.

The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes.

Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another.

Background: Research has shown that eating a well-balanced, nutritious diet reduces the risk of coronary heart disease, strokes, some cancers, and osteoporosis. But it's important to take a close look at the nutritional values, ingredients, and **calorie counts** in the food you're buying. Food labels provide this information and allow you to make informed healthy food choices to help meet your family's nutritional needs. The Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) require labels on almost all packaged foods that include nutrition information in readable type. The information usually appears on the back or side of packaging under the title "Nutrition Facts" (see Previous Knowledge section).

But do all types of food contain the same amount of energy? Every animal maintains its life processes by consuming (digesting) complex molecules that store energy. The processed plants and animals we eat as foods contain varying amounts of proteins, carbohydrates, and fats. Because each of these types of foods contains varying amounts of energy, these foods will release varying amounts of energy when they are used by cells. Within our bodies, the energy is released slowly by a series of chemical reactions called cellular respiration.

Energy content is an important property of food. The energy your body needs for running, talking, and thinking comes from the food you eat. You can determine energy content by burning a portion of food and capturing the heat released to a known mass of water in a calorimeter. Fats are an important source of energy - they contain twice as much energy per gram as carbohydrate or protein (9 kcal/g versus 4-5 kcal/g). That means by converting excess food to fats – rather than carbohydrates like the starch glycogen stored in your liver – you can store more energy in less space.

By burning (oxidizing) pieces of food, the chemical energy stored in molecular bonds is released as heat and light. The heat can be measured in units called **calories**. A calorie is the amount of heat (energy) required to increase the temperature of one gram of water by one degree Celcius. This process is the basis of the technique of **calorimetry**. The more calories a food contains, the more heat is given off when burned. Foods high in calories will release large amounts of energy. One gram of a protein will release far fewer calories than one gram of fat. You will study foods with different proportions of protein, fats, and carbohydrates to see how much energy (calories) they release. A generalization is that carbohydrates provide about 4 Cal/g (unbuttered popcorn and marshmallows) while fat rich peanuts and cashews provide about 9 Cal/g. (1 Cal = 1 dietary calorie).

What an animal eats, in other words, if it is herbivorous, carnivorous, or omnivorous, will determine how long the intestines need to be. Because plant materials are hard to digest, and because plant eaters eat more continuously throughout the day, keeping their stomachs full, it is an advantage to spend more time in the digestive tract before they are eliminated, so more can be digested and less wasted. Herbivores, with a digestive tract length about 25 times the body length, tend to have proportionally longer digestive tracts than carnivores, whose digestive tract is about 6 times the body length. Carnivores eat meat, and meat is full of protein and is relatively easier to digest (versus plants). It makes sense that larger animals have a proportionally longer intestinal tract than smaller animals (remember, too, that the length of your intestines grow as you grow from a baby to an adult).

<u>**Previous Knowledge:**</u> **(nutrition): Serving Size and Servings Per Container.** All of the information about the nutritional value of the food that is listed on the label is given according to the serving size. So if a serving size is 2 crackers and you eat 4 crackers - which would be two servings - you need to double all of the nutrition information.

Calories. A calorie is a unit of energy that measures how much energy a food provides to the body. The number of calories that's listed on the food label indicates how many calories are in one serving. Technically, a **Calorie** (kilocalorie) is the amount of energy needed to raise one liter of water by one degree celcius.

Calories From Fat. The second number, calories from fat, tells the total calories in one serving that come from fat. Although eating too much fat can lead to obesity and related health problems, our bodies do need some fat every day. Dietitians generally recommend that no more than 30% of calories come from fat over the course of the day. That means that if the food you eat over the course of a day contains 2,000 calories total, no more than 600 of these should come from fat. Fats are an important source of energy - they contain twice as much energy per gram as carbohydrate or protein (9 kcal/g versus 4-5 kcal/g). Fats provide insulation and cushioning for the skin, bones, and internal organs. Fat also carries and helps store certain vitamins (A, D, E, and K). But because eating too much fat can contribute to health problems, including obesity, heart disease, and diabetes, adults and children older than age 2 should have no more than about 30% of their daily calorie intake come from fat.

