Laboratory Basics

Course
Anatomy & Physiology

Unit I
Orientation to the Human Body

Essential Question
What equipment aids the scientist in a laboratory?

TEKS
130.206 (c)
1A, 1B

Prior Student Learning
n/a

Estimated time
2-5 hours

Rationale
In the laboratory, students learn by actively conducting and observing experiments to better understand the principles discussed in the textbook or in class.

Objectives
Upon completion of this lesson, the student will be able to:

- understand the metric system
- convert units of measurement
- develop a standard operating procedure
- learn the correct way to use a triple beam balance
- care for a compound microscope

Engage
What types of measurements might you need to make in the laboratory?

Key Points

I. Metric System – metric units consist of a prefix and a base word. The base word tells the kind of measurement being taken, and the prefix tells the size of the item being measured. The most commonly used prefixes are *milli*-, *centi*-, and *kilo*-. The metric system is based on the decimal system (multiples of 10). Because the metric system is based on powers of 10, it is easy to convert from one derived unit to another. For example, there are 100 centimeters in a meter and there are 10 decimeters in a meter. Therefore, there are 10 centimeters in 1 decimeter.
   A. Length measurements – the unit of length is the meter. A meter is equal to 39.4 inches in the English system, which we use in the United States. When the prefix *kilo*- is added to the base unit *meter*, the word *kilometer* is formed (a derived unit meaning 1000 meters).When the prefix *centi*- is combined with the base unit *meter*, the word *centimeter* is formed (a derived unit meaning 1/100 of a meter). The following chart lists some commonly used prefixes and their meanings. The prefixes modify the value of the base to describe very small lengths or very long distances.
   B. Mass measurements – the amount of matter in an object is known as its mass. The mass of an object is a measure of how difficult it is to change the object's state of motion. The more mass an object has, the harder it is to start it moving, stop it from moving, or change its direction. The international standard unit of measurement for mass is the kilogram (kg). One liter of water has a mass of 1 kg. The device we use to determine mass is a balance. Three common types of balances are the equal-arm, triple-beam, and analytical balance.

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C. Volume measurements – as area is used to describe a two-dimensional region, volume represents the measure of a three-dimensional figure. Volume is how much space an object occupies. Volume can be shown with closely stacked cubes that fill a certain space, and have no gaps between them. Units of volume are based on cubes and are called cubic units. As shown in Figure 5, the volume of a rectangular solid can be measured by determining how many cubes cover the base and by counting how many layers of these cubes are needed to reach the height of the object.

Prefix	Symbol	Exponential	Rational	Meaning
tera	T	10^{12}	1,000,000,000,000	trillion
giga	G	10^{9}	1,000,000,000	billion
mega	M	10^{6}	1,000,000	million
kilo	k	10^{3}	1,000	thousand
hecto	h	10^{2}	100	hundred
deka	da	10^{1}	10	ten
deci	d	10^{-1}	1/10	one tenth
centi	c	10^{-2}	1/100	one hundredth
milli	m	10^{-3}	1/1,000	one thousandth
micro	μ	10^{-6}	1/1,000,000	one millionth
nano	n	10^{-9}	1/1,000,000,000	one billionth
pico	p	10^{-12}	1/1,000,000,000,000	one trillionth

II. Triple Beam Balance – a triple-beam balance determines the mass of an object in grams.
   A. How to use a triple-beam balance
      1. Make sure the balance is on a level surface and that the pan can move freely. Position all the sliders to zero. Use the adjustment knob (usually located under and to the left of the pan) if the pointer does not come to rest in the middle of the scale.
      2. Place the mass on the pan.
      3. Move the largest rider along the beam to the right until it is at the last notch that does not move the pointer below the zero point in the center of the scale.
      4. Follow the same procedure with the next largest rider.
      5. Move the smallest rider until the pointer rests at zero in the middle of the scale.
      6. Total the readings on all the beams to determine the mass of the object.

