LAB

8

Diet Analysis

Americans spend more money on high-Calorie fast foods and low-Calorie diet foods than anyone else in the world. More books have been written on body weight than any other health issue. We enjoy the highest availability of foods, but processed foods far outsell fresh vegetables and fruits. What seems like the richest-fed nation is really a country with too many people suffering from diet-based diseases and excess overweight.

The curses of processed foods follow their blessings. They taste so good that we eat too much. They have extra salt (better taste and long shelf-life), and we surpass our daily need with one entrée. They are convenient, and we pass by the needed natural foods. Stripped of indigestible components (fiber, etc.), what we call "junk food" is really too high in Calorie value. Our body is designed for eating low Calorie food that has a lot of indigestible material in it. A sugary donut is so concentrated in sugar and starch that our pancreas reacts like we just ate a crate of oranges (an exaggeration). The pancreas releases an extra big shot of insulin to push sugar into the cells of your body. But the donut doesn't actually have that much sugar, so the excess insulin drives down the normal blood sugar. You're hungry for another donut in an hour. Junk food is just too darn concentrated for us.

Decades of research tells us that the foundation of a healthful diet is unprocessed food consisting of mostly plants, lean protein sources, and dietary oils from fruits and nuts. The addition of modest amounts of whole-grain foods provides additional fiber and nutrients. Something like this diet is our goal.

Exercise #1
Energy Balance of the Body

Energy is the ability to do work. The chemical energy in food is called potential energy because it has to be converted into work by the body's metabolism. The work performed by the body can be movement or it can be chemical change using food energy to produce other organic molecules needed by the body.

Drives active body processes.

Drives chemical reactions to produce organic molecules needed by the body.

The ***energy balance equation*** of the body is a simple principle that explains weight changes. If energy input (food eaten) equals energy output (food metabolized for all body activities), then the body weight remains constant. If more food energy goes into the body than is used by the metabolic processes, your weight will increase (fat storage). Likewise, if less energy goes into the body than is used, body weight will decrease.

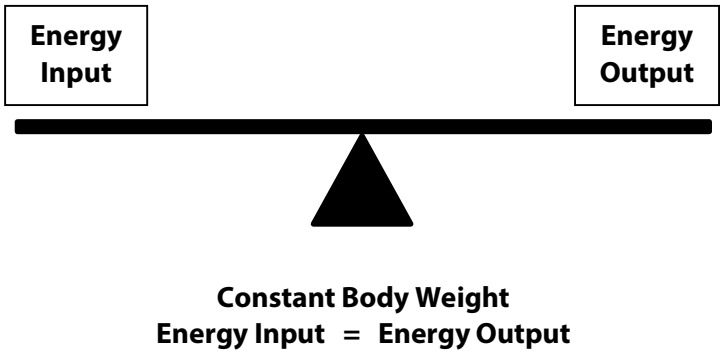
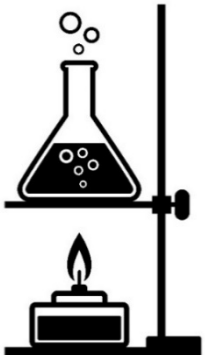


Figure 8.1. The Energy Balance Equation.

Energy Input



A Calorie is the amount of heat energy required to raise the temperature of 1 liter of water by 1^0C.

Food contains potential energy. That energy is located in certain chemical bonds of the food molecule. These bonds are broken during metabolism, and energy is released as the food molecule is processed. The potential chemical energy in a food can be determined by measuring the amount of heat given off when that food is burned in a Calorie Chamber. One gram of sugar has a certain amount of potential chemical energy. If that amount of sugar is burned and we measure the heat given off, the amount of energy in one gram of sugar is revealed. The answer is about 4 Calories. A ***Calorie*** is a unit of heat energy. To be exact, it is the amount of heat required to raise the temperature of 1 liter of water by 1^0 C. One gram of sugar has 4 Calories of food value. That amount of energy is enough to raise the temperature of 1 liter of water by 4^0C. Another very different way to imagine a Calorie is to compare it to the amount of energy from a 100 watt light bulb for 40 seconds.