Saturated Fat and Trans Fat. The amount of saturated fat appears beneath total fat. The FDA also requires food makers to list trans fats separately on the label. Saturated fats (animal products, like butter, cheese) and trans fats (oils hydrogenated to remain solid at room temperature – like shortening) are often called "bad fats" because they raise cholesterol and increase a person's risk for developing heart disease. Both saturated and trans fats are solid at room temperature (picture them clogging up arteries!) Saturated fats should account for less than 10% of the calories that a child eats each day, and the amount of trans fat that your child consumes should be as low as possible.

Whole Milk
Serving Size 8 fl oz (240mL)
Servings Per Container 2

Amount Per Serving	
Calories 150	Calories from Fat 70
	% Daily Value*
Total Fat 8g	12%
Saturated Fat 5g	25%
Cholesterol 35mg	12%
Sodium 125mg	5%
Total Carbohydrate 12g	4%
Dietary Fiber 0g	0%
Sugars 11g	
Protein 8g	

Vitamin A 6% • Vitamin C 4%
Calcium 30% • Iron 0% • Vitamin D 25%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Unsaturated Fat. Unsaturated fats are also listed under total fat. These are fats that are liquid at room temperature. Foods high in unsaturated fat are vegetable oils, nuts, and fish. Unsaturated fats are often called "good fats" because they don't raise cholesterol levels like saturated fats do.

Total Carbohydrate. This number, listed in grams, combines several types of carbohydrates: dietary fibers, sugars, and other carbohydrates. Carbohydrates are the most abundant source of calories. Up to 60% of a child's total calories should come from carbohydrates. The best sources of carbohydrates are whole-grain cereals and breads and brown rice. Other sources include pastas, fruits, and vegetables.

Sugars. Also listed under total carbohydrate on food labels, sugars are found in most foods. Fruits contain simple sugars but also contain fiber, water, and vitamins, which make them a healthy choice, too. Snack foods, candy, and soda, on the other hand, often have large amounts of added sugars. Although carbohydrates have just 4 calories per gram, the high sugar content in soft drinks and snack foods means the calories can add up quickly, and these "empty calories" usually contain few other nutrients.

Protein. This listing tells you how much protein is in a single serving of a food and is usually measured in grams. Most of the body - including muscles, skin, and the immune system - is made up of protein. If the body doesn't get enough fat and carbohydrates, it can use protein for energy . Foods high in protein include eggs, meat, poultry, fish, milk, cheese, yogurt, nuts, soybeans, and dried beans. Anywhere from 10% to 20% of the calories that a child consumes each day should come from protein.

Previous Knowledge: (nutrition): This chart gives the relative Kcal/g for a variety of foods. Foods that are mostly made up of fats will have the highest kcal/ g reading and proteins / carbs have half as much Kcal/g (9 kcal/g versus 4-5 kcal/g).

FOOD	KCal/Q	%H_2O	% Protein	% Fat	%Carbohydrates
Almond	6.4	4.7	18.6	54.1	19.6
Navy Bean	3.5	10.5	22.0	1.5	62.1
Bread, white	2.61	35.9	8.5	2.0	52.3
Cheese, cheddar	3.93	39.0	23.9	32.3	1.7
Cooking oil, Crisco	9.00	..	..	100.0	..
Egg, white boiled	.57	..	12.3	.6	..
Lard	9.30	..	..	100.0	..
Peanuts, roasted	6.00	2.6	26.9	44.2	23.6
Popcorn, popped	4.03	5.0	10.7	5.0	78.7
Pecans	7.47	3.0	9.4	73.0	13.0
Soybeans, dry	3.51	7.5	34.9	18.1	12.0
Sugar, white	3.98	0.5	..	..	99.5
Walnuts, black	6.57	6.0	27.6	56.3	10.0
Walnuts, English	7.02	3.3	15.0	64.4	15.6
Zweiback bread	4.22	6.0	9.8	9.9	73.5

<u>Previous Knowledge</u>: (cell biology / energetics): Photosynthesis and cellular respiration are complementary processes. During photosynthesis, the energy of sunlight is used to combine carbon dioxide (CO_2) and water (H_2O) into glucose ($C_6H_{12}O_6$). Oxygen is released as a waste product of photosynthesis. The balanced chemical equation for photosynthesis is:

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

During respiration, organisms use oxygen to extract energy from the chemical bonds in glucose. The balanced chemical equation for cellular respiration is the reverse of the photosynthesis equation:

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

The simple symmetry of these equations disguises the complexity of the processes involved. Cellular respiration, for example, takes place in three phases: *glycolysis*, the *Krebs cycle*, and the *electron-transport chain*.