III. Microscope – compound microscopes contain a number of lenses,

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usually 10x in the eyepiece and 10x, 40x or 45x, and 100x (immersion oil) lenses in the objectives. The microscope magnification is calculated by multiplying the eyepiece magnification by the objective magnification. For example:

10x (eyepiece) x 100x (objective) = 1000x
The specimen is therefore magnified 1000 times

A. Definitions
    1. Resolution – the microscope's ability to distinguish between two points that are close together. The resolving power is expressed in length.
    2. Oil immersion objective – this objective uses immersion oil to allow light to pass through it the same way light passes through the glass slide. The oil decreases the bending of the light rays allowing more light to pass directly to the specimen.
    3. Binocular – a microscope with two eyepieces as opposed to one. Most hospital laboratories use binocular microscopes.

B. Components of the Microscope
    1. Eyepiece
    2. Arm
    3. Base
    4. Binocular tube
    5. Revolving nosepiece
    6. Objective lens
    7. Mechanical stage
    8. Stage clips
    9. Iris diaphragm
    10. Coarse adjustment knob
    11. Fine adjustment knob
    12. Lamp
    13. Bulb
    14. On/off switch

C. Using the Microscope
    1. Lower the stage to its lowest position using the coarse focusing knob. Always start with the 10x power objective.
    2. Place the slide on the stage and place the stage clips on top of the slide to hold the slide in place.
    3. Use the coarse adjustment knob to focus on the slide, and then use the fine adjustment knob until the object is in sharp focus.
    4. Adjust the light intensity by raising and lowering the condenser to give the best image.
    5. After focusing with the 10x objective, rotate the 40x objective into the position over the slide. Use only the fine adjustment knob to obtain a sharp image.
    6. Rotate the objectives so that there is not a lens directly over

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the slide. Place one drop of the immersion oil on the slide. Slowly rotate the 100x objective into position over the slide.
7. Use only the fine adjustment knob to focus on the specimen slide. Adjustment of light intensity may be necessary.
8. To change slides during the investigation, follow steps 1 through 7.
9. At the conclusion of the laboratory investigation, lower the stage to the lowest position. Clean all lenses and place the 10x objective in position.
10. Wrap the cord around the arm of the microscope and replace the dust cover.

D. Care of the Microscope
1. The microscope should always be carried by the base and the arm.
2. The microscope cord should be wrapped around the arm of the microscope.
3. The microscope should always be covered with a dust cover to prevent dust buildup on the lenses.

IV. Standard Operating Procedures (SOPs)

A. What is an SOP?
1. Documents used by laboratories to instruct personnel in how to perform particular tasks.
2. Provide a step-by-step outline of how a task is to be performed.
3. Indicate in which situations the task is done, who is qualified or responsible for the work, what problems may arise and how to deal with them, and how to document that the task was performed properly.
4. Since everyone in a laboratory or company follows the same SOPs when performing tasks, SOPs help ensure that work is performed correctly and consistently over time, regardless of who is doing it.

B. What to think about when writing an SOP.
1. What is the purpose of the procedure? What will be the outcome or product of the procedure?
2. What resources and materials will the person performing the SOP require in order to achieve the desired result? What equipment will they need? Does the model of equipment need to be specified? What supplies and reagents are needed? Is a raw material produced by a particular manufacturer needed?
3. What steps will the person following the SOP perform to achieve the desired product? What must the person do to ensure that the product of the SOP is good? Are there any potential problems that the person may run into while performing the SOP? If so, how can these problems be

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avoided?

4. It is important that the SOP be complete and clearly written so that others can follow it.

Activity

I. Complete the Converting Measurements Activity.
II. Complete the SOP Activity.
III. Complete the Using a Balance Activity.
IV. Complete the Triple-Beam Balance Laboratory Investigation.
V. Complete the Microscope Laboratory Investigation.

Assessment

Laboratory Investigation Rubric

Materials

http://www.scienceteacherprogram.org/biology/biolps.html
Converting Measurements Key
Math Conversion Chart

Accommodations for Learning Differences

For reinforcement, the student will practice basic mathematical conversion problems.

For enrichment, the student will investigate the use and application of the electron microscope and design a multimedia presentation.

National and State Education Standards

National Health Science Cluster Standards
HLC01.01 Academic Foundations
Health care workers will know the academic subject matter required (in addition to state high school graduation requirements) for proficiency within their area. They will use this knowledge as needed in their role.
HLC06.01
Health care workers will understand the existing and potential hazards to clients, co-workers, and self. They will prevent injury or illness through safe work practices and follow health and safety policies and procedures.
HLC06.02
Health care workers will understand the fundamentals of wellness and the prevention of disease processes. They will practice preventive health behaviors among their clients.
HLC1O.01 Technical Skills
Health Care Workers will apply technical skills required for all career specialties. They will demonstrate skills and knowledge as appropriate.

