

## Lab 5: Nutrition and Metrics Lab

Name \_\_\_\_\_

Date \_\_\_\_\_

### Learning Objectives:

1. Become familiar with nutritional labels and some basic dietary recommendations.
2. Identify the metric units used to describe weight, length, volume and temperature.
3. Identify the prefixes used with the basic metric units.
4. Make measurements using the metric system.
5. Convert values between different metric units (ex. grams to milligrams).
6. Convert values between English system units and metric units.
7. Use and identify scientific notation.
8. Accurately determine the average of a series of measurements.
9. Know how to calculate percentage.
10. Know some standard temperatures in Celsius and Fahrenheit.

### Pre-Lab Activity:

“Order” a hypothetical meal – sandwich, side, drink, and dessert – using an online menu from your favorite restaurant.

List the items in this meal:

Look up the **Nutrition Fact sheet** for this restaurant chain. Determine the total amount of fat (total and saturated), salt, sugar, and calories in the entire meal (be sure to include units) and fill in the table below. See [FDA Nutrition Label at a Glance](#) posted to D2L for more information.

**Table 1. Nutritional Information for Your Favorite Meal Based on a 2,000 Calorie Diet**

	Sandwich	Side	Drink	Desert	Total
<b>Total Fat</b>					
<b>Saturated Fat</b>					
<b>Total Carbohydrate (sugar)</b>					
<b>Sodium (salt)</b>					

1. How many Calories would this meal provide?
2. Based on a 2000 Calorie diet, how many more Calories would you be allowed for the rest of the day?

## Introduction Part A: Metric System and Measurement

In the United States, measurement units which are used daily (e.g. oz, lb, inches, mile, gallon, etc) are known as United States Customary System (USCS), which are derived from English units. The majority of countries worldwide use an International system for the measurements of weight, length, volume and other, which is known as the Metric System. The concept of zero came from ancient India and the metric system with a combination of zero with multiples of 10 was adopted in France during the French revolution. After that time it has been modified and standardized by International Bureau of Weights and Measurements, an inter-governmental organization. Though USCS is used for daily use, when it comes to Science, Technology and Engineering United States also uses the **International System of Measurement (SI) or Metric Unit**.

The tables below introduce **basic units** used in the metric system, and their common prefixes. Basic conversions to English units are also provided.

**Table 2: Metric Values and Prefixes**

Symbol	Prefix	Relative Value
G-	Giga-	1,000,000,000 = $1 \times 10^9$
M-	Mega-	1,000,000 = $1 \times 10^6$
k-	Kilo-	1,000 = $1 \times 10^3$
Basic Unit ( <b>gram, meter, liter</b> )		1
c-	Centi-	0.01 = $1 \times 10^{-2}$
m-	Milli-	0.001 = $1 \times 10^{-3}$
μ-	Micro-	0.000001 = $1 \times 10^{-6}$
n-	Nano-	0.000000001 = $1 \times 10^{-9}$

**Table 3: Measurement Units and Values for Length, Area, Mass and Volume**

	Unit (* basic unit)	Symbol	Values (In relation to base unit)	English Equivalents	Metric Equivalents
<b>Length</b>	Kilometer	km	1000 m	1 km = 0.62 miles	1 mile = 1.61 km
	Meter*	m	1 m	1 m = 39.37 inches (in)	1 m = 3.3 feet (ft)
	Centimeter	cm	0.01 m	1 cm = 0.39 in	1 inch = 2.54 cm
	Millimeter	mm	0.001 m	1 mm = 0.04 in	1 inch = 25.4 mm
	Micrometer	μm	0.000001 m	1 μm = 0.00000004 in	
<b>Area</b>	Hectare	ha	10,000 m <sup>2</sup>	1 ha = 2.471 acres	1 acre = 0.405 ha
<b>Mass</b>	Kilogram	kg	1000 g	1 kg = 2.2 pounds (lb)	1 lb = 0.45 kg
	Gram*	g	1 g	1 g = 0.035 oz	1 oz = 28.35 g
	Milligram	mg	0.001 g	1 mg = 0.000035 oz	
<b>Volume</b>	Liter*	l	1 l	1 l = 1.06 quarts (qt)	1 gallon = 3.78 l
	Milliliter	ml	0.001 l	1 ml = 0.0338 fl oz	1 fluid oz = 29.7 ml
	Microliter	μl	0.000001 l		

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*Note:* It is important to know the difference between Metric Units and USCS and their conversion. Due to an oversight of conversion, NASA's mission failed in 1999 and lost ~125million dollars.

### Activity 1: Using the Metric System

#### Material Needed

For a team of four students, you need:

- Electronic scale
- Weigh boat
- Crisco, table salt, or granulated sugar
- Graduated cylinder
- Ruler
- Thermometer
- Hotplate with 200 ml beaker
- Ice bath with 200 ml beaker

#### Exercise A – Exponential Notation

The metric system uses prefixes and powers of 10 to indicate multiples or fractions of the basic units (**meter, gram, liter**, etc.) of measure. In this exercise we will learn how to use exponential notation, an alternative method of expressing numbers.

Scientific notation is a specific example of exponential numbers which almost always uses 10 as the base number. Powers of 10 are used to express numbers that have many zeros. For example  $10^3$  means  $10 \times 10 \times 10$ , and  $10^{-3}$  is the notation for  $1/1000$ . The exponent, or raised number of the right of the 10, is equal to the number of zeros in the number that is being expressed in scientific notation.

A number is expressed in scientific notation by writing the first non-zero digit, then a decimal point, and the rest of the digits. For example:  $12,345 = 1.2345 \times 10,000 = 1.2345 \times 10^4$ . For small numbers, the same process is used, but the exponents is negative.

You should use scientific (exponential) notation whenever you express very large or very small numbers.

**Table 4: Exponential Notation Values**

$1 \times 10^3$	$1 \times 10^2$	$1 \times 10^1$	$1 \times 10^0$	$1 \times 10^{-1}$	$1 \times 10^{-2}$	$1 \times 10^{-3}$
1000	100	10	1.0	0.1	0.01	0.001

1. Given the pattern in table 4, what can you infer between a positive exponent and the number of zeros to the left of where the decimal point is located?
2. Given the pattern in the above table, what is the relationship between a negative exponent and the number of zeros to the right of the decimal point?

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3. For the following exponential notations, provide an equivalent expression using decimals.

$5 \times 10^3 \text{ m}$	$1 \times 10^{-6} \text{ L}$	$3 \times 10^{-5} \text{ km}$	$2.3 \times 10^6 \text{ mg}$	$1 \times 10^{-2} \text{ g}$	$1 \times 10^9 \mu\text{g}$	$6 \times 10^{-4} \text{ kL}$

4. For the following values, provide an equivalent exponential notation.

0.002 m	1,000,000 L	0.056 km	96,000 mg	0.31 g	863 $\mu\text{g}$	2,000 kL

### Exercise B – Can I Accurately Estimate Mass?

**Mass** is commonly referred to as weight. Look at the following table, which provides weights of various common items.

**Table 5. Weights of Some Common Items**

Examples	Weight in grams
Peacock feather	0.8 g
Slice of bread	28 g
Candy Bar	100 g
Football	420 g

1. Given this information in Table 5, estimated the weights of your phone and pencils or pens. Then, calculate the average estimated weight for each.

Item	Student 1	Student 2	Student 3	Student 4	Average estimated weight
Phone					
Pencil / Pen					

2. Now, use the provided electronic scale to weigh of each of the items. **Do not forget to zero your scale!**

Item	Student 1	Student 2	Student 3	Student 4	Average actual weight
Phone					
Pencil / Pen					

3. How close were your estimates?

4. How close were the group average estimates?

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5. Determine **% error** using this formula:  $((\text{actual mass} - \text{estimated}) / \text{actual}) \times 100$

### Exercise C – How much is that in real life?

#### Procedure

1. Using the electronic scale, measure out *1 gram* of fat, salt, or sugar using Crisco, table salt, or granulated sugar provided by the instructor.
  - a. Is one gram a large amount of material?
2. Now, use the scale to measure out the *total* fat or sugar in the meal from your pre-lab exercise.
  - a. What is your impression of the quantity you measured?
  - b. If this quantity was not mixed with other ingredients, would you be able to eat it?
3. Using a graduated cylinder, measure out 1 milliliter (ml) of tap water. Pour the water into the weigh boat (don't forget to zero out your weigh boat).
  - a. How much does it weigh?
  - b. How does the volume of water compare to the 1 gram of sugar or fat that you previously weighed out?
4. Using the provided ruler, measure the width of your thumb nail in **millimeters** (mm) \_\_\_\_\_ and in cm.
  - a. Do the mathematical conversion to inches.
5. Use the other side of the ruler to re-measure it in inches\_\_\_\_\_.
  - a. How accurate is your measurement?

### Exercise D – Percentage Value

**Percentage:** A ratio of numbers expressed as a fraction of 100 and written as %.

20% means 20 in 100 or  $\frac{20}{100}$

Percentage calculation is important to understand a lot of daily life uses, e.g. – interest rate from banks, pay raise for salary, and off course for your grades.

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How to calculate percentage:

Example: You received a grade of 120 out of total 150 point test. Your percentage will be...

$$(\text{Point received/total point}) \times 100 = \frac{120}{150} \times 100 = 80\%$$

Calculate:

1. 12% of 400 = \_\_\_\_\_
2.  $83/100 =$  \_\_\_\_\_ %
3. A pair of jeans was \$50. There was a 50% reduction. What will be the cost after sale?