- Glycolysis occurs in the cytoplasm. A molecule of glucose ($C_6H_{12}O_6$)* is broken down into two molecules of pyruvic acid ($C_3H_4O_3$) and two hydrogen ions (H^+). Glycolysis produces a net gain of two ATP molecules. (ATP, or adenosine triphosphate, is a molecule that is used as an energy source in cellular reactions.) No oxygen is required for glycolysis.
    - * actually, most foods, carbs, fats, and proteins, can be broken down in aerobic cell respiration – the textbooks always show glucose for consistency, but if you were breaking down a protein, it may enter the glycolysis reaction in a slightly different place and make slightly different amounts of ATP, NADH etc, but any food can be "burned" or oxidized into ATP energy

- The Krebs cycle (also called the *citrus acid cycle* or the *tricarboxylic acid cycle*) occurs in the mitochondria. The Krebs cycle is a series of eight enzyme-regulated reactions that break down pyruvic acid into carbon dioxide. The result is a variety of high-energy molecules: 6 NADH, 2 $FADH_2$, and 2 ATP.

- In the electron-transport chain (ETC), electrons from NADH and $FADH_2$ are transferred from one substance to another. In the process their energy is harvested to form ATP molecules. A total of 32 to 34 ATP molecules are formed in this process. At the end of the chain, the electrons combine with hydrogen ions and oxygen to form water molecules, which are released as a waste product along with the carbon dioxide.

- The whole point of aerobic cell respiration is to pass the energy from high E reactants, like fats, carbs, proteins, to high Energy electron carriers like NADH to proteins in the electron transport chain. As the Energy is being passed (like a hot potato down the series of proteins in the electron transport chain), energy is released, and this released energy causes H+ to be pumped, creating a gradient to be set up over the mitochondrial membrane (with H+ building up in space between inner and outer mitochondrial membrane). At the end of the electron transport chain, embedded in the inner mitochondrial membrane with the rest of the proteins, is the protein / enzyme called ATP synthase. When the H+ gradient is released, it rushes (osmosis) through the ATP synthase back to the inside of the inner membrane of the mitochondria, and causes the phosphorylation of ADP + Pi to ATP. Chemiosmotic phosphorylation! It's all in the gradient! You can launch a discussion of potential energy here, too, the gradient is potential E.

Materials: walnuts, fritos corn chips, mini marshmallows, tea light candle, foil pie plate or a sheet of tin foil, lighter stick, test tubes, beaker with water, test tube clamp, 25 ml graduated cylinder, scale, dissecting needle, thermometer, calculators.

Procedure: (* **NOTE: This lab involves the use of flame.** Take appropriate precautions – including limiting loose clothing, tying back long hair, and alerting campus safety to the fact that you are burning in the class (sometimes fire alarms are triggered, so know where your smoke detector is, and don't burn under it).

You will test four foods to determine which one has the most calories.

QUESTION:

HYPOTHESIS: Which food do you think will raise the temperature of the water the most (have the greatest number of calories)? Why do you think this is?

1. Look at the nutrition labels for each food item on your desk (walnut, frito, marshmallow). Fill out the following chart:

	Walnut	**Frito**	**Marshmallow**
Protein (g)			
Carbohydrate (g)			
Total Fat (g)			

Table 1. Nutrition Information for Foods to be burned.

2. Spread a sheet of aluminum foil out on your desk, so burning bits of food will fall

onto it rather than the desktop.   Place a candle on one side of your aluminum foil (not in the center).

2. Place **20.0 mL** of water in the test tube and put the test tube in the clamp. Place the thermometer in the test tube. Allow it to sit for one minute.

3. Measure the temperature of the water in the test tube to the nearest **0.5 degree C** and record in the Data Table as **initial** water temperature

4. Obtain a 1 to 3 g sample of test food number 1. Find the mass of the test food sample to the nearest **0.01 g** and record its name and mass in the Data Table. (This is about 2 mini marshmallows, 1 frito, ½ a walnut).

