Name(s):	Period:	Date:

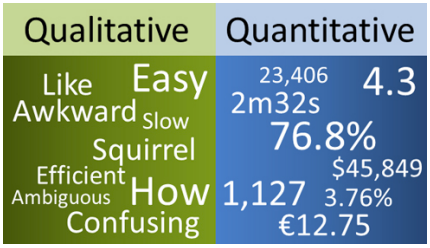
Scientific Measurements & Equipment

HASPI Medical Biology Lab 01b

Background/Introduction

Scientific Data

In the science and medical field, two types of data are collected: quantitative and qualitative. **Quantitative data** can be expressed with numbers or quantities. Mass, length, and temperature are examples of quantitative data. **Qualitative data** is not expressed with numbers, and is gained through observation. Color change, appearance, and texture are examples of qualitative data.



http://www.analyticshero.com/wp-content/uploads/2012/11/qual_quant.jpg

The Metric System

How do we measure quantitative data? The metric system is the most widely used system of measurement in the world. It is a more universal measurement standard as compared to the customary system used in the United States. The metric system is based on a set of standard basic units to measure length, weight, and volume. The amounts of these basic units can be made larger or smaller with metric prefixes.

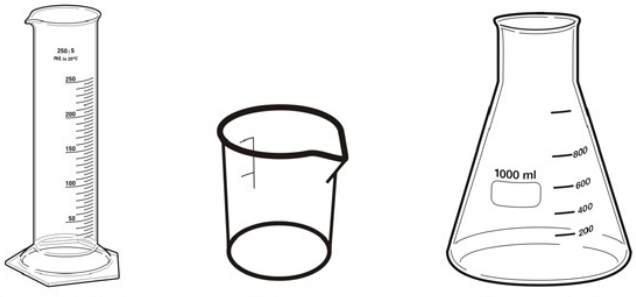
Length

The standard unit of length in the metric system is the **METER**. The primary measurement tool for measuring length is the ruler or measuring tape. For reference, 1 meter is a little longer than 1 yard or 3 feet. It is about half the height of a very tall adult. A centimeter is nearly the diameter of a dime, a little less than half of an inch. A millimeter is about the thickness of a dime.

http://www.technologyuk.net/physics/measurement_and_units/images/measurement_0013.jpg

Volume

The standard unit of volume in the metric system is the **LITER**. The primary measurement tools for measuring volume include the graduated cylinder, micropipette, beaker, and flask. For reference, 1 liter is a little more than 1 quart. One teaspoon equals about 5 milliliters.



Graduated cylinder Beaker Erlenmeyer flask

http://www.mathblaster.com/coolmath/articles/measuring-the-volume-of-a-liquid

Mass

The standard unit of mass in the metric system is the **GRAM**. The primary measurement tool used for measuring mass is the scale. For reference, 1 gram is about the mass of a paper clip. One kilogram is about the mass of a liter of water.

Electronic Weighing Scale

http://2.imimg.com/data2/SX/WR/MY-3125923/electronic-weighing-scales-250x250.jpg
http://www.wikihow.com/Measure-Mass

Temperature

Temperature is expressed in degrees **CELSIUS** in the metric system. The boiling point of water (at sea level) is 100° Celsius, or 100° C. The freezing point of water (at sea level) is 0° Celsius. A hot day is about 30° Celsius.

http://trade.indiamart.com/details.mp?offer=2354937148
http://images.jr-international.fr/images_jr/jr/THM.jpg

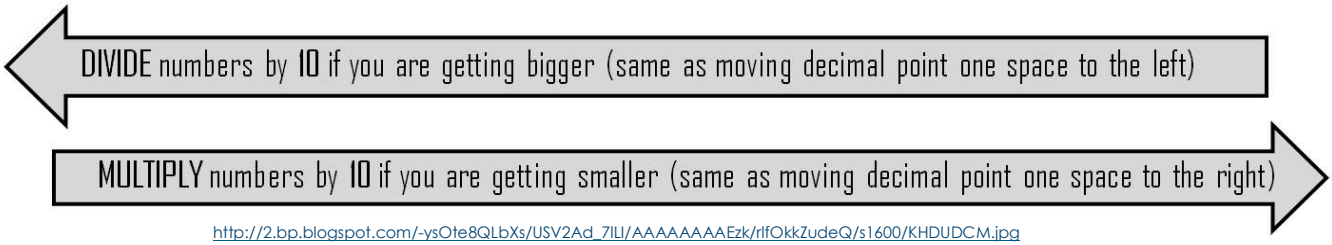
Name(s):	Period:	Date:

Metric Conversions

The metric system is based on the decimal system, and base units of 10s. The following chart can be used to determine how a metric system unit can be converted. In this chart, the metric prefix kilo- would be the largest unit of measurement, while the prefix milli- would be the smallest unit. There are even larger and smaller prefixes in the metric system. For example, the microgram (µg) is 10^{-6} grams, or 10x10x10x10x10x10 smaller than a gram. The microgram is commonly used in healthcare to measure and prescribe medications. Converting from one metric unit to another is as simple as multiplying or dividing by 10s. Using this chart, a person would convert metric units to the left by dividing by 10 for each unit. If converting the metric unit to the right, multiply by 10 for each unit.