Demonstration of Energy in Sugar

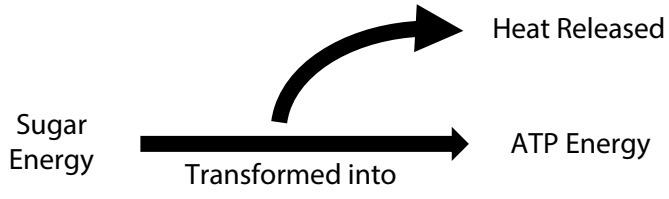
Your instructor will take the class outside to show you how much heat energy is released when sugar is burned. The amount of sugar in this demonstration is approximately what some people add to their coffee. A chemical has been mixed with the sugar that makes it burn faster. None of the released energy comes from that added compound.

? Question

Are you surprised at how much heat was released? Any comments?

Food can be burned in a calorimeter to determine how much potential energy it has.

Heat is released during metabolism, and organisms would combust if all of that energy were released at once. Cells release the energy a little bit at a time, and enzymes and hormones regulate the rate at which energy converts and is released from potential chemical energy to body activities. The metabolic rate varies within the population because of the unique enzyme and hormone profile of each person. More on this later.



A first complication in calculating the energy input for humans is that some of our food is unusable for metabolism. The main component of plants, cellulose (fiber), isn't digested by humans because we don't have the enzymes to do so. And some of the digestible nutrients in our food aren't completely absorbed by the small intestine. Absorption depends on the concentration of digestive enzymes and the speed that food is moved through the digestive tract. It varies from person to person. And some people have an inherited ability to easily store fat. There is a nutritional opinion that says, "Don't count Calories". Rather, what is the impact of the Calories on your metabolism of fats? Do you store fat easily, or do you burn fat? These nutritional advisors recommend that you change the balance of nutrients instead of counting Calories. The view we use in this lab is to focus on Calorie analysis as a foundational approach that certainly can be modified as you learn more about specific treatments for weight imbalance. All nutritional approaches require some consideration of the "counting Calories" method.

There are physiological differences among people. Although variations in physiology complicate the calculations, the values listed in the following table are accurate enough to begin an estimation of energy balance in your body.

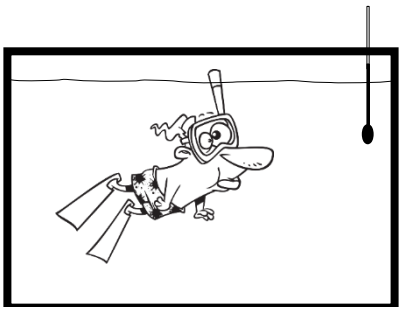
Table 8.1. Approximate Calorie Value of Primary Nutrients.

1 g of carbohydrate ≈ **4** Calories of energy input
1 g of protein ≈ **4** Cal of energy input
1 g of fat ≈ **9** Cal of energy input
4000 excess input Calories ≈ 1 pound gain in fat
4000 deficit of Calories ≈ 1 pound loss in fat
* These estimates are "rounded off" for easier calculation.

Grams into Calories

Energy Output

Energy output is the term used to represent all of the energy expended to maintain the metabolic processes and activities of an organism. The most accurate and direct way of determining the energy output is to measure the ***amount of heat given off***. Physics tells us that heat is released whenever energy is transformed from one form into another (such as nutrient energy into physical work). A technical problem with using this method of analysis is that the person must be inside an insulated container surrounded by a known quantity of water. The temperature of the water increases as heat is released by the person. Although this procedure is very accurate, it is also expensive and difficult.



This is a very accurate method, but it is expensive and difficult.

Korr Medical Technologies Inc.

Figure 8.2. Apparatus for measuring oxygen consumption. This method is easier to do than the heat production method.

The usual method of measuring energy output is the ***oxygen consumption technique***. If the oxygen requirement of a resting person is known, then that value can be compared to the increased amount of oxygen used during a particular physical activity. This approach is easier and less expensive than the heat method. Most general studies of energy expenditure are based on oxygen consumption.