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TEKS
130.206 (c) (1)(A) demonstrate safe practices during laboratory and field investigations; and
130.206 (c) (1)(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

Texas College and Career Readiness Standards
English Language Arts
II. B. Understand new vocabulary and concepts and use them accurately in reading writing and speaking.
III. B. Develop effective speaking styles for both group and one on one situations.
IV. A. Apply listening skills as an individual and as a member of a group in a variety of settings.

Mathematics
I. B. 1. Perform computations with real and complex numbers.
IV. A. 1. Select and use the appropriate type of unit for the attribute being measured.
IV. B. 1. Convert from 1 measuring system to another

Science
1.E.1. Use several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic.
1.E.2. Use essential vocabulary of the discipline being studied.
2. A. 1. Understand the real number system and its properties.
2. A. 7. Use calculators, spreadsheets, computers, etc., in data analysis.
3.A.1. Use correct applications of writing practices in scientific communication.

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MATH CONVERSION CHART

Length
1 meter = 100 centimeters
1 meter = 1000 millimeters
10 millimeters = 1 centimeter

Volume for Fluids
1 liter = 1000 milliliters
1 milliliter = 1 cubic centimeter
10 centiliters = 1 deciliter
10 deciliters = 1 liter

Weight Conversions
1 gram = 1000 milligrams
1 kilogram = 1000 grams
1 kilogram = 2.2 pounds
1 pound = 16 ounces

Terms and abbreviations
Gram (g) measures mass or weight
Liter (l) measures volume or liquid
Meter (m) measures length or distance

Kilo (k) = thousands
Deci (d) = tenths
Centi (c) = hundredths
Milli (m) = thousandths

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Converting Measurements: Volume

Solve the following problems. Show your work.

1. Jeremy is asked to prepare 2 liters of a 2% solution of sodium chloride. Can he use a 2-quart container to store the solution?

2. Mrs. Jonas drinks 4 ounces of orange juice and 8 ounces of milk. What is her fluid intake in milliliters?

3. Sam needs to dilute 1 quart of stock disinfectant to 1 gallon for cleaning rubber tubing. How many liters of diluted disinfectant will he have?

4. In measuring output for Mr. Emery, Jill collects 250 milliliters of urine and 45 millimeters of vomitus. How many total ounces is this?

5. Evelyn Smith requires 2 pints of 5% glucose in saline. How many millimeters does she need?

6. John and Mary decide to share a 12-ounce milk shake. If they divide it evenly, how many millimeters will they each have?

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Key - Converting Measurements: Volume

1. No, 2 l = 2.11 qt.
2. 360 ml
3. 3.8 l
4. 9.83 oz.
5. 960 ml
6. 180 ml

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Converting Measurements: Weight

Solve the following problems. Show your work.

1. Mr. Overton is very pleased to find he weighs only 100 kilograms. How many pounds does he weigh?

2. Irene is allowed 15 grams of cheese each day. How many ounces will she need for a week?

3. Karen needs 4 ounces of dry powder for a prescription for Sammy Bowman, but she only has scales to measure grams. How many grams does she need?

4. A dye for kidney function tests is to be used at the rate of 0.1 gram per pound of body weight. If a patient weighs 80 kilograms, how many grams of dye would be needed?

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Key - Converting Measurements: Weight

1. 220 lb.
2. 3.7 oz.
3. 112 g
4. 17.6 g

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Standard Operating Procedure

1. What is the purpose of an SOP?

2. Suppose you were writing an SOP to operate an iPod.
    a. What is the purpose of the procedure?

    b. What will be the outcome or product of the procedure?

    c. What resources and materials will the person performing the SOP require in order to achieve the desired result?

    d. What equipment is needed?

    e. Does the model of equipment need to be specified?

    f. What supplies and reagents are needed?

    g. Is a raw material produced by a particular manufacturer needed?

    h. What are the steps in operating an iPod?

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Using a Balance

With your assigned balance, complete the following:

1. Who is the manufacturer and what is the model number? (This is important to know in case you have to call the company if it breaks or you need to order a replacement part.)

