Living Environment Curriculum

Uniondale High School

Mr. Arthur Registre, Science Director

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Unit 1. Introduction and Scientific Method

Time Frame – 2 weeks

Overview

A. Observation vs. Inference
   a. Nature of science
   b. Qualitative vs. quantitative observations
   c. Making inferences

B. Laboratory Safety
   a. Safety rules in the science lab
   b. Scientific equipment
   c. Metric system
   d. SI units & conversions

C. Scientific Method
   a. Steps of a scientific controlled investigation
      i. Observing
      ii. Making a hypothesis
      iii. Performing controlled experiment
         1. Independent/dependent variable
         2. Experimental group
         3. Control group
      iv. Collecting data
      v. Organizing data
         1. Tables and Graphs
            a. Pie/bar/line
            b. Creating an appropriate scale
            c. Plotting
            d. Inferring from graphed data
      vi. Making a valid conclusion (Does it confirm or refute the hypothesis? Why?)
      vii. Repeating the experiment (How can its validity be increased?)
      viii. Possibly forming a theory (once supported by a large body of scientific evidence)

D. Living vs. Nonliving
   a. Traits of living things

NYS Standards

Standard 1: Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Key Idea 1: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Key Idea 2: Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Standard 4: The Living Environment

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1: Living things are both similar to and different from each other and from non-living things

Lesson Objectives:

Students will be able to:

- Differentiate between observation and inference
- Make quantitative and qualitative observations
- Infer from evidence
- List and explain lab safety rules
- Follow appropriate lab safety procedures
- Adequately utilize SI unites when making quantitative observations
- Follow the steps of the scientific method in order to investigate problems or perform scientific inquiry
- Organize data in graphs
- Conclude from graphed data
- Decide how to increase the validity of given scientific experiments
- Differentiate between living and nonliving

Suggested Activities:

- The Edible Candle
- Mystery Footprints (Scenes 1,2,3 to be handed out separately)
- Lab: Safety in the Laboratory
- Video http://www.teachertube.com/viewVideo.php?video_id=194405
- SpongeBob Activity
- Introduction to the Microscope Lab
- Bio Lab Packet (Suggested as HW)
- M&M or Skittle Lab
- Graphing Work
- Graphing Lab
- Seeds Experiment
- Germinated Seeds Lab (cont'd from Seeds Exp.)
- Bubble Gum Lab
- Living vs. Nonliving

Key Vocabulary

Assumption
Bias
Conclusion
Control
Controlled Experiment
Data
Dependent Variable
Evidence
Experiment
Hypothesis
Independent Variable
Inference
Metric
Microscope
Model
Observation
Opinion
Qualitative
Quantitative
Research Plan
Scientific Theory
Slide
Ocular Lens
Pipette
Graduated Cylinder
Triple Beam balance

The Edible Candle

Demonstrate that things are not always what they seem to be.

Applications

Observation • Process of science • Discrepant events • Inference

Theory

Careful observation is a cornerstone of science. This demonstration will illustrate that we often make quick, false assumptions about what we see. In science, and in life in general, it is important to be critically observant so that truth is not obscured by surface appearances.

A "candle" will be constructed out of edible substances. At the end of the demonstration students will be shocked when the candle is eaten, since they assumed it was made of wax and candlewick.

Materials

Potato

Large cork borer or apple corer

Lemon juice or vinegar, a few drops

Brazil nut

Safety Precautions

This demonstration is not considered hazardous, but always follow appropriate laboratory safety rules.

Preparation

Use a cork borer to make a cylinder of potato. Rinse the potato with a few drops of lemon juice or vinegar to prevent browning. Cut a sliver of Brazil nut to resemble the shape and size of a candlewick. Insert the Brazil nut into the top of the potato cylinder. Use a match to slightly char the tip of the Brazil nut "wick."

Demonstration

Have the simulated candle at the front of the room. Tell the students that they are going to practice making careful observations. If possible, dim the lights in the room slightly so that details of the "candle" are hard to see. Light the top of the Brazil nut "wick". Tell the students to quietly and independently record as many observations (from their desks—do not let them get too close to the candle) as they can on the burning candle. After a minute or two, blow out the flame. Cool the burnt tip of the nut sliver with some water on your fingers. Eat the candle!

Note: To make the "candle" look more convincing, consider removing it from a box or beaker full of candles.

Disposal

None required if eaten. Otherwise, follow Flinn Suggested Disposal Method #26a.

Reference

Bilash, B.; Gross, G.; Koob, J. *A Demo A Day—A Year of Chemical Demonstrations;* Flinn Scientific, Inc.: Batavia, IL, 1995; p 5.

Living Environment

Name:_____

Mystery Footprints
Scene 1

Look at these two sets of animal tracks.
List 3 OBSERVATIONS

1.

2.

3.

Make an INFERENCE

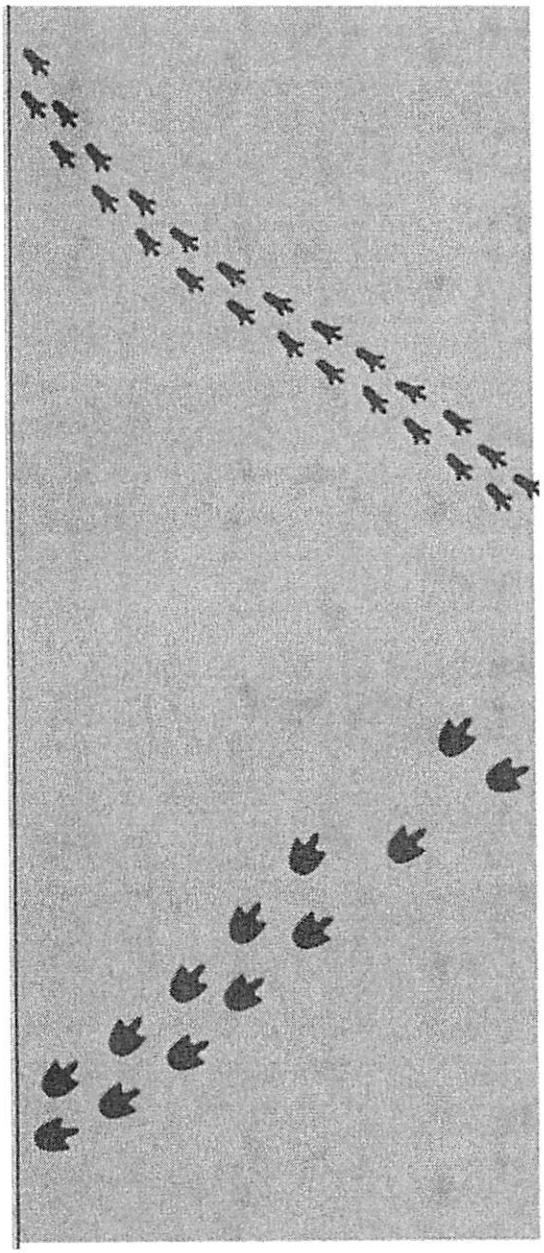
_____

_____

_____

_____

_____



Living Environment

Name:_____

Mystery Footprints
Scene 2

Now what do you think?
List 3 OBSERVATIONS

1.

2.

3.

Make an INFERENCE

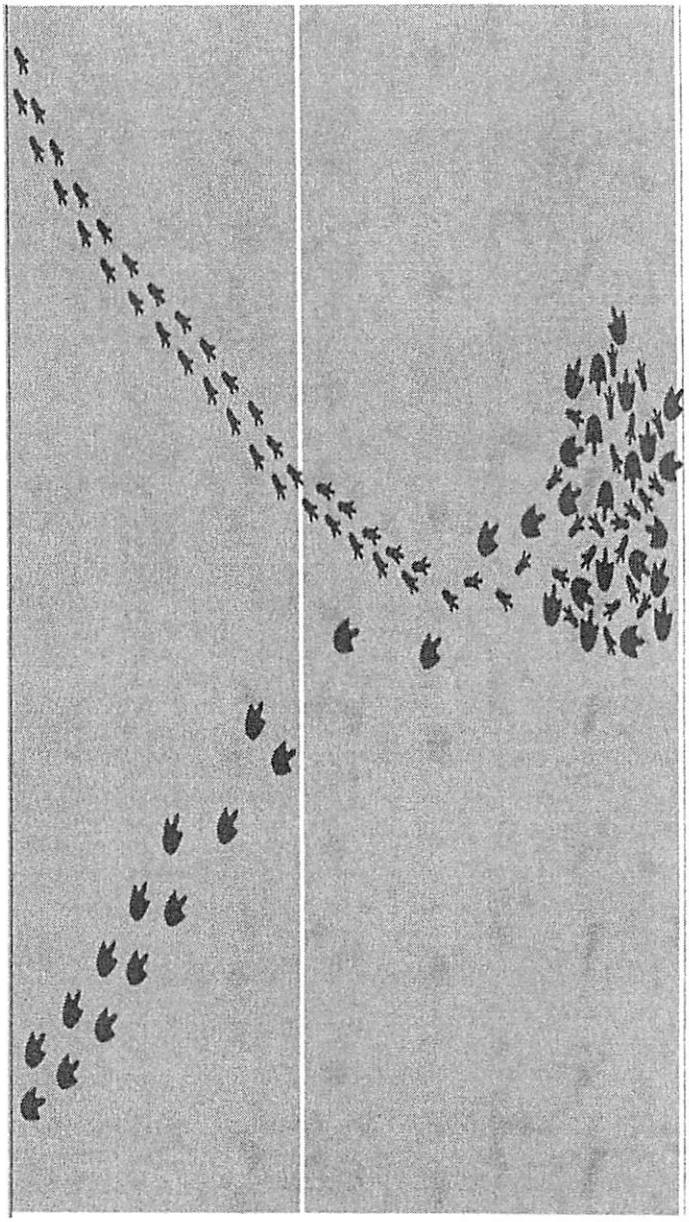
_____

_____

_____

_____

_____



Living Environment

Name:_____

Mystery Footprints
Scene 3

Now what do you think?
List 3 OBSERVATIONS

1.

2.

3.

Make an INFERENCE

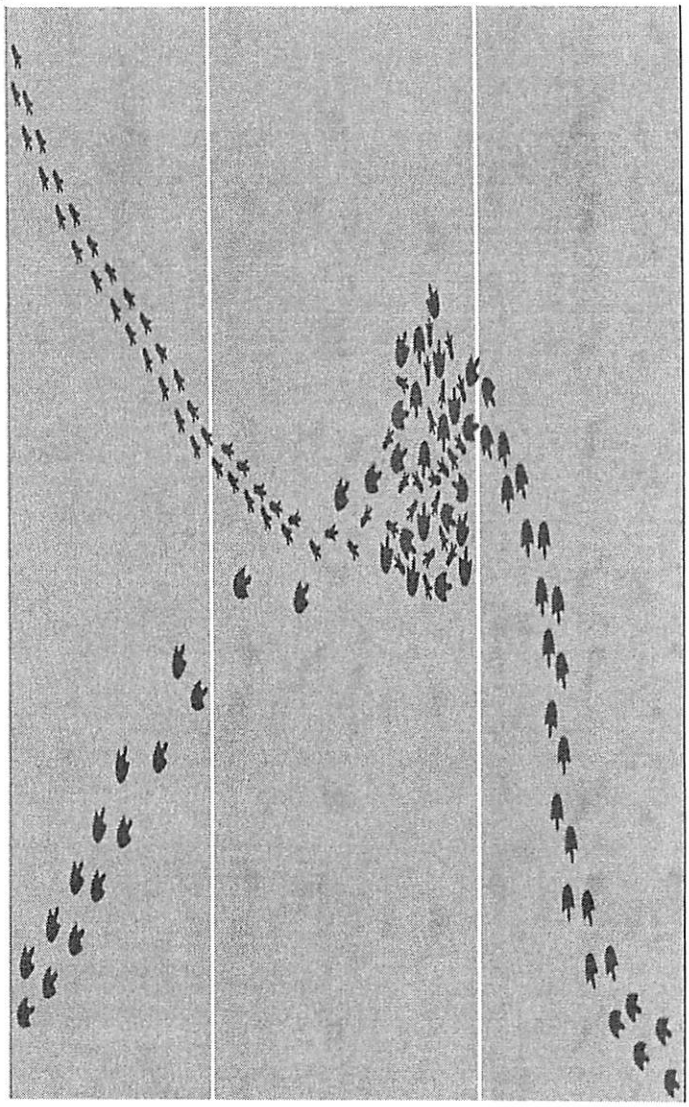
_____

_____

_____

_____

_____



HW assignment:

Name_____ Date_____

CW: Observations vs. Inferences Team_____

Observations vs. Inferences

Observation-

Qualitative observation:

Quantitative observation:

Inference (infer)-

Statement	Type of observation or inference
Bird is covered in feathers of different colors.	
Why?	
Bird is large, so it probably does not fly.	
Why?	
Bird has long tail feathers protruding almost 2 feet from rear.	
Why?	
Bird has brown beak directly in front of eyes.	
Why?	

Name_____

Lab: Safety in the Laboratory

Introduction:

A research laboratory is a place where discovery leads to knowledge and understanding. It is also a place where caution is essential for safety and careful attention is necessary to obtain valid results. There are many potential hazards in the research laboratory. Familiarity with these potential hazards makes it possible for you to take the proper precautions to keep you and your peers safe while actively participating in laboratory activities.

Part I:

1. Please review the laboratory safety guidelines with the other students in your group. **When you have completed this lab, please place these guidelines in your Living Environment (LE) lab notebooks, so that you can refer to them when necessary.**
2. Study the picture below and discuss it with your lab partners. Describe a possible situation that may have led to this accident. **Remember that each student must hand in a fully completed lab report.**

   _____

   _____
3. Write down one way that this accident could have been prevented.

   _____

   _____

   _____

4. The drawing on the next page illustrates both safe and unsafe procedures in the school laboratory. After reviewing this illustration and discussing it with your lab partners, answer the following questions, using the safety guidelines sheet.
   a. List 3 unsafe activities shown in the laboratory drawing.

   b. Explain why each activity is unsafe.

   c. List 2 correct lab procedures shown in the lab drawing.

   d. Explain how following each procedure would help to make the lab safer.

   e. Name 2 safe procedures that are not illustrated.

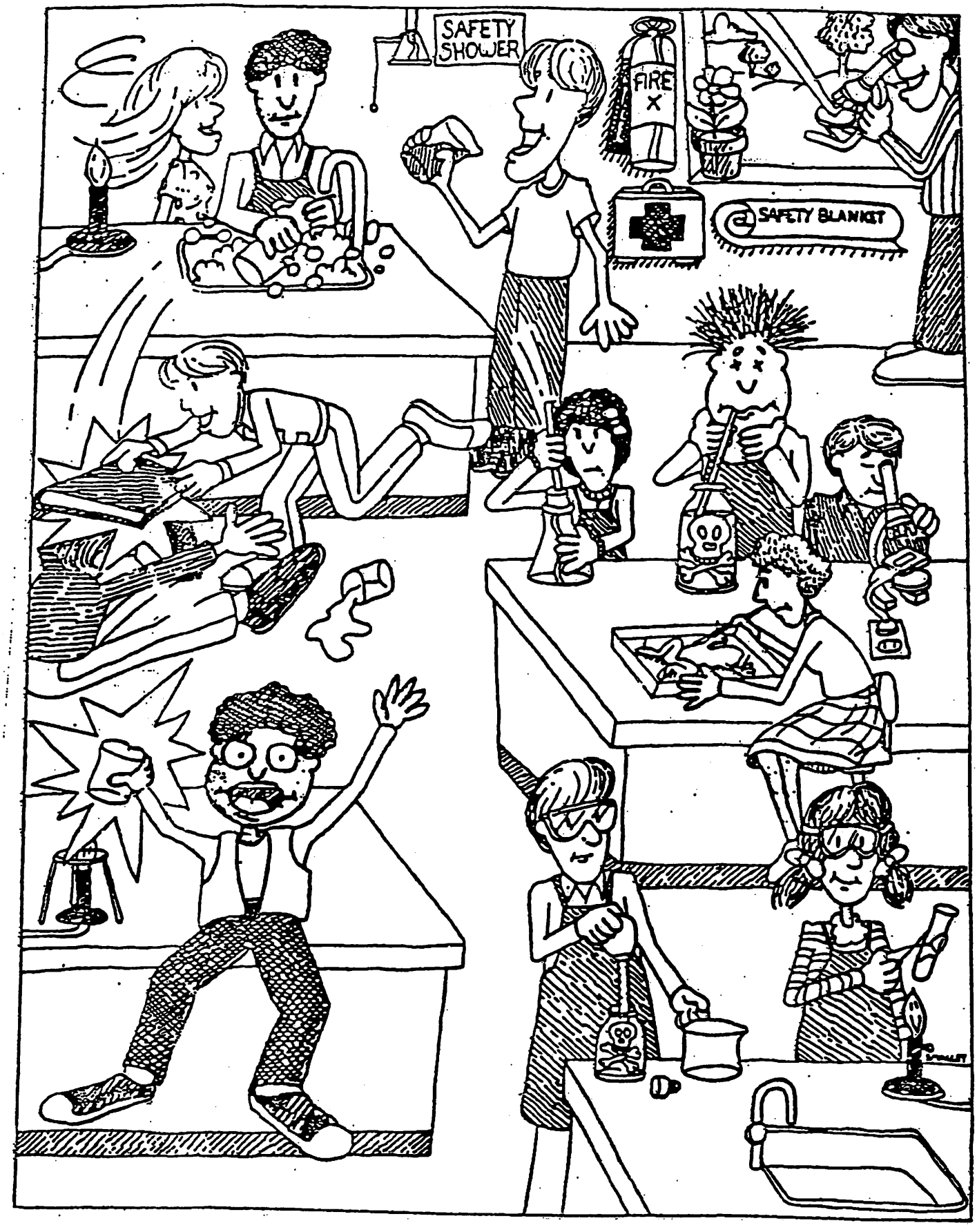
   f. Discuss the procedures you would follow in each of these situations:
      i. Clothing on fire

      ii. Chemical spill on your hand

      iii. Particle in your eye

      iv. Cut from broken glass

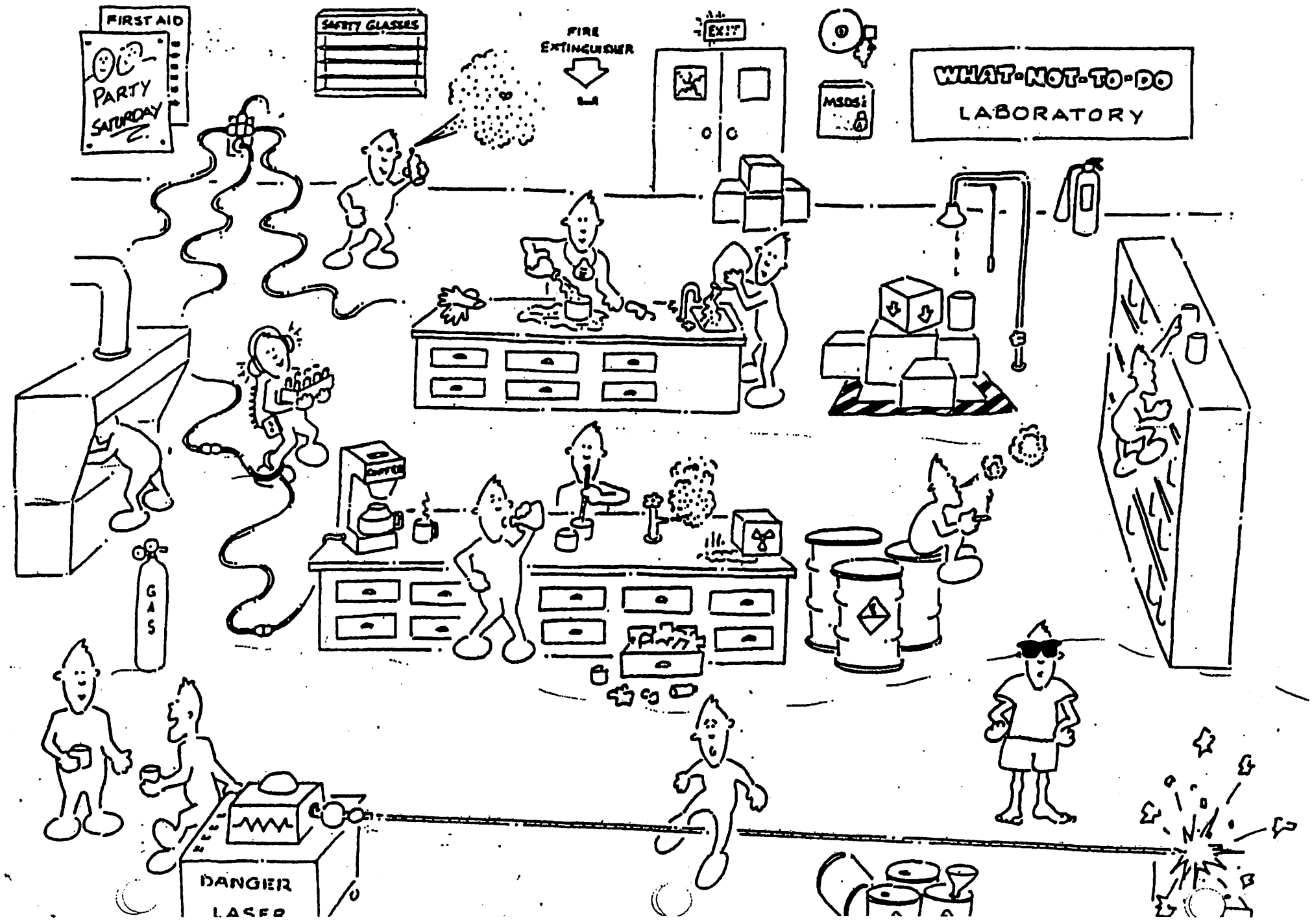
      v. Animal bite


SAFETY SHOWER
FIRE
SAFETY BLANKET

Part II:

Sketch your biology room/laboratory. Indicate the location of safety equipment: fire extinguisher, safety blanket, eye wash, first aid kit, and emergency exit window. Also indicate the location of the sinks, gas jets, emergency cut-off switch, and electrical outlets.

Do Now: Circle "What not to do" Name: _____



Scientific Method
Science Safety Rules

Name _____

The Bikini Bottom gang has been learning safety rules during science class. Read the paragraphs below to find the broken safety rules and underline each one. How many can you find?

SpongeBob, Patrick, and Gary were thrilled when Mr. Krabbs gave their teacher a chemistry set! Mr. Krabbs warned them to be careful and reminded them to follow the safety rules they had learned in science class. The teacher passed out the materials and provided each person with an experiment book.

SpongeBob and Gary flipped through the book and decided to test the properties of a mystery substance. Since the teacher did not tell them to wear the safety goggles, they left them on the table. SpongeBob lit the Bunsen burner and then reached across the flame to get a test tube from Gary. In the process, he knocked over a bottle of the mystery substance and a little bit splashed on Gary. SpongeBob poured some of the substance into a test tube and began to heat it. When it started to bubble he looked into the test tube to see what was happening and pointed it towards Gary so he could see. Gary thought it smelled weird so he took a deep whiff of it. He didn't think it smelled poisonous and tasted a little bit of the substance. They were worried about running out of time, so they left the test tube and materials on the table and moved to a different station to try another experiment.

Patrick didn't want to waste any time reading the directions, so he put on some safety goggles and picked a couple different substances. He tested them with vinegar (a weak acid) to see what would happen even though he didn't have permission to experiment on his own. He noticed that one of the substances did not do anything, but the other one fizzed. He also mixed two substances together to see what would happen, but didn't notice anything. He saw SpongeBob and Gary heating something in a test tube and decided to do that test. He ran over to that station and knocked over a couple bottles that SpongeBob had left open. After cleaning up the spills, he read the directions and found the materials he needed. The only test tube he could find had a small crack in it, but he decided to use it anyway. He lit the Bunsen burner and used tongs to hold the test tube over the flame. He forgot to move his notebook away from the flame and almost caught it on fire.

Before they could do another experiment, the bell rang and they rushed to put everything away. Since they didn't have much time, Patrick didn't clean out his test tube before putting it in the cabinet. SpongeBob noticed that he had a small cut on his finger, but decided he didn't have time to tell the teacher about it. Since they were late, they skipped washing their hands and hurried to the next class.

Teacher Notes:

After discussing safety rules with my students, I allow time for them to read the paragraphs and identify the broken safety rules by underlining each one. When finished, we discuss each example and make a list of the correct safety rules as a class on the blackboard. After this lesson, students create their own experiments as part of our scientific method unit and are required to list safety rules that apply. They have many opportunities to review the lab safety rules throughout the school year as we do experiments in class or develop their own experiments. You might consider allowing the students to create their own "bad science" cartoons, bumper stickers, or posters to illustrate the safety rules.

Answer Key:

SpongeBob, Patrick, and Gary were thrilled when Mr. Krabbs gave their teacher a chemistry set! Mr. Krabbs warned them to be careful and reminded them to follow the safety rules they had learned in science class. The teacher passed out the materials and provided each person with an experiment book.

SpongeBob and Gary flipped through the book and decided to test the properties of a mystery substance. Since the teacher did not tell them to wear the safety goggles, they left them on the table[1]. SpongeBob lit the Bunsen burner and then reached across the flame[2] to get a test tube from Gary. In the process, he knocked over a bottle of the mystery substance and a little bit splashed on Gary[3]. SpongeBob poured some of the substance into a test tube and began to heat it. When it started to bubble he looked into the test tube[4] to see what was happening and pointed it towards Gary[5] so he could see. Gary thought it smelled weird so he took a deep whiff of it[6]. He didn't think it smelled poisonous and tasted a little bit of the substance[7]. They were worried about running out of time, so they left the test tube and materials on the table[8] and moved to a different station to try another experiment.

Patrick didn't want to waste any time reading the directions[9], so he put on some safety goggles and picked a couple different substances. He tested them with vinegar (a weak acid) to see what would happen even though he didn't have permission to experiment on his own[10]. He noticed that one of the substances did not do anything, but the other one fizzed. He also mixed two substances together to see what would happen[11], but didn't notice anything. He saw SpongeBob and Gary heating something in a test tube and decided to do that test. He ran over to that station[12] and knocked over a couple bottles that SpongeBob had left open[13]. After cleaning up the spills, he read the directions and found the materials he needed. The only test tube he could find had a small crack in it, but he decided to use it anyway[14]. He lit the Bunsen burner and used tongs to hold the test tube over the flame. He forgot to move his notebook away from the flame[15] and almost caught it on fire.

Before they could do another experiment, the bell rang and they rushed to put everything away. Since they didn't have much time, Patrick didn't clean out his test tube before putting it in the cabinet[16]. SpongeBob noticed that he had a small cut on his finger, but decided he didn't have time to tell the teacher about it[17]. Since they were late, they skipped washing their hands[18] and hurried to the next class.

Safety Rules:

1 - Always wear safety goggles whenever you are working with chemicals or other substances that might get into your eyes.
2 - Never reach across a flame.
3 - Immediately notify your teacher if any chemical gets on your skin or clothing to find out what to do to clean it off.
4 - Never look directly into a test tube when mixing or heating chemicals.
5 - Always point a test tube away from you and others when heating it over a flame or other heat source.
6 - Never smell a chemical directly from the container. Wave your hand over the opening of the container and "waft" the fumes towards your nose.
7 - Never taste a chemical unless you are instructed by your teacher to do so.
8 - Always clean up your work area and equipment after an experiment is completed. Equipment must be returned to its proper place.
9 - Read and follow all directions exactly as they are written. If in doubt, ask your teacher for help!
10 - Never mix chemicals (or perform tests) without your teacher's permission.
11 - Never mix chemicals without your teacher's permission.
12 - Never run (or push someone else) in the lab. (I let the kids know this rule applies at all times!)
13 - Keep lids on bottles and containers when not in use.
14 - Never use broken or chipped glassware.
15 - Keep your work area clean and keep all materials (clothing, hair, papers, etc.) away from a flame or heat source.
16 - Always clean up your work area and equipment after an experiment is completed Equipment must be returned to its proper place.
17 - Immediately notify your teacher if you get cut or have another injury when performing an experiment.
18 - Wash your hands before and after each experiment.

Introduction to the Microscope Lab Activity

Introduction

"Micro" refers to **tiny**, "scope" refers to **view or look** at. Microscopes are tools used to enlarge images of small objects so as they can be studied. The compound light microscope is an instrument containing **two lenses**, which magnifies, and a variety of **knobs to resolve (focus)** the picture. Because it uses more than one lens, it is sometimes called the compound microscope in addition to being referred to as being a light microscope. In this lab, we will learn about the proper use and handling of the microscope.

Instructional Objectives

- Demonstrate the proper procedures used in correctly using the compound light microscope.
- Prepare and use a wet mount.
- Determine the total magnification of the microscope.
- Explain how to properly handle the microscope.
- Describe changes in the field of view and available light when going from low to high power using the
  compound light microscope
- Explain why objects must be centered in the field of view before going from low to high power using the compound light microscope.
- Explain how to increase the amount of light when going from low to high power using the compound light microscope.
- Explain the proper procedure for focusing under low and high power using the compound light microscope.

Materials

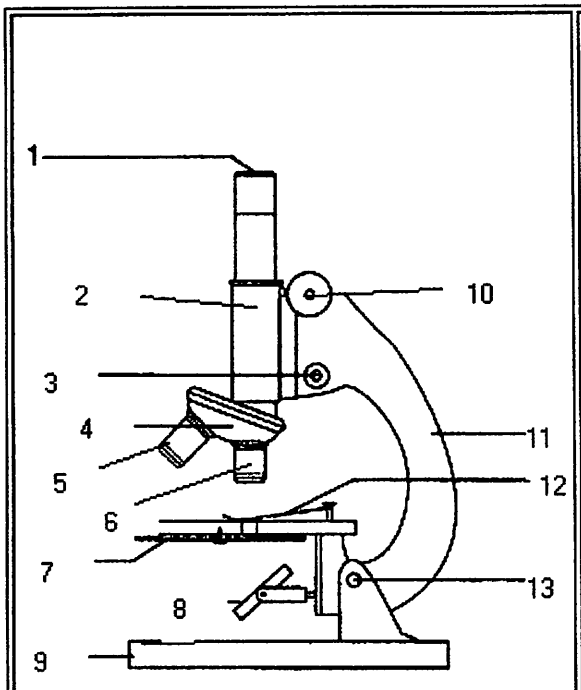
- Compound microscope
- Glass slides
- Cover slips
- Eye dropper
- Beaker of water
- The letter "e" cut from newsprint
- Scissors

Procedures

I. Microscope Handling

1. **Carry the microscope with both hands** --- one on the arm and the other under the base of the microscope.
2. One person from each group will now go over to the microscope storage area and properly **transport one microscope to your working area.**

3. The other person in the group will **pick up a pair of scissors, newsprint, a slide, and a cover slip.**
4. **Remove the dust cover** and store it properly. Plug in the scope. Do not turn it on until told to do so.
5. **Examine the microscope and give the function of each of the parts** listed on the right side of the diagram.

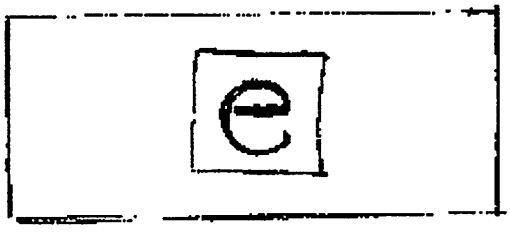


1. eyepiece or ocular
2. body tube
3. fine adjustment knob
4. nosepiece
5. high power objective
6. low power objective
7. diaphragm
8. mirror (many microscopes have a light instead)
9. base
10. coarse adjustment
11. arm
12. stage clip
13. inclination joint

Names of parts and their functions (place these on a sheet attached to this report)

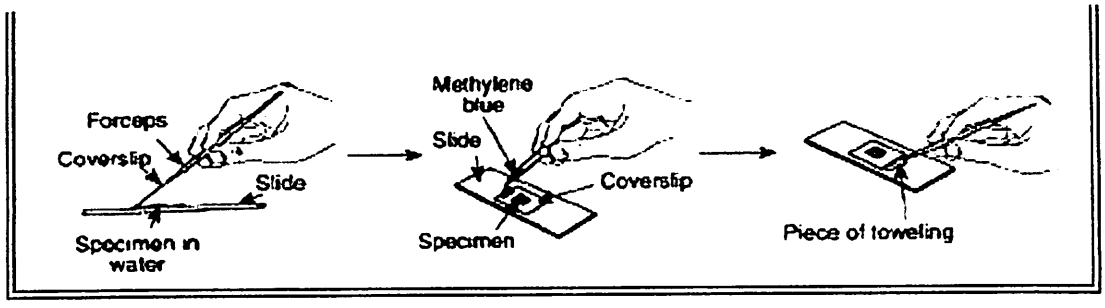
Part II. Preparing a wet mount of the letter "e".

1. With your scissors **cut out the letter "e" from the newspaper.**
2. Place it on the **glass slide** so as to look like (e).
3. **Cover it with a clean cover slip**. See the figure below.

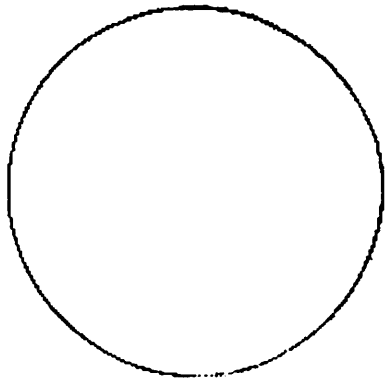


4. **Using your eyedropper, place a drop of water on the edge of the cover slip** where it touches the glass slide. The water should be sucked under the slide if done properly.

Technique for Adding a Stain when making a Wet Mount



5. **Turn on the microscope and place the slide on the stage; making sure the "e" is facing the normal reading position** (see the figure above). Using the course focus and low power, move the body tube down until the "e" can be seen clearly. **Draw what you see** in the space below.



6. Describe the relationship between what you see through the eyepiece and what you see on the stage.

_____

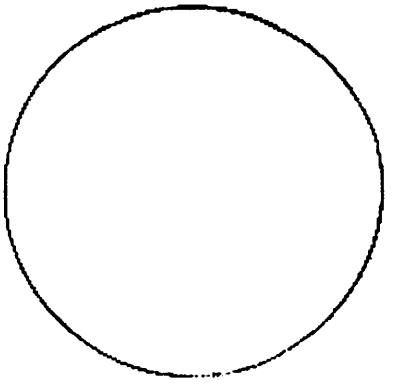
7. Looking through the eyepiece, move the slide to the upper right area of the stage. **What direction does the image move?**

_____

8. Now, move it to the lower left side of the stage. **What direction does the image move?**

_____

9. Re-center the slide and change the scope to high power. You will notice the "e" is out of focus. **Do Not** touch the coarse focus knob, instead use the fine focus to resolve the picture. Draw the image you see of the letter e (or part of it) on high power.



10. **Locate the diaphragm under the stage.** Move it and record the changes in light intensity as you do so.

_____

III. Determining Total Magnification:

1. Locate the numbers on the eyepiece and the low power objective and fill in the blanks below.

Eyepiece magnification _____	(X)	Objective magnification _____	=	Total Magnification _____X

2. Do the same for the high power objective.

Eyepiece magnification _____	(X)	Objective magnification _____	=	Total Magnification _____X

3. Write out the **rule for determining total magnification of a compound microscope.**

_____

4. **Remove the slide and clean it up.** Turn off the microscope and wind up the wire so it resembles its original position. Place the low power objective in place and lower the body tube. Cover the scope with the dust cover. Place the scope back in its original space in the cabinet.

Conclusion Questions:

1. **State 2 procedures which should be used to properly handle a**

light microscope.

2. Explain why the light microscope is also called the compound microscope.

3. Images observed under the light microscope are reversed and inverted. Explain what this means.

4. Explain why the specimen must be centered in the field of view on low power before going to high power.

5. A microscope has a 20 X ocular (eyepiece) and two objectives of 10 X and 43 X respectively:

a.) Calculate the low power magnification of this microscope. Show your formula and all work.

b.) Calculate the high power magnification of this microscope. Show your formula and all work.

6. In three steps using complete sentences, describe how to make a proper wet mount of the letter e.

7. Describe the changes in the field of view and the amount of available light when going from low to high power using the compound microscope.

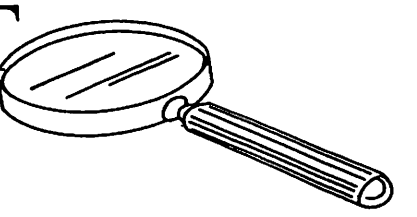
8. Explain what the microscope user may have to do to combat the problems incurred in question # 7.

9. How does the procedure for using the microscope differ under high power as opposed to low power?

10. Indicate and describe a major way the stereomicroscope differs from the compound light microscope in terms of its use.

Name: _____ Period: _____

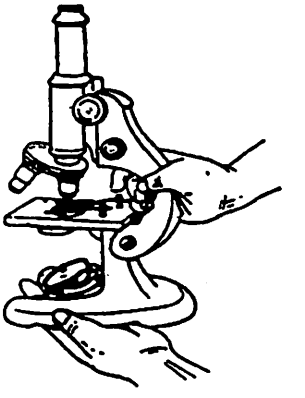
THE MAGNIFICENT MICROSCOPE LAB



Introduction:

What is there to say? Microscopes make little tiny itsy bitsy things look big. That makes the microscope is an important scientific tool in my book. There are literally billions of things, perhaps more even, that would not appear to exist at all if not for the microscope. A microscope seems like a most fabulous tool indeed, for it allows us to see the very foundation of our living selves, the cell. In many of the activities in this lab you will use a compound microscope, a microscope having two lenses.

Procedure Part A:



1. Obtain your microscope from your teacher. Always carry the microscope in an upright position with one hand holding the arm and the other supporting the base. Set It down away from the edge of the table. Note: The microscope is an expensive, precision instrument. Handle it carefully.

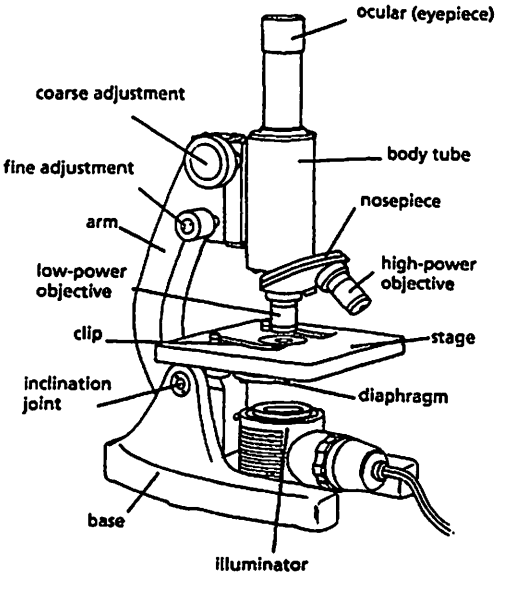
2. Identify each part on your microscope.

3. Examine the diaphragm. Adjust it to the largest opening so that the most light enters the microscope. You can tell this by looking through the ocular.

4. While looking at your microscope from the side, slowly turn the coarse adjustment one-half turn toward you.

   In which direction does the stage move?

5. Continue to turn the coarse adjustment until the low power objective is about 3 cm from the stage. The low power objective is the shorter, or the shortest, objective.



6. Look at the number, usually followed by an "X" on the side of each objective. If there is more than one number, the magnification is generally the larger, whole number. This number is the objective's magnifying power. The "X" stands for "times." Thus the number tells how many times an object is magnified by this lens.

   What is the magnifying power of the low-power objective?

7. Locate the high-power objective.

   What is its magnifying power?

8. If the lenses look dirty or smudged, carefully wipe them with lens paper. Use only lens paper because other kinds of paper can damage the lenses.

9. The ocular lens also has a magnifying power. The total magnifying power of the microscope is easy to calculate. Simply multiply the magnifying power of the ocular by the magnifying power of the objective.

10. Examine the ocular lens.

    What is its magnifying power?

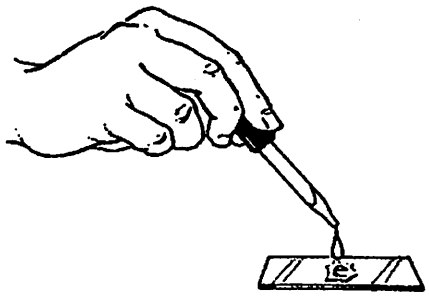
11. What is the total magnification produced when the low-power objective is used? Show your calculations.

12. What is the total magnification produced when the high-power objective is used? Show your calculations.

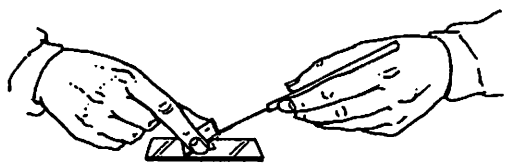
Procedure Part B:

1. Find a small letter "e" in a piece of newspaper. Cut a 1-cm square of paper with the "e" near the center. The letter 'e' can be inside a word, it does not need to be isolated.

2. Place the square in the middle of a clean slide.



3. With a pipette, put 1 drop of water on the square. Drop the water from about 1 cm above the slide. Do not touch the pipette to the paper or the paper will stick to the pipette.



4. Now cover the mount with a clean cover slip. One way to do this is to hold the cover slip at about a 45° angle to the slide and move it toward the drop. As the water touches the cover slip, it will spread along the edge. Gently lower the cover slip into place. Another way to put the cover slip Into place is to support the cover slip with a dissecting needle slowly lowering the supported edge and watch as the water fills the space. Use whichever method is easier for you and gives you a good wet mount. Do not press on the cover slip-it should rest on the top of the water. A good wet mount is free of bubbles. If your mount has too many bubbles, take off the cover slip and absorb the water with a paper towel. Then repeat Steps 3 and 4.

5. Click the low-power objective into place. Make sure you have a good light source and that the diaphragm is at the largest opening. Look through the microscope and adjust the mirror or illuminator to give the brightest light.

6. Check to be sure the bottom of the slide is dry before placing it on the stage of the microscope. Set it on the stage so that the "e" is in reading position and over the hole in the stage. Fasten the slide with stage clips.

7. Look at the microscope from the side. Use the coarse adjustment knob to lower the body tube until the objective is about 1/2 to 1 cm above the slide, or until you feel an automatic stop.

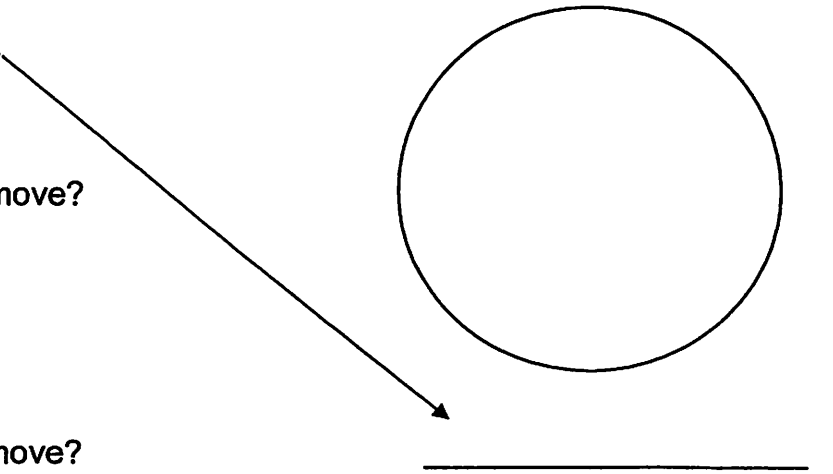
8. Look through the ocular, keeping both eyes open. Keeping both eyes open is difficult at first, but it helps to prevent eyestrain. It will become easier with practice. Note: Always look at the microscope front the side while you lower the

low-power objective. If you look through the eyepiece you could run the objective into the slide, breaking the slide and damaging the microscope.

9. Slowly raise the objective by turning the coarse adjustment until the letters come into focus. Use the fine adjustment to sharpen the focus. Observe the letter "e."

10. Draw the letter "e" the same size and in exactly the same position as you see it through the microscope.

    Label the total magnification.



11. Move the slide to the left.

    Which way does the image move?

12. Move the slide to the right.

    Which way does the image move?

13. Move the slide backward and forward.

    Which ways does the image move?

14. Observe the wet mount as you change the diaphragm to each of its settings. Adjust it to give good contrast and illumination without glare.

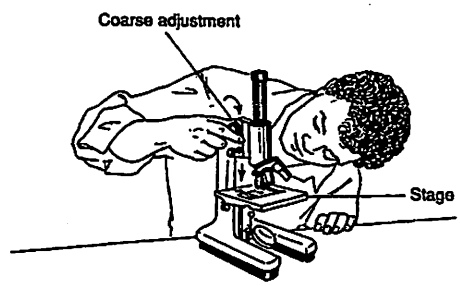
    What does the diaphragm control?

15. Before using high power, the specimen must be in sharp focus in the center of the low-power field of view.

    Note: All focusing under high power is done with the fine adjustment knobs.

    There is no automatic stop for the high-power objective.

16. Watching from the side, carefully switch to the high-power objective. Make sure that the objective does not hit the slide, but expect it to be very close.



17. Focus on the letter "e." Only a slight turn of the fine adjustment knob will be needed to do this.

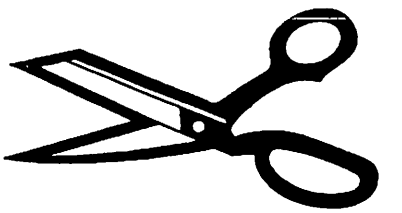
18. Draw the letter "e" exactly as you see it under high power. If the image is not visible under high power, switch to medium power for this part.

19. Is the field of view larger under high power or low power?

20. Compare the brightness of the field under high power and low power.

Procedure Part C:

1. Make a wet mount using a 1-cm square of a colored newspaper cartoon or a colored picture from a magazine printed on thin paper. Choose a square that has both light and dark tones, but not black.

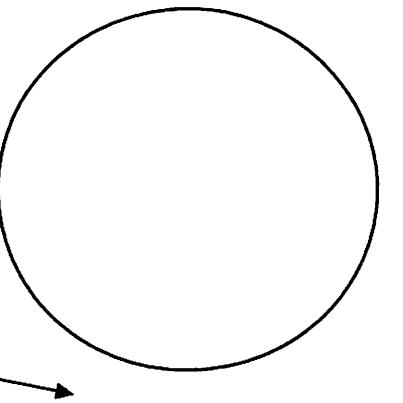


   Record the colors of the square.

2. Resolving power is the ability to distinguish between two separate points that are very close together. Microscopes have a resolving power greater than that of the human eye.
   Observe the slide under low power. Then switch to high power. Examine the light and dark areas of the square.

   Draw the magazine print exactly as you see it under high power.

   Label the total magnification.

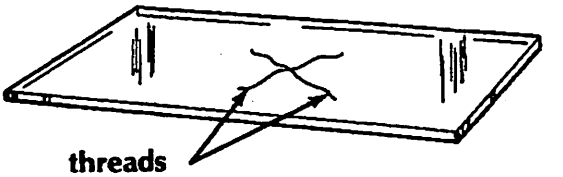


3. How is the color distributed? What colors do you see?

Procedure Part D:

1. The depth of field is the distance above the slide in which the object is in good focus.

2. Prepare another wet mount, this time using two threads of different colors. Cross them on the slide, and then add a drop of water and the cover slip.



3. View the slide under low power. Focus directly on the point where the threads cross.

   Are both threads in focus (at the same time) under low power?

4. Switch to high power and observe the threads.

   Are both threads in focus (at the same time) under high power? Explain.

5. Practice bringing one thread and then the other into focus.

6. How is the term: 'depth of field' applied to this part of the lab?

_____

_____

_____

Procedure Part E:

1. Many objects observed with a microscope are colorless. Thus, they appear almost transparent and are difficult to see. Stains often are used in microscope work to color objects for easier and more detailed observation. Stains can be added to a wet mount without disturbing the slide.

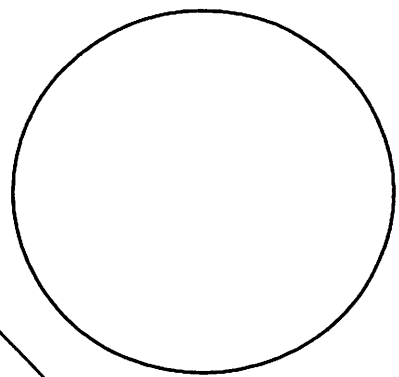
2. With a razor blade, gently scrape the edge of a peeled potato. DO NOT scrape the potato skin. White starch grains will build up on one side of the razor blade. CAUTION: Scrape away from your fingers.

3. Smear the starch grains across the center of a slide and add a drop of water to the slide. Add a coverslip.

4. View the wet mount with low power. You are looking at starch grains.

   Label the magnification. ——————

   Diagram several unstained starch grains.



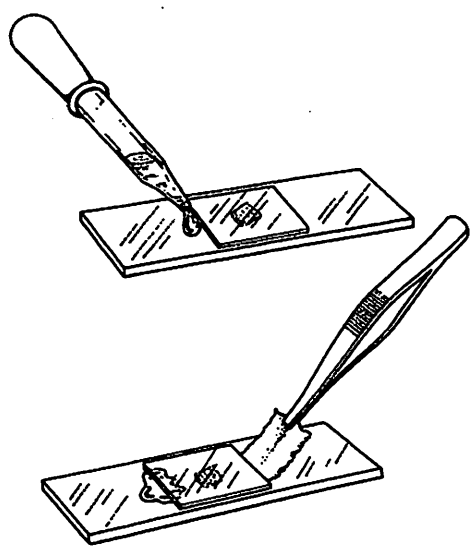
5. Remove the slide from the microscope.

6. Add a drop of iodine solution to your slide along one edge of the coverslip.

   Do not get any iodine on top of the coverslip.

7. Place a piece of tissue paper along the edge of the coverslip opposite the iodine solution.

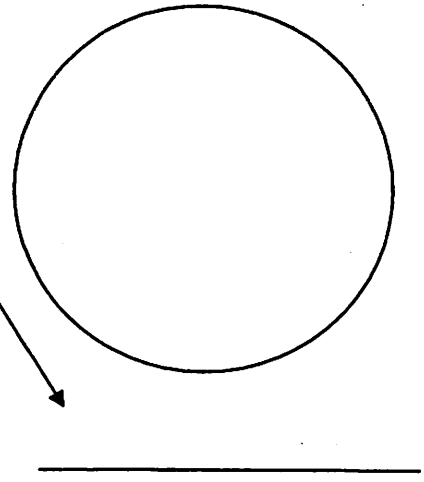
   Allow the tissue paper to touch the water of the wet mount. Water will soak into the tissue paper, drawing the iodine stain under the coverslip and into contact with the starch grains.



8. Observe the stained starch grains with low power.

   Label the total magnification.

   Diagram several stained starch grains.



   What is the purpose of the iodine?

Chapter 2: The Biology Laboratory

A. SAFETY IN THE LABORATORY. The laboratory is as safe as its least safe person. It is the **responsibility of each student to avoid accidents.** Some safety suggestions for the biology laboratory are listed below.

Safety in the Biology Laboratory

- **Read, understand,** and **follow** your laboratory directions exactly.
- **Work quietly, thoughtfully,** and **efficiently. Do not** "fool around" in the laboratory.
- Work in the laboratory room **only when a teacher is present.**
- **Do not** handle chemicals or equipment until you have been given specific instructions.
- **Never** directly **taste** or **inhale** laboratory chemicals.
- **Do not pour** reagents back into stock bottles or exchange stoppers.
- **Never point** the **open end** of a heated test tube toward anyone.
- Any reactions that appear to be proceeding in an **abnormal** way should be reported.
- Be **very** careful when handling **hot glassware** or other equipment.
- **Report at once** any equipment in the laboratory that appears to be unusual or improper such as **broken, cracked, or jagged apparatus.**
- **Prevent loose clothing and hair** from coming in contact with any science apparatus, chemicals, or sources of heat or flame.
- **Tell your teacher immediately** if you have any personal injury or damage to your clothing.
- **Wear safety goggles** when heating substances, dissecting, or working with acids or bases that can cause burns.
- **Do not** use dissection instruments until you have been given proper instructions.
- **Tell your teacher** if you see any electrical wiring that is frayed, exposed or loosely connected.
- **Make sure you know** where the fire blanket, fire extinguisher, and eye baths are located.
- Laboratory materials **should not be moved** through hallways by unsupervised students.

REVIEW QUESTIONS

1. The laboratory is as safe as its _____ safe person.

2. List five rules for laboratory safety.

B. IDENTIFYING LABORATORY APPARATUS. When you work in the laboratory, you will be required to know the names of your laboratory apparatus (equipment) and how they are used. Some common biology laboratory apparatus and their uses are shown in Figure 2-1.

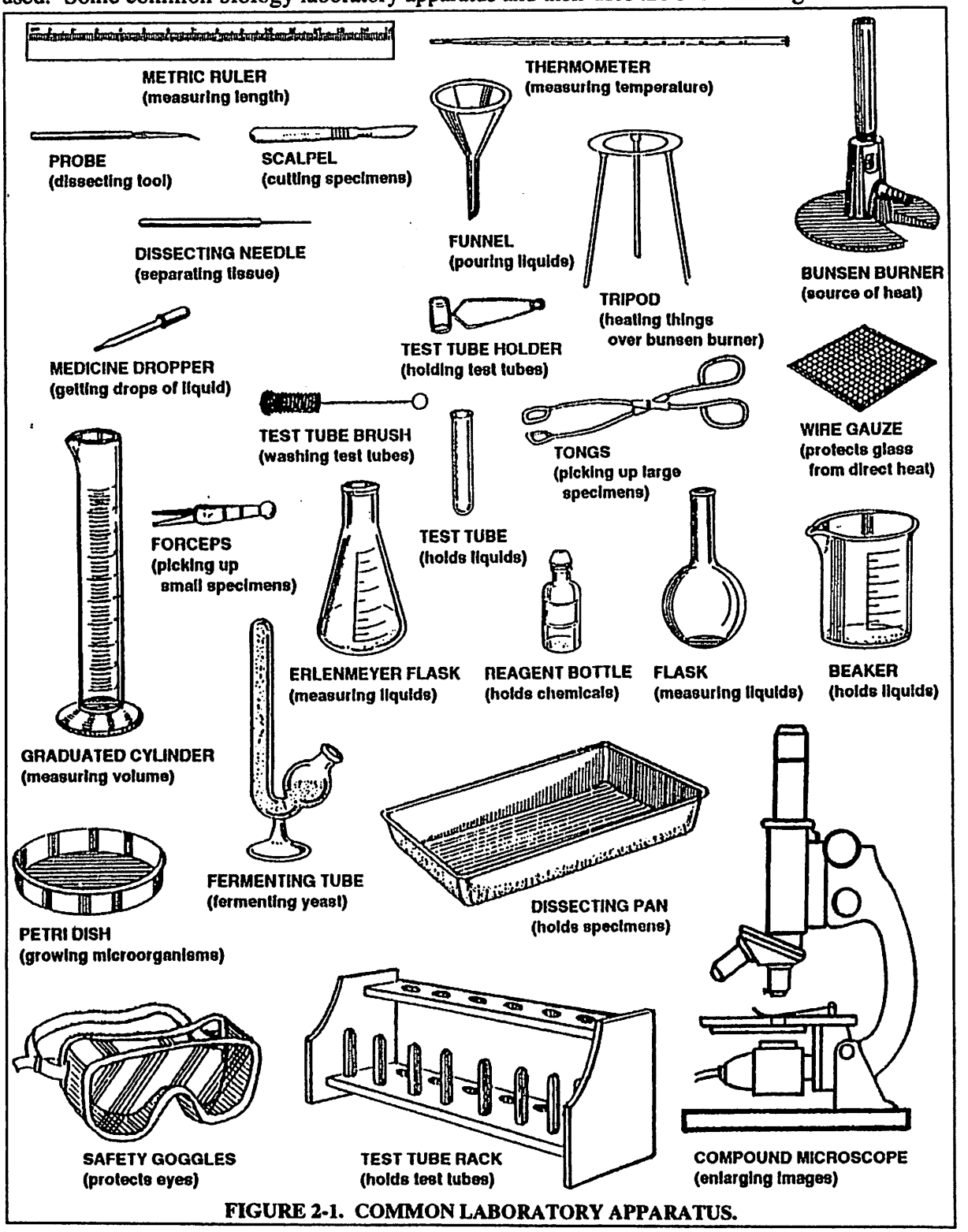
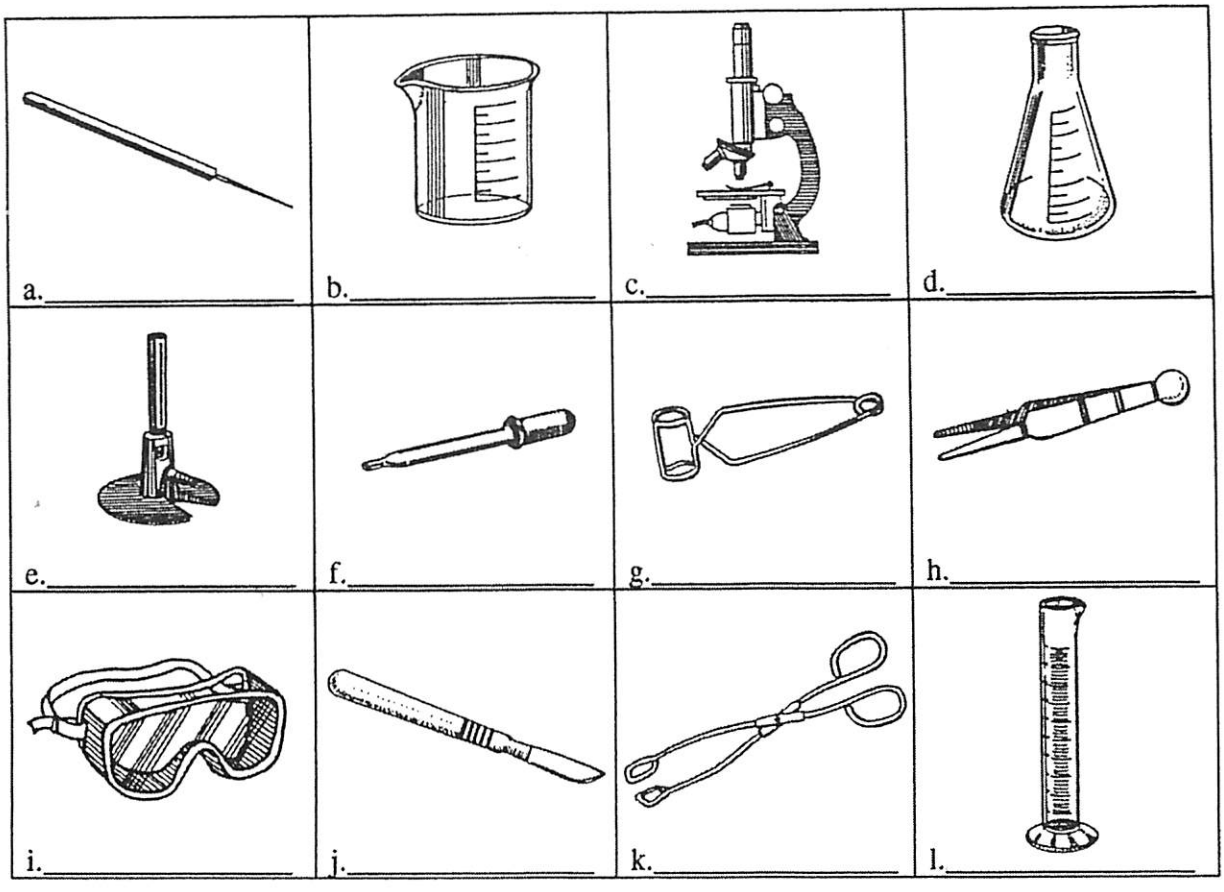


FIGURE 2-1. COMMON LABORATORY APPARATUS.

Name_____ Class_____ Date_____

REVIEW QUESTIONS

1. On the line provided, identify the following laboratory equipment.



a._____ b._____ c._____ d._____

e._____ f._____ g._____ h._____

i._____ j._____ k._____ l._____

2. On the line provided, name the piece of laboratory equipment you would use to perform each the following tasks.

a. measure length_____ b. measure volume_____

c. measure temperature_____ d. holds liquids_____

e. observe a cell_____ f. heat a test tube_____

g. pick up a beaker_____ h. cut open a frog_____

i. protect your eyes_____ j. place water on a slide_____

k. pick up an earthworm_____ l. wash out a test tube_____

Name_____ Class_____ Date_____

C. MEASUREMENT IN THE LABORATORY. The most common system of measurement used by scientists is the **metric system.** The metric system is based on multiples of ten. Distance (length) is measured in units called **meters (m);** weight is measured in **grams (g);** and volume is measured in **liters (L).** Temperature is measured in **Celsius or centigrade degrees (°C).** (Microscope measurement will be covered in Unit 2.)

REVIEW QUESTIONS

1. The most common system of measurement used by scientists is called the _____.

2. Meters are used to measure _____, weight is measured in units called _____, and _____ is measured in units called liters.

D. PREFIXES. Prefixes are words that are used with the basic units of the metric system (Table 2-1). Prefixes are placed in front of the unit to show how large or small the unit is.

PREFIX	SIZE	EXAMPLE
centi(c)	1/100 of the unit (0.01)	A centigram(cg) is 1/100 of a gram(g)
milli(m)	1/1000 of the unit (0.001)	A millimeter(mm) is 1/1000 of a meter(m)
kilo(k)	1000 of the unit	A kilometer(km) is 1000 meters(m)

TABLE 2-1. COMMON PREFIXES.

REVIEW QUESTIONS

1. _____ are words that are placed in front of the basic units of the metric system.

2. Centi means _____ of the unit, milli means _____ of the unit, and 1000 of a unit has the prefix _____.

3. Complete the following equations.

   a. 1 kilogram = _____grams

   b. 1000 meters = _____kilometer

   c. 1 milliliter = _____liter

   d. 1 gram = _____kilogram

4. A centimeter is equal to
   (1) 1/100th of a meter
   (2) 100 meters
   (3) 1/1000th of a meter
   (4) 1000 meters

Name_____ Class_____ Date_____

E. MEASURING VOLUME. The volume of a liquid is measured with a **graduated cylinder.** When liquid is poured into the cylinder, a curved surface called the **meniscus** is formed. Volume readings are made at the bottom of the meniscus (Figure 2-2).

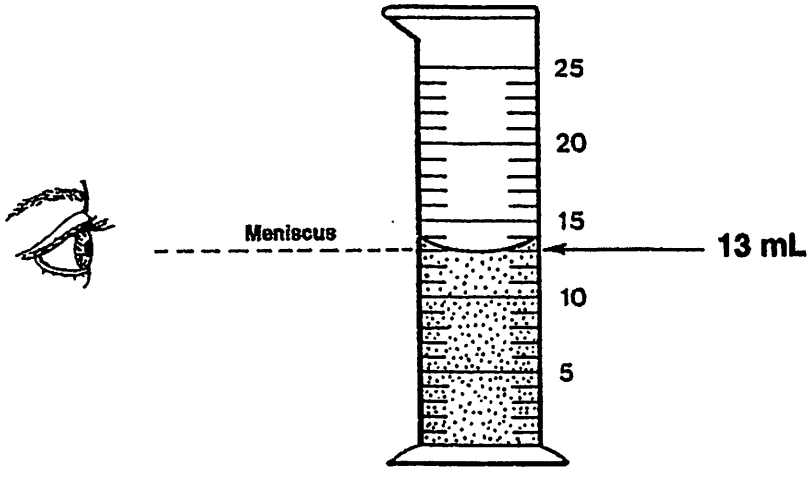


FIGURE 2-2. MEASURING VOLUME WITH A GRADUATED CYLINDER.

REVIEW QUESTIONS

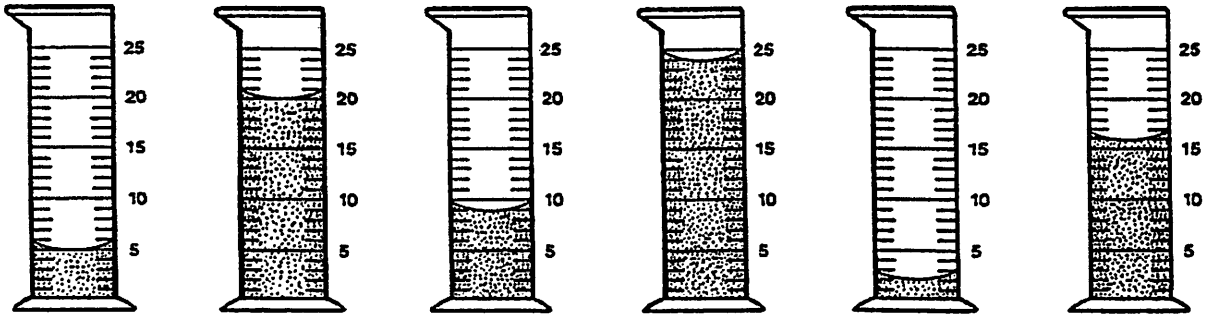
1. In the diagram above, the volume of water is _____mL.

2. A _____ is used to measure liquids in the laboratory.

3. A meniscus is a _____ surface.

4. Volume readings are made at the _____ of the meniscus.

5. Find the amount of liquid (to the nearest milliliter) in each of the graduated cylinder sections shown below.



a._____ b._____ c._____ d._____ e._____ f._____

Name_____ Class_____ Date_____

F. MEASURING LENGTH. The **metric ruler** is used in the laboratory to measure length. The most common units used to measure length are the centimeter and millimeter. The worm in Figure 2-3 measures 9 centimeters, or 90 millimeters.

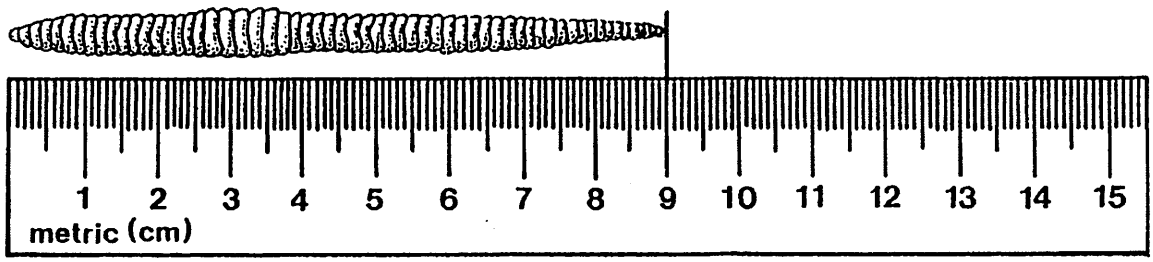
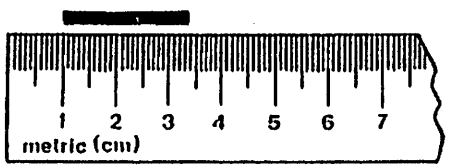


FIGURE 2-3. MEASURING LENGTH WITH A METRIC RULER.

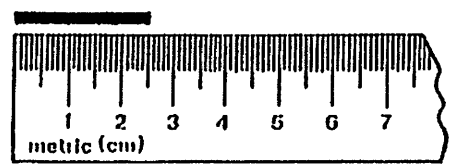
REVIEW QUESTIONS

1. The _____ is used in the laboratory to measure length.

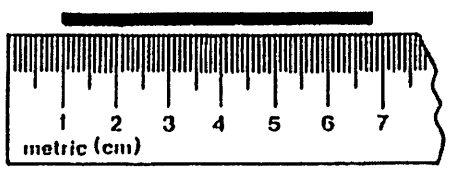
2. Below are drawings of metric rulers. Write the length of each object in the space provided.



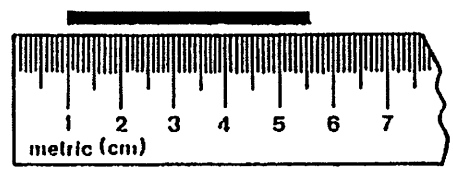
a._____



b._____



c._____



d._____

G. MEASURING WEIGHT (MASS). Materials are weighed in the laboratory by using a **balance.** The balance compares the weight (mass) of the object to be weighed with the weight of known objects called weights. Figure 2-4 is an example of one type of balance found in biology laboratories. Your school may have other types of balances.

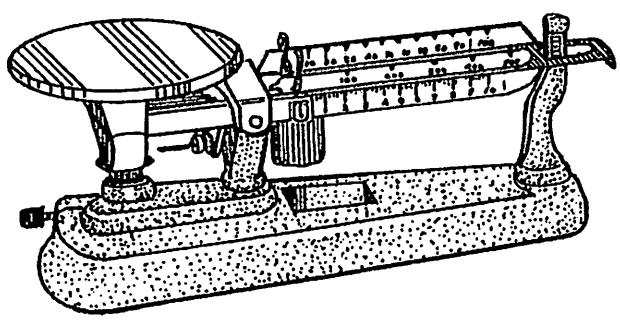


FIGURE 2-4. A BALANCE

Name_____ Class_____ Date_____

REVIEW QUESTIONS

1. A balance is used in the laboratory to measure_____.

2. The balance compares the weight(mass) of _____ with the weight of _____

H. MEASURING TEMPERATURE. A **Celsius or centigrade thermometer** is used to measure temperature (Figure 2-5). On the Celsius or centigrade scale, 0 degrees is the freezing point of water and 100 degrees is the boiling point of water. The divisions on the thermometer are called centigrade degrees or ^{o}C.

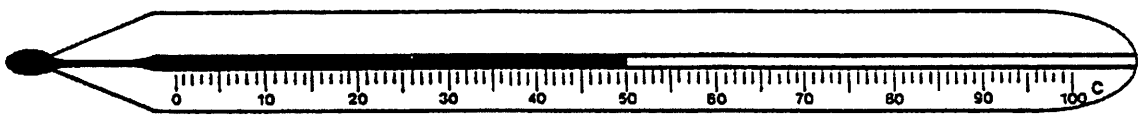


FIGURE 2-5. A CELSIUS OR CENTIGRADE THERMOMETER.

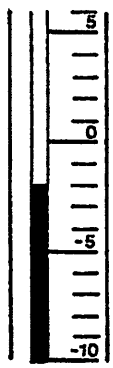
REVIEW QUESTIONS

1. A _____ or _____ thermometer is used to measure temperature in the laboratory. _____ is the freezing point of water and _____degrees is the boiling point.

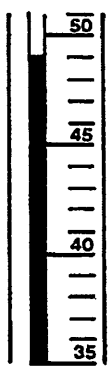
2. What is the temperature in degrees Celsius indicated on the thermometer in Figure 2-5?

_____

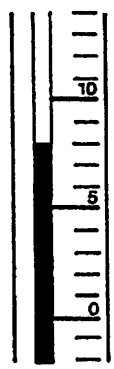
3. In the spaces provided write the Celsius temperatures shown in each of the following diagrams.



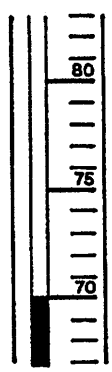
a._____



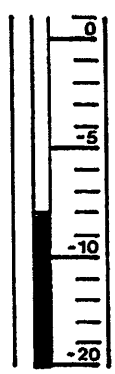
b._____



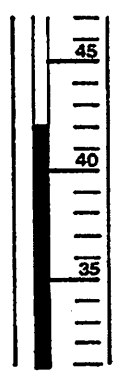
c._____



d._____



e._____



f._____

Name_____ Class_____ Date_____

I. ORGANIZATION AND INTERPRETATION OF DATA. Scientists record laboratory observations and measurements in an orderly manner. This careful method of organization helps the scientist reach more accurate conclusions. Three common methods used to record observations are the data table, the bar graph and the line graph.

REVIEW QUESTION

1. Name three methods used to record data.

♦ **The Data Table.** The **data table** is used to record numerical data. The information is organized by arranging observations in columns with appropriate headings. Table 2-2 is an example of a data table.

TYPE OF TREE	AVERAGE FALL TIME OF 100 FRUITS
Silver Maple (A)	3.2 sec.
Norway Maple (B)	4.9 sec.
White Ash (C)	1.5 sec.
Red Oak (D)	0.8 sec.
Shagbark Hickory (E)	0.8 sec.

TABLE 2-2. A DATA TABLE.

REVIEW QUESTIONS

1. Based on the information in the Data Table above, the fruit of which type of tree(s) had the longest fall time?_____

2. Which type(s) had the shortest fall time?_____

3-4. Two groups of 100 carrot seeds each were used in an investigation to test for the influence of temperature on germination of seeds. One group was kept at a temperature of 20°C and the other at 10°C. All other conditions were the same. Observations made during the investigation were used to construct the data table below.

Data Table

Day Of Observation	Total Number of Seeds That Germinated	
	10°C	20°C
7	0	5
10	20	35
15	40	70
20	45	80
25	45	80

Name_____ Class_____ Date_____

3. According to this investigation, what is the difference in the number of seeds germinated at the two temperatures on day 10?
   (1) 15 (3) 30
   (2) 20 (4) 35

4. Which is a correct conclusion based on the results of this investigation?
   (1) The only variable in this experiment was the amount of germination time.
   (2) The experiment was a failure since not all of the carrot seeds germinated.
   (3) At a temperature of 20°C fewer seeds germinated that at 10°C.
   (4) At a temperature of 20°C more seeds germinated that at 10°C.

♦ **The Bar Graph.** A **bar graph** allows the scientist to compare data. The bar graph shown in Figure 2-6 represents the same data as Table 2-2. Notice how easy it is for you to compare the data when you use a bar graph.