Metric Conversion

King	**H**enry	**D**ied	**U**nusually 	**D**rinking	**C**hocolate	**M**ilk
Kilo  **10 x 10 x 10 x LARGER than a unit**	Hecto **10 x 10 x LARGER than a unit**	Deca **10 x LARGER than a unit**	* Unit * ***Meter*** *(length)* ***Liter*** *(liquid volume)* ***Gram*** *(mass/weight)* **1 unit**	Deci **10 x SMALLER than a unit**	Centi **10 x 10 x SMALLER than a unit**	Milli **10 x 10 x 10 x SMALLER than a unit** 
1 kilo = 1,000 units	1 hecto = 100 units	1 deca = 10 units		10 deci = 1 unit	100 centi = 1 unit	1,000 milli = 1 unit
km = kilometer kL = kiloliter kg = kilogram	hm = hectometer hL = hectoliter hg = hectogram	dam = decameter daL = decaliter dag = decagram	m = meter L = liter g = gram	dm = decimeter dL = deciliter dg = decigram	cm = centimeter cL = centiliter cg = centigram	mm = millimeter mL = milliliter mg = milligram
Example: 5 kilo	50 hecto	500 deca	5,000 units	50,000 deci	500,000 centi	5,000,000 milli



http://2.bp.blogspot.com/-ysOte8QLbXs/USV2Ad_7ILI/AAAAAAAAEzk/rlfOkkZudeQ/s1600/KHDUDCM.jpg

Example Conversions		
Meter Conversions	Liter Conversions	Gram Conversions
12 m → 1,200 cm →12,000 mm	52 L → 5,200 cL →52,000 mL	226 m → 22,600 cm → 226,000 mm
35 cm → 0.35 m → 0.00035 km	640 cL → 6.40 L → 0.0064 kL	730 cm → 7.30 m → 0.00730 km
1.5 km → 150 dam → 15,000 dm	0.3 kL → 30 daL → 3,000 dL	5.1 km → 510 dam → 51,000 dm
986 mm → 9.86 dm → 0.00986 hm	173 mL → 1.73 dL → 0.00173 hL	42 mm → 0.42 dm → 0.00042 hm

Name(s): **Period:** **Date:**

Scientific and Medical Equipment

Many different types of equipment are used in the biology lab and healthcare industry. Some of this equipment, such as digital scales, graduated cylinders, and thermometers, are very basic and will be used commonly in your biology labs. Other equipment, particularly in healthcare, is so complex that an individual must undergo schooling and training to learn how to operate it. In fact, entire careers in the medical field revolve around the engineering, operating, and repair of medical equipment.

http://www.imminst.com/wp-content/uploads/2012/10/Medical-Equipment.jpg

These machines can be used to diagnose disease, monitor conditions, or for treatment. Some common diagnostic equipment includes an MRI machine, CT scanner, or ultrasound machine. Examples of monitoring equipment include blood pressure monitors, medical monitors, and electrocardiograph (ECG) machines. Treatment equipment might include ventilators, dialysis machines, or heart-lung machines.

Review Questions – *answer questions on a separate sheet of paper*

1. What is the difference between qualitative and quantitative data? Give an example of each.
2. What is the metric system, and why is it important to use a universal measurement system in science and medicine?
3. What is the standard unit of length? What can be used to measure length?
4. What is the standard unit of volume? What can be used to measure volume?
5. What is the standard unit of mass? What can be used to measure mass?
6. What is the standard unit of temperature? What can be used to measure temperature?

Conversion Practice

Use the "Metric Conversion" chart on the previous page to convert each of the following measurements.

7. 18 m = _____cm
8. 23 dm = _____hm
9. 5 cm = _____mm
10. 5.3 hL = _____mL
11. 167 mm = _____m
12. 1,589 daL = _____dL
13. 35.45 mg = _____hg
14. 43 dam = _____dm
15. 500 kg = _____g
16. 700 mL = _____kL
17. 130 dag = ____kg
18. 59,932 mm = _____km

Name(s):	Period:	Date:

Scientific Measurements & Equipment

HASPI Medical Biology Lab 01b

Background

This is a station activity that will allow you to become more familiar with common measurements and equipment used in the medical biology labs for this course.