2. Find the manual for the balance if available, or use the numbers on the balance to determine the following characteristics:
   a. maximum capacity: (largest mass it can hold) be sure and put the units (ie: grams, kilograms)

   b. range of masses it can hold (0 to _____)

   c. sensitivity – what is the smallest mass difference the balance can distinguish?

3. Standard operating procedures (SOPs) are a scientist's user's guide. These are very important when first using a new piece of equipment. Using either the manual or personal experience (after you've used the balance several times), write an SOP for the use of this balance. Things to include in your SOP:
   a) directions for using the balance

   b) directions for cleaning the balance

   c) directions for storing/housing the balance

4. Give your SOP to a fellow student and have him or her use the balance by reading the directions in your SOP. Revise your SOP if necessary.

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Triple-Beam Balance Laboratory Investigation

Purpose
In this laboratory investigation, the student will learn the correct way to use a Triple-Beam Balance, learn the parts of a Triple-Beam Balance, and take precise measurements when finding the mass of an object.

Background Information

Materials
Sets of Brass weights: 200, 100, 50, 20, 10, 5, 2, & 1 gram
Nickel
Paperclip
Empty 250 ml beaker
Water
Oil
House key
Triple-Beam Balances for student teams

Procedure

1. Listen and watch carefully to the demonstration on how to use the Triple-Beam Balance.
2. You and your partner will share a triple-beam balance.
3. Check to see that the pointer is pointing to zero.
4. If it is not, check to see that all the riders are all the way to the left at the zero mark.
5. Adjust the balance by turning the adjustment screw **slowly** until it points to zero.
6. Place the known brass weights onto the pan and practice measuring until you are comfortable using the balance beam. Start with the largest mass, 200 g, and work your way down to the smallest mass, 1 g.
7. Find the mass of the objects.
8. Record their mass in Table 1.

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Data

Table 1: Mass of the objects in grams.

	a nickel	Empty 250 mL beaker	250 mL beaker filled 100mL of water	250 mL beaker filled with 100 mL of oil	house key
Grams					

Conclusion

1. How should you hold a triple-beam balance?

2. Why should your balance say zero before you place an object in the pan?

3. What object had the largest mass?

4. Was it easier to find the mass of an object with a lot of mass or a little amount of mass? Explain.

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Microscope Laboratory Investigation

Purpose
In this laboratory investigation, the student will care for a compound microscope and use all of the objectives.

Background Information

Materials
Compound light microscope
Lens paper
Immersion oil
3 prepared slides of different types of organisms (bacteria, molds, fungus, parasites, etc.)

Procedure
Examine the three slides and record your observations.

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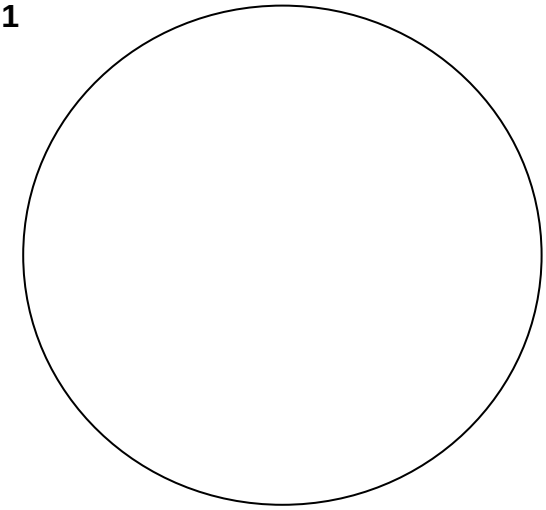
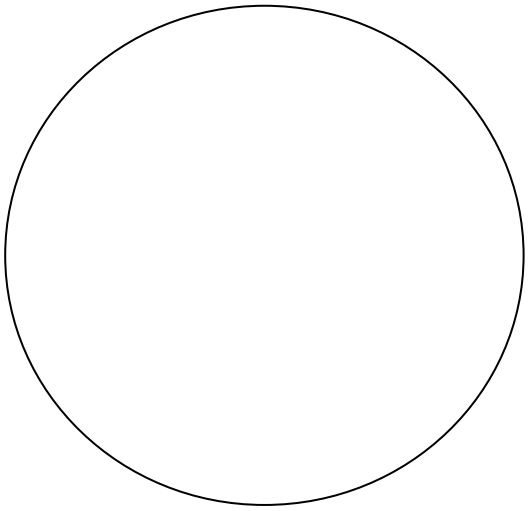
Data