5. Use the dissecting needle to hold the food sample. Light the candle, and hold the food over the flame just until it catches on fire.   Once on fire, immediately move the food sample under the test tube and away from the candle (we want the water to heat up because of the food, not the candle / wax). The burning food and the test tube should be close together and centered over your aluminum foil. **Gently** stir the water with the thermometer, using an up and down motion.

6. After the food sample is completely burned, measure the temperature of the water again to the nearest **0.5 degrees C**, and record in the Data Table as **final** water temperature.

7. Find the mass of the sample remaining to the nearest **0.01 g** and record in Table 1 as mass of sample **after** burning (ash weight).

8. **Repeat until you have tested all 3 foods**: marshmallow, walnut, frito's corn chip. You may ask the students if they have a 4th food they would like to test.

<u>Data Analysis:</u>

9. Subtract the mass of the sample after burning (ash weight) from the mass of the sample before burning. This is the change in mass.   **Change in mass = _______ g**

10. Calculate the change in temperature for the water by subtracting the initial water temperature from the final water temperature.
Change in water temperature = _______ ^{o}C

11. To estimate the calories in the food sample you will need the mass of the water you heated. By definition the density of water is 1g/mL, so 1 mL of water has a mass of 1 g. The **20.0 mL** of water you used would be **20.0 g**.   **Mass of water = 20.0 g**

The following formula will calculate **Kilocalories (Kcal)**. One kilocalorie = 1000 calories. The **specific heat** of water is 1 kilocalorie/Kg degree C.

$$\text{Kilocalories of sample} = \begin{pmatrix} mass \\ of \\ water \end{pmatrix} \times \begin{pmatrix} change \\ in \\ water \\ temp \end{pmatrix} \times \left({}^{1kg}\!/\!_{1000g} \right) \times \begin{pmatrix} specific \\ heat \\ of \\ water \end{pmatrix}$$

You will see that all units of measurement except kilocalorie cancel each other out of the equation. Everything is already in the equation except your change in temperature for the water. Put in your change in temperature and work the calculation. You now have the total kilocalories of energy given off by the food sample. **Energy given off by sample = _______ Kcal**

12. Calculate the kilocalories per gram of the food sample. This is the total kilocalories divided by the **change in mass** of the sample. The unit will be Kilocalories/gram. **Kilocalories per gram of sample = _______ $^{\text{Kcal}}/_{\text{g}}$**

	Walnut	Frito	Marshmallow	Food 4 = ?
Mass of food (before burning) (g)				
Mass of food (after burning) (g)				
Initial water temperature (^{o}C)				
Final water temperature (^{o}C)				
Calories (Kcal)				
Calories per gram (Kcal/g) (Calories / difference between initial and final food mass)				
Class Averages for Calories per gram (Kcal/g)				

Table 1: Determination of Kcal / g for different food types.

Extensions:
How can **Gut Length** determine feeding group (carnivore, omnivore, herbivore)? Simulate a measurement of the length of a human digestive tract. Using flagging tape, mark each section of the "digestive tract" as follows: Measure one organ as starting where the previous organ left off (Don't go back to the beginning of the flagging!)

Organ	Length (cm)
Mouth	11
Esophagus	25
Stomach	22
Small intestine	690
Large intestine	152
Rectum	14

Is the comparison of digestive tract length to body length (1.8 m = 6 feet tall) closer to that of an herbivore or a carnivore?

Reflection Questions:

- **What is a Calorie?** (A measure of how much energy a food contains. A calorie is the amount of heat (energy) required to increase the temperature of one gram of water by one degree Celcius).
- **Which type of food molecule – fat, protein or carbohydrate – has the most energy per gram?** (fat).
- **Which food had the most fat?** (the walnut) **The most carbohydrate?** (masrshmallow).
- **Compare the nutrition labels for walnuts, fritos and marshmallows to your calculated kcal/g - why, specifically, did walnuts have such a high kcal/g? (**because they were predominately fat!)
- **Why do athletes load up on carbohydrates before a big game? Why not fat?** (fats are harder to break down – they are great for storing energy long term – with the same amount of fat you can store twice as much energy (more energy, less weight/work). But in a race you want access to the energy quickly so you want an energy source that is easier to break down and enter the process of aerobic cell respiration – so carbs are better). A generalization is that carbohydrates provide about 4 Cal/g (unbuttered popcorn and marshmallows) while fat rich peanuts and cashews provide about 9 Cal/g. (1 Cal = 1 dietary calorie).