? Question

1. If you were comparing a natural-food based diet to a processed-food diet, what would be typical?

   Natural food is almost completely digested and absorbed into your blood. Yes or No

   Processed food is high in fiber. Yes or No

2. The problem with a donut is not so much the amount of sugar and starch, but the _____ of them.

3. Which hormone is released by the pancreas when we eat a food that is very high in carbohydrate (sugar and starch)?

4. List two kinds of work performed by the body.

5. Write the energy balance equation of the body.

6. How much heat energy is 1 Calorie?

7. Why does the "burning" method of analyzing some human foods provide an inaccurate Caloric estimate of how much energy we get from those foods?

8. One Calorie of fat provides more energy input than one Calorie of protein. (T or F)

9. List how many Calories of energy are provided to the body by 1 gram of each of the three primary nutrients.

   Carbohydrate =
   Fat =
   Protein =

10. Assume that a person requires 1600 Cal to maintain constant weight. If this person eats no food (water only), then how much fat can they lose in a week? (Assume that only fat is being metabolized, and that there is no metabolic slowdown during the fast.)

11. Why is the measure of heat production an accurate estimate of energy expended by the body?

12. Although the heat production method is very accurate, it is difficult. What is the usual method for measuring energy output by the body?

13. You will be using several foods as examples during this lab. Let's see how you evaluate them before doing the activities. Put a check mark if you think the food is high Calories, high protein, or high fat.

Food Example	High Calorie	High Protein	High Fat
Tuna Sandwich			
Milk (8oz)			
Afternoon Snack 1 cup of peanuts 1oz of cheese 6 crackers			
Cheeseburger			

14. If the normal resting energy output is 80 Calories per hour and the energy output during moderate exercise is 200 Calories per hour, then what is the energy output for the exercise?

Exercise #2
Energy in Foods - Basic Calculations

Internet Resource for Food Composition

The three primary nutrients (sometimes called ***macro-nutrients***) are carbohydrate, fat, and protein. We need to balance the ratio of these nutrients in our diet depending on the particular demands of our body. The general recommendation by governmental nutritional agencies is C=60%, F=20%, and P=20% of our Caloric intake. Furthermore, it is suggested that the carbohydrate not go above 65% or less than 45% over an extended period of time. Fat is to stay between 15-35%, and protein 10-35%. Complete ***Food Composition Tables*** can be found on the Internet (USDA National Nutrient Database for Standard Reference, Release 25 or newer) and in most nutrition books. Also, there are several sets of complete Food Tables in the lab room for your use.

Basic Calculations

There are three steps for calculating the nutrient composition of a particular food.

How Do You Calculate % of Nutrients in Food?

- **Step 1** Look up the grams of each nutrient. (Use Food Composition Tables.)
- **Step 2** Convert grams to Calories.
- **Step 3** Determine % of each nutrient.

Example

A tuna sandwich is the example we will use for calculating the % of Calories for each nutrient in a food. A sandwich is a mixture of ingredients.

Step 1: The grams of each nutrient is determined from the Food Composition Table.

Tuna Sandwich	Nutrient Content		
	Carbohydrate	Protein	Fat
2 Slices of Bread	24 g	4 g	1.4 g
1 Tbsp. of Mayonnaise	trace	trace	11 g
Lettuce	trace	trace	trace
2 oz of Tuna	0 g	15 g	1 g
Totals	24 g	19 g	13.4 g

Step 2: Convert grams of nutrient into Calories using the Conversion Factors presented in Table 8.1. Do that now.

Tuna Sandwich	Caloric Conversion Factor	Caloric Value
24 g C	x 4 Cal per gram	
19 g P	x 4 Cal per gram	
13.4 g F	x 9 Cal per gram	

Total = _____ Cal

You should have calculated the total Calories to be 293? Did you get that?

Step 3: Calculate the % of each nutrient in the food using the following formula. Do that now.

$$\frac{\textbf{Caloric Value of a Particular Nutrient}}{\textbf{Total Calories in the Food}} \quad \textbf{x} \quad \textbf{100} \quad \textbf{=} \quad \textbf{\_\_\_\_\_\%}$$

$$C = \frac{\quad\quad}{293} \times 100 = \_\_\_\_\_ \%$$

$$P = \frac{\quad\quad}{293} \times 100 = \_\_\_\_\_ \%$$

$$F = \frac{\quad\quad}{293} \times 100 = \_\_\_\_\_ \%$$

Procedure

- Let's see if you can calculate the Caloric percentages of each nutrient in 8oz or whole milk. This glass of milk would be approximately 12g of carbohydrate, 9g of protein, and 9g of fat (from Food Composition Table).