SLIDE 1



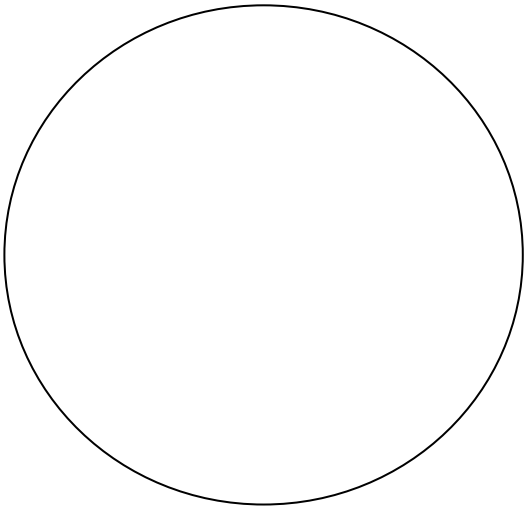
Type of Specimen:

Magnification: 10x



Type of Specimen:

Magnification: 40x or 45x



Type of Specimen:

Magnification: 100x

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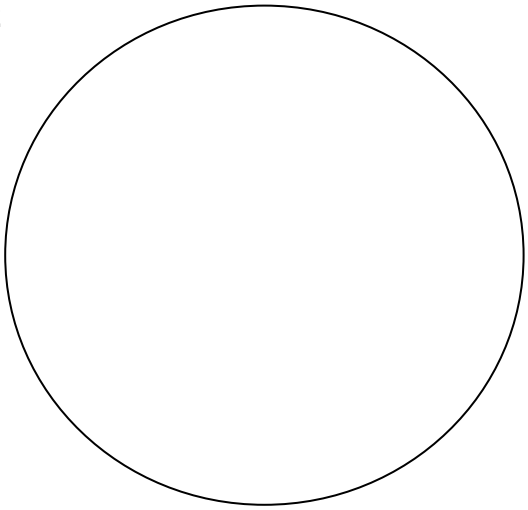
SLIDE 2



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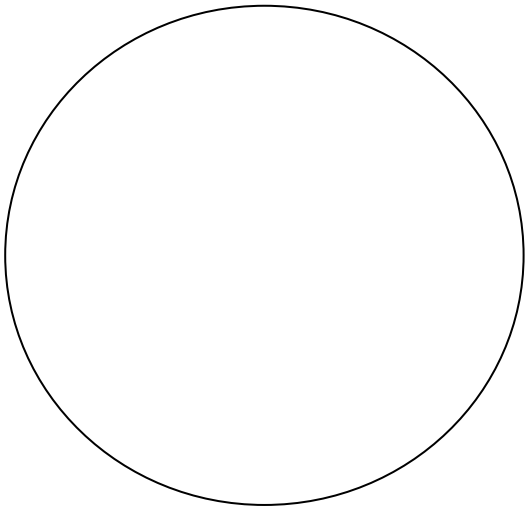
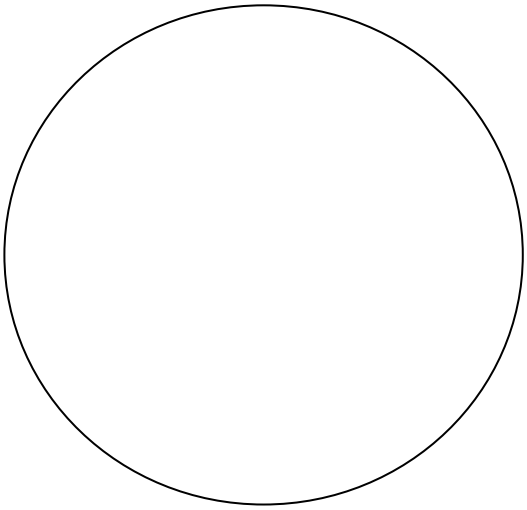


Type of Specimen:

Magnification: 40x or 45x



Type of Specimen:

Magnification: 100x

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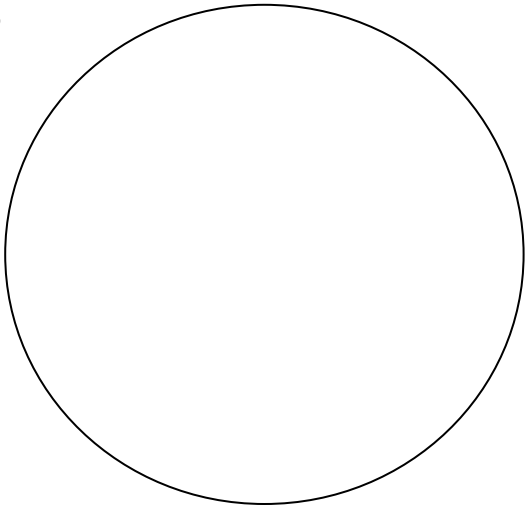
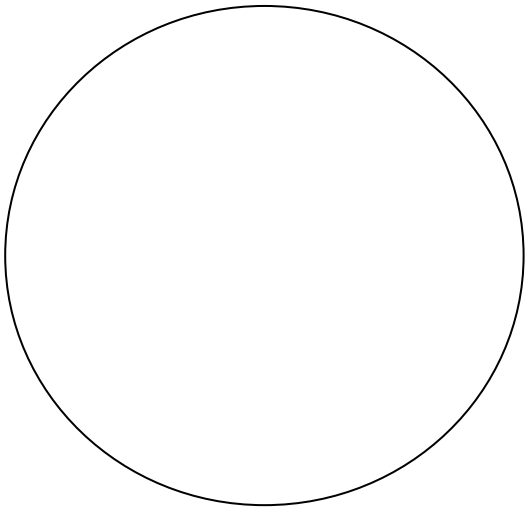
SLIDE 3



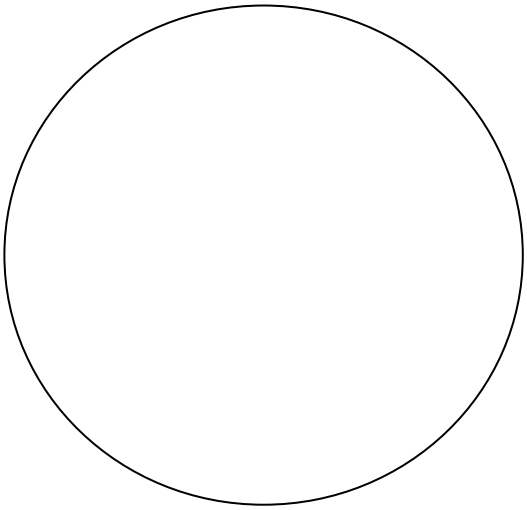
Type of Specimen:

Magnification: 10x



Type of Specimen:

Magnification: 40x or 45x



Type of Specimen:

Magnification: 100x

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Conclusion

1. Calculate the magnification of an object when the eyepiece is 10x and the high-dry objective lens is 45x.

2. What is the purpose of immersion oil?

3. Define resolution.

4. What is the function of the iris diaphragm?

5. What is the function of the revolving nosepiece?

6. Predict the consequences of the following:

    a. lenses not cleaned before storage

    b. stage not lowered before cleaning lens

    c. using the coarse adjustment to focus the 100x objective

Bonus

What organisms cannot be viewed by using the compound microscope?

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Laboratory Investigation Rubric

Student:_____

Course:_____

Date:_____

Scoring Criteria	4. Excellent	3. Good	2. Needs Some Improvement	1. Needs Much Improvement	N/A
Problem is appropriately identified					
Problem is precise, clear, and relevant					
Association between the problem and the predicted results is direct and relevant					
All variables are clearly operationalized					
Student demonstrates comprehension of the use of scientific concepts and vocabulary					
All significant data is measured.					
Data is recorded effectively and efficiently					
Data table is well-designed to the requirements of the task.					

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All graph forms are appropriate.					
All data is accurately plotted					
Graph is visually compelling, highlights conclusions of the study					
Conclusion relates directly to the hypothesis					
Conclusion has relevancy in the resolution of the original problem					
Conclusion relates the study to general interest					

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