Models and Explanations: In this lab we the calorie content of different foods, and made an analogy (with fire) of how these foods are "burned" (oxidized) to release that energy in aerobic cell respiration. **A student who demonstrates**

understanding of these concepts can explain why the walnut produced more heat, flame, and energy – and thus had the highest kcal/g. This student can go on to look at the nutrition label of a variety of foods and correctly predict which one will give off the most energy. This student further understands that the food we eat is processed, first by digestion (into small particles that can be absorbed by the small intestine), then by cellular respiration, where the energy in the food is transferred into the (potential) energy behind a H+ gradient (which, when released, is stored in ATP). ATP is the smaller form of energy (this 1 glucose = 36 ATP) that is more readily used by our bodies for the myriad of activities and processes that we do daily. A Glucose molecule is like a $100 (not much use in a soda machine) but an ATP is like a $1, much more useful.

Bibliography:

Campbell Biology (9th edition). (2010). Benjamin Cummings Publishing.

Cesa, I. *Flinn ChemTopic™ Labs, Volume 10, Thermochemistry;* Batavia, IL, 2002; pp 39–49.Kotz, J. C.; Treichel, Jr., Paul. *Chemistry and Chemical Reactivity*, 3rd Ed.; Saunders College: New York, 1996; pp 264–271.

Flinn Scientific. (2011). Publication 10861. Retrieved November 23, 2014 from https://www.flinnsci.com/media/510570/soda_can.pdf.

Massengale, C. (n.d.) the heat is on – the energy of stored food. Retrieved Nov. 23, 2014 from http://www.biologyjunction.com/energy_in_food.htm

Pike, L., Krebs, J., Stoeckmann, A., Steinmetz, J., Ludlam, J., Malakauskas, D.; Malakauskas, S.; and Vanderhoff, N. (2013). *Biology 103L Environmental Biology Laboratory, 3rd edition.* Francis Marion University custom publishing, Florence SC, USA.

Tipler, P. A. *Physics for Scientists and Engineers*, 3rd Ed., Vol. 1; Worth: New York, 1990; pp 518–524, 534–537.

Student Worksheet:

Do all types of food contain the same amount of energy? Every animal maintains its life processes by consuming complex molecules that store energy. The processed plants and animals we eat as foods contain varying amounts of proteins, carbohydrates, and fats. Because each of these types of foods contains varying amounts of energy, these foods will release varying amounts of energy when they are used by cells. Within our bodies, the energy is released slowly by a series of chemical reactions called aerobic cellular respiration.

Energy content is an important property of food. The energy your body needs for running, talking, and thinking comes from the food you eat. You can determine energy content by burning a portion of food and capturing the heat released to a known mass of water in a calorimeter. Fats are an important source of energy - they contain twice as much energy per gram as carbohydrate or protein. That means by converting excess food to fats – rather than carbohydrates like the starch glycogen stored in your liver – you can store more energy in less space.

By burning (in cells: oxidizing) pieces of food, the chemical energy stored in molecular bonds is released as heat and light. The heat can be measured in units called **calories**. A calorie is the amount of heat (energy) required to increase the temperature of one gram of water by one degree Celcius. This process is the basis of the technique of **calorimetry**. The more calories a food contains, the more heat is given off when burned. Foods high in calories will release large amounts of energy. One gram of a protein will release far fewer calories than one gram of fat.

You will study foods with different proportions of protein, fats, and carbohydrates to see how much energy (calories) they release.

Question:

Hypothesis:

Data Analysis:

1. Subtract the mass of the sample after burning (ash weight) from the mass of the sample before burning. This is the change in mass.

   Change in mass = ________ g

2. Calculate the change in temperature for the water by subtracting the initial water temperature from the final water temperature.

   Change in water temperature = ________ °C

3. To estimate the calories in the food sample you will need the mass of the water you heated. By definition the density of water is 1g/mL, so 1 mL of water has a mass of 1 g. The **20.0 mL** of water you used would be **20.0 g**.