Do the Calculation for Whole Milk.

Whole Milk (8oz)

Carbohydrate _____ **%**

Protein _____ **%**

Fat _____ **%**

? Question

1. Look at your answers to question #13 in Exercise #1. How would you describe these foods now? Are they high carbohydrate, protein, or fat?

   Tuna Sandwich = _____
   Whole Milk = _____
   After School Snack = _____
   Cheeseburger = _____

2. Calculate the Caloric % of fat in a 3 ounce piece of sirloin steak using the following data: P = 20 g; C = trace; and F = 27 g.

   _____ = total Calories

   _____ % fat

3. If you eat a 6 oz steak, what has changed?

   _____ = total Calories

   _____ % Fat

But what happens when you add a creamy dressing?

4. A green leafy salad is considered to be low in fat and low in Calories. What happens to the fat content when you add a tablespoon of salad oil or creamy dressing?

5. Whole milk is more accurately called 3% milk because it is 97% water. Reduced Fat Milk is 2%, and Low Fat is 1%. Are any of these actually low fat?

6. What is the actual fat % (based on Calories) for Low Fat Milk?

Exercise #3
Your Food Journal

People come to health professionals for help in creating a healthy diet, weight management, or special conditioning challenges. There are two basic approaches to working with them. You can do a detailed analysis of their existing diet, and then make modifications to that. Or you can set them up with a known diet that can achieve their goals. You should be able to do both, and you may have to do both with the same person. This exercise is practice with some of the methods that you will need.

The first step in diet analysis is the Food Journal. And here we meet our first big challenge. It was clearly demonstrated in the 1970's that people can not accurately describe their own diet from memory. The explanation for this phenomenon is that the brain areas regulating eating are below the conscious regions of the brain. These control centers are very important, and we have more to say about them in the next labs. For now, let's accept that the conscious parts of the brain "think" they know what we eat, but they don't. When it comes to food our brain will just "make stuff up" without realizing it. So what do we do?

The next exercise is to complete and analyze a Food Journal for a typical day. To get good information about your client's diet, you need to convince them that writing down every detail during the week will pay off. We ask you

to come up with your own ideas, and here is one hint. Researchers explained to football players that there had been great success with conditioning stronger muscles when the exact proteins and other nutrients were balanced. Those athletes delivered very detailed journals. Think about what would motivate you, and let that start your creative thinking.

How can you motivate people to keep an accurate food journal?

Group Discussion

Break into lab groups and see if you can come up with five ways to motivate people to write down what they eat and when they eat it.

1.

2.

3.

4.

5.

What are the three best ideas?

Have a 5 minute class discussion to share the best ideas. List what you think are the three best ideas.

1.

2.

3.

Now that you have considered the challenge of getting an accurate Food Journal, let's start with an imperfect recollection of your own. To the best of your ability, create a list of foods you might eat during a typical day (perhaps a blend of the variety during the week). Use Table 8.2. List foods first, then use the printed lab copies of Food Tables. Find each food you consumed. Estimate the grams of each nutrient, and then convert that amount to Caloric value.

Table 8.2. Your Food Journal. Use this journal to record and analyze your typical daily diet.

Food Eaten	**Approximate Amount**	**Conversion of Grams of Nutrients into Caloric Value**		
(Break foods into components.)	(Use Food Tables for standard measurements.)	C=_____g (x4)=_____Cal	P=_____g (x4)=_____Cal	F=_____g (x9)=_____Cal
Food Eaten at Breakfast				
Food Eaten at Lunch				

Snacks & Beverages During the Day				
Food Eaten at Dinner				

24 Hour Calculations

Total Calories for Carbohydrates = _____

Total Calories for Protein = _____

Total Calories for Fat = _____

Total Calories for the Day = _____