### Exercise E- Temperature

Most people in the United States use the degree Fahrenheit (F) to measure temperature. In science and most nations worldwide the degree Celsius (°C) is the basic unit of temperature. There are several common temperatures that you should know in Celsius (shown in the table below).

#### **Comparison of common temperatures**

Common Temperature		
	Fahrenheit (°F)	Celsius (°C)
Boiling Point of Water	212	100
Body Temperature	98.6	37
Room Temperature	71.6	22
Freezing Point of Water	32	0

### Procedure

Use the provided thermometer to measure the temperature for the following:

1. What is the room temperature of the lab in Celsius? \_\_\_\_\_
2. What is the temperature of the provided ice bath in Celsius? \_\_\_\_\_
  - a. Why is this the temperature not 0°C?
3. What is the temperature of the water on the provided hot plate in Celsius? \_\_\_\_\_

### **Introduction Part B: Modern Foods and Nutrition**

Thanks to our modern systems for food production, processing, packaging & transport it is now possible to eat a diverse diet year-round. It is also possible to eat only foods that are pre-prepared and either ready to cook or are completely ready to eat. One down-side to this is that most manufacturers of food are NOT

focused on providing a completely healthy and balanced diet. One of their major goals is to have you continue to purchase their product. Towards this end, they make food that looks, feels, smells, and tastes appetizing. It is not uncommon for such tasty foods to contain excessive fat, sugar and/or salt while lacking adequate amounts of other essential nutrients. In addition, many of these foods are 'calorie-dense', which means that it is easy to eat an excessive number of Calories before you begin to feel full.

The outcomes of this began to become apparent during the 1980's, when the U.S. rates of obesity began sharply increasing. Along with this increase came increases in rates of cardiovascular diseases and type 2 diabetes. Increasingly sedentary lifestyles have only served as a multiplier for the harm that can be caused by our new food choices. That our foods are correlated with these negative effects is demonstrated by the fact that the same increases in disease rates also appear in other cultures once they replace their traditional food choices with stereotypically American foods.

Responses to the increases in diet-caused diseases have been varied, but they often focus on the effects of specific ingredients, rather than looking at the whole set of interacting factors. This has led to a barrage of information and claims about food and nutrition - many of them conflicting. At various times fats (or specific types of fat), sugars (or specific types of sugars), complex carbohydrates, salt, meat (or specific types of meat), and specific types of processing (or lack of processing) have all been either demonized or held up as necessary and healthful. Information campaigns and lobbying efforts by producers and manufacturers of particular food types only complicate the issues further.

Many people have made attempts to sort through the mass of conflicting claims, evaluate them and organize the useful information that is also factual – that is, well supported by data. One of the most widely read and influential is Michael Pollan, whose books include *The Omnivores Dilemma* and *In Defense of Food*. He eventually summarized the available and fact-based nutritional recommendations in seven words: "Eat food. Mostly plants. Not too much." He specifically distinguishes **food** (recognizable as something which is grown or raised) from **food-like** (that which is produced by mixing highly processed parts of food with obvious chemicals and/or many things that cannot be recognized as part of their original food source). There is strong evidence that, if you eat a diverse diet chosen from items recognizable as food and limit the highly processed food-like items to occasional treats, your risk of diet-associated diseases will decrease.

Regardless of your food preferences or specific nutritional requirements, effectively taking control of your diet and nutrition means that you must know what you are eating. We are assisted to do this by the Federal government, which requires that food labels list ingredients AND that some basic nutrition facts also must be included. The USDA (United States Department of Agriculture) and FDA (Food and Drug Administration) websites make extensive information available to assist you to make healthy choices and to meet your nutritional needs. Note that the labels of foods are currently in transition because the new requirements take effect in 2020. See [FDA New and Improved Nutrition Facts Label](#).

### Activity 2: What's in Your Food?

#### Material Needed

For a team of four students, you need:

- Variety of "food" and "food-like" nutritional facts labels
- List of common food ingredients

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### Exercise A - Food? Or, Food-Like?

#### Procedure

1. Without reading the ingredients, sort through the available nutritional fact labels and have each person choose two items that you enjoy to consume: one that they consider “**food**” and one that they consider to fit the above definition of “**food-like**”.
2. Starting with the item considered “food”, read the ingredients listed on the label, count the number of ingredients that you recognize as food and the number that seem to be chemicals. Fill in the table below (Table 6). Be sure to record the information for the food item of each of your group members and determine the average # of ingredients.
3. Now, using the item considered “food-like”, read the ingredients listed on the label, count the number of ingredients that you recognize as food and the number that seem to be chemicals. Fill in the table below. Be sure to record the information for the food item of each of your group members and determine the average # of ingredients.

**Table 6. Food or Food-Like?**

	Student 1	Student 2	Student 3	Student 4	Average # of ingredients
<b>Food Item – # of food ingredients</b>					
<b>Food Item – # of chemical ingredients</b>					
<b>Food-like Item – # of food ingredients</b>					
<b>Food-like Item – # of chemical ingredients</b>					

4. Use the above table to answer the below questions:
  - a. After comparing the food and food-like ingredients, and knowing their contents, does that make you re-think your choice to consume those items?
  - b. Why or why not?
  - c. Overall, how “healthy” would you consider the choices of your group? (Hint: Base this on the overall average number of food ingredients vs. chemicals in the items selected)



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### Exercise B - What's that chemical doing in my food?

#### Procedure

Using the labels from the previous exercise, each student should select one non-food ingredient that makes you curious.

1. Use the provided list of Common Food Ingredients to determine why the manufacturer added that ingredient.
2. Answer the following questions:
  - a. What ingredient did you choose?
  - b. What is the purpose of this ingredient?
  - c. What ingredients were chosen by your group members?
  - d. Was the purpose of any ingredient a surprise? (i.e. did you maybe think it was added for a reason different from the actual purpose that it served)

#### Reference:

Michael Pollan, *In Defense of Food* . Penguin Press 2008

Michael Pollan, *The Omnivores Dilemma*. Penguin Press 2006

FDA New and Improved Nutrition Facts Label: <https://www.fda.gov/food/food-labeling-nutrition/changes-nutrition-facts-label>

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### Post-Lab Activity:

Name: \_\_\_\_\_

After completion of the lab, answer the following questions. Your instructor may require you to turn this in.

What is the basic metric unit for the following?

1. mass = \_\_\_\_\_
2. volume = \_\_\_\_\_
3. distance/length = \_\_\_\_\_

Write the relative value for each of the following prefixes.

4. kilo = \_\_\_\_\_
5. centi = \_\_\_\_\_
6. milli = \_\_\_\_\_

Write the following in exponential notation.

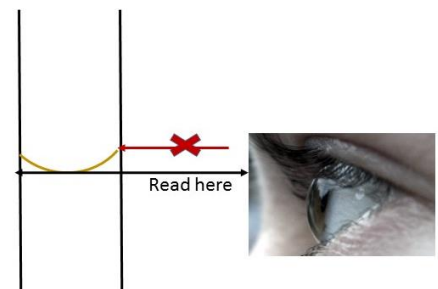
7. 0.000063 = \_\_\_\_\_
8. 7,620,000 = \_\_\_\_\_
9. 0.001 = \_\_\_\_\_

Complete the following conversions.

10. 6.5 g to mg = \_\_\_\_\_
11. 4300 ml to L = \_\_\_\_\_
12. 9 cm to mm = \_\_\_\_\_
13. 1 gallon of milk = \_\_\_\_\_ ml; \_\_\_\_\_ L
14. 1 cup of water is 8 US fl Oz, which will be \_\_\_\_\_ ml
15. A can of coke is 12 fl oz. How many ml of coke is there in the can? \_\_\_\_\_

When measuring liquid, remember to read at the base of the meniscus (derived from Greek word meaning crescent of moon). Meniscus is formed due to adhesion of two different types of objects (like water and glass).

16. Measure the volume of water in the measuring cylinder  
\_\_\_\_\_
17. What will be the weight of this volume  
\_\_\_\_\_
18. What is the maximum volume of water you will be able to measure using this measuring cylinder? \_\_\_\_\_



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Challenge Questions. Complete the following conversions to answer the question.

19. The water is 0.75m deep. Should you swim across or just wade?
20. The dose of cold medicine is 45 ml and you have a 1 oz. shot glass. How many glasses do you need?
21. Refer to your “hypothetical” meal from the pre-lab activity. Determine the metric total, English total, and % DV for each of the following.

To calculate % DV use the formula: **(actual / maximum recommended) X 100**. Also note that sodium is given in milligrams (mg), while the others are given in grams (g). Did this meal provide more than 50% of your recommended DV for any of the following?

	Metric total (g)	English total (oz)	Maximum recommended amount (DV)	%DV consumed in this meal
<b>Total Fat</b>			< 65 g	
<b>Saturated Fat</b>			< 20 g	
<b>Total Carbohydrate (sugar)</b>			300 g	
<b>Sodium (salt)</b>			< 2400 mg	

Critical thinking:

When anesthesia is given during surgery, the dose is calculated in ml based on the body weight in Kg. If the dose is not calculated right, what will happen? Explain.