Mass of water = 20.0 g

4. The following formula will calculate **Kilocalories (Kcal)**. One kilocalorie = 1000 calories. The **specific heat** of water is 1 kilocalorie/Kg degree C.

$$\text{Kilocalories of sample} = \begin{pmatrix} mass \\ of \\ water \end{pmatrix} \times \begin{pmatrix} change \\ in \\ water \\ temp \end{pmatrix} \times \left({}^{1kg}\!/_{1000g} \right) \times \begin{pmatrix} specific \\ heat \\ of \\ water \end{pmatrix}$$

You will see that all units of measurement except kilocalorie cancel each other out of the equation. Everything is already in the equation except your change in temperature for the water. Put in your change in temperature and work the calculation. You now have the total kilocalories of energy given off by the food sample.

Energy given off by sample = _______ Kcal

5. Calculate the kilocalories per gram of the food sample. This is the total kilocalories divided by the **change in mass** of the sample. The unit will be Kilocalories/gram.

Kilocalories per gram of sample = _______ Kcal / g

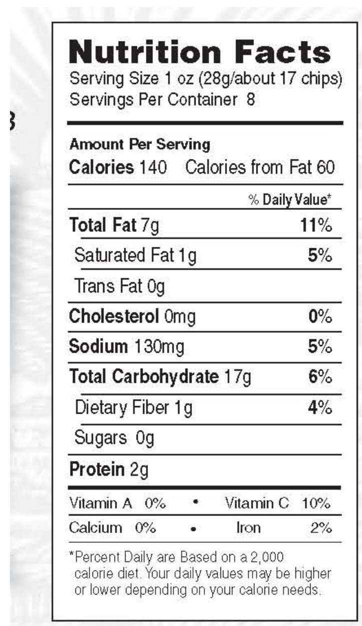
	Walnut	Frito	Marshmallow	Food 4 = ?
Mass of food (before burning) (g)				
Mass of food (after burning) (g)				
Initial water temperature (^oC)				
Final water temperature (^oC)				
Calories (Kcal)				
Calories per gram (Kcal/g) (Calories / difference between initial and final food mass)				
Class Averages for Calories per gram (Kcal/g)				

Table 1: Determination of Kcal / g for different food types.

Reflection:

1. **Daily Reference Values (DRVs)** (Based on 2,000 Calories a day for adults and children over 4 only)

Food Component	DRV
fat	65 grams (g)
saturated	fatty acids 20 g
cholesterol	300 milligrams (mg)
total carbohydrate	300 g
fiber	25 g
sodium	2,400 mg
potassium	3,500 mg
protein**	50 g



A. Look at the nutrition label for reduced fat potato chips.

B. How many Calories in one serving of chips? ______

C. How much total fat in one serving of chips? ______

D. What percentage of the DRV for fat would you eat if you consumed one serving of chips?____________%__

2. For example, the Daily Value for fat, based on a 2,000-calorie diet, is 65 grams (g). A food that has 13 g of fat per serving would state on the label that the "percent Daily Value" for fat is 20 percent ((13g / 65g)*100).

A. How much carbohydrate in one serving of chips? ____

B. If Regular chips have 972 calories, and 64 g of Fat, how many bags of the lowfat chips can you eat to equal one bag of regular chips? ______________________

C. Look at the nutrition label for Peanuts. How many Calories in one serving of peanuts? ____________

D. How much total fat? ________ % DRV for fat? ________

E. How many servings of peanuts could you eat before you maxed out on your DRV of fat? _________________.

3. A Wendy's Homestyle Chicken Fillet Sandwich has 540 Calories, 22 g of Total Fat (4 g Saturated Fat), 57 g Carbohydrates, 2 g Fiber, 8 g Sugar and 29 g Protein.

A. Based on Calories, if you eat **two** sandwiches for lunch, how many Calories do you have **left over** to eat for breakfast or dinner? ______________

AB. How many fat grams do you have leftover for the rest of the day (based on the DRV diet of 2,000 Calories) __________________

4. What is a Calorie?

5. Which type of food molecule – fat, protein or carbohydrate – has the most energy per gram?

6. Which food had the most fat?_________ the most carbohydrate? ________

7. Compare the nutrition labels for walnuts, fritos and marshmallows to your calculated kcal/g - why, specifically, did walnuts have such a high kcal/g?

8. Why do athletes load up on carbohydrates before a big game? Why not fat?