Materials

Station 1. Ratios & Percentages: Getting Into Medical School
Table 1 & 2 sheet

Station 2. Measuring Mass & Volume: Creating IV Solutions
Sodium chloride (salt)
Water
Graduated cylinder
Weighing boat
Digital scale
Flask/beaker
IV drip bag

Station 3. Graphing: Comparing Hormone Levels
Graph paper
Ruler

Station 4. Measuring Length: Can Fractures Affect Bone Length?
Forearm X-ray images
Ruler

Station 5. Making Observations: Mole or Skin Cancer?
Identifying Skin Cancer sheet
Patient Mole images

Station 6. Measuring Time: Pulse and Respiration Rate
Timer

Station 7. Research and References: To Vaccinate or Not
Computer
Reference Format sheet

Station 8. Measuring Temperature: Body Heat
Thermometer
Thermometer cover

Directions

	Task	Response
1	Find a partner.	a. Who is your partner?
2	This is a station lab. There are 8 stations placed throughout the room.	
3	Choose a station and follow the instructions to practice different scientific measurements and/or familiarize yourself with equipment you may use throughout this biology course. Each station should take approximately 10-15 minutes to complete.	b. Why do you think it is important to collect and use accurate measurements in science and medicine?
4	Answer the questions for each station using the lab answer sheet.	

Name(s):	Period:	Date:

Connections & Applications

Your instructor may assign or allow you to choose any of the following activities. As per NGSS/CCSS, these extensions allow students to explore outside activities recommended by the standards.

1. **EVALUATING A RESEARCH PROJECT:** The Public Library of Science (PLOS) contains a variety of open access (free) scientific research articles. Go to the main PLOS web page:

   www.plos.org

   a. Using the search box at the top of the page, type in any medical disease or condition you are interested in learning more about. A list of research projects associated with that disease or condition will appear. Each research article contains an abstract that summarizes the research project, followed by an in-depth description of the research.
   b. Choose one of the listed research articles. Some of the articles will be very high level, and you may need to skim a few to find one that is understandable.
   c. Summarize and evaluate the aim (hypothesis), methods, results (data), and conclusions of the research article.
   d. Determine whether the research article contains quantitative and/or qualitative data, and give a data example from the actual article.
   e. Find and summarize an additional research article to challenge or corroborate the conclusion of the first article.
   f. Cite both articles as references.

2. **COST VS. BENEFIT OF MEDICAL EQUIPMENT:** Choose and research one of the following pieces of medical equipment to answer the questions below. Cite your references.

MRI machine	**CAT scan machine**
Hemodialysis machine	**Heart-lung machine**
Neonatal incubator	**Cochlear implants**
Da Vinci surgical robot	**Artificial pacemaker**
Ultrasound system	**Angiography machine**

   a. How does the equipment work?
   b. What medical condition(s) is the equipment used to diagnose, monitor, or treat?
   c. How safe is the equipment?
   d. How reliable is the equipment?
   e. Explain any social, cultural, or environmental impacts that occur through the making and/or use of this equipment.
   f. What is the average cost for a healthcare facility to purchase this equipment?
   g. What is the average cost to use this equipment on a patient?
   h. How many patients will the equipment need to treat before it pays for itself? *(Remember to apply what you have learned from this lab about ratios in order to calculate)*

Name(s):	Period:	Date:

3. **MORE CONVERSIONS:** Conversions between units within the metric system are easily done. Converting units between the metric system and the customary units commonly used in the United States are a bit more difficult. The following chart contains the metric conversions for some of the customary units used in the U.S.

Customary Units → Metric Units	
Customary Units	**Metric Units**
1 inch (in)	2.54 centimeters (cm)
1 foot (ft)	30.47 centimeters (cm) **or** 0.3048 meter (m)
1 yard (yd)	0.914 meter (m)
1 mile (mi)	1.609 kilometers (km)
1 ounce (oz)	28.35 grams (g)
1 pound (lb)	454 grams (g) **or** 0.454 kilograms (kg)
1 fluid ounce (fl oz)	29.574 milliliters (mL)
1 quart (qt)	0.946 liter (L)
1 gallon (gal)	3.784 liters (L)

To convert the customary units to metric units, simply multiply by the metric unit conversion rate. For example, if the customary unit is 5 inches, multiply 5 x 2.54 = 12.7 centimeters (cm). To convert metric units to customary units, simply divide by the metric unit conversion rate. For example, if the metric unit is 10 liters (L), divide 10/3.784 = 2.643 gallons (gal). Using the chart, convert the following measurements:

a. 100 yd → _____ m
b. 105 lbs → _____ kg
c. 3.5 fl oz → _____ mL
d. 3.278 mi → _____ km
e. 1,256,890 in → _____ cm
f. 25 L → _____ qt
g. 290 km → _____ mi
h. 233 m → _____ ft
i. 8540 mL → _____ fl oz
j. 6,235,129 g → _____ lbs
k. 26 qt → _____ L → _____ dL
l. 250 in → _____ cm → _____ hm
m. 560 mi → _____ km → _____ mm
n. 185 lbs → _____ kg → _____ g → _____ dag
o. 780 gal → _____ L → _____ dL → _____ hL
p. 1,250 mm → _____ cm → _____ in
q. 8,971,250 cg → _____ kg → _____ lbs
r. 2.4 kL → _____ mL → _____ fl oz
s. 25,269 mL → _____ L → _____ gal → _____ qt
t. 6,750 cm → _____ m → _____ yd → _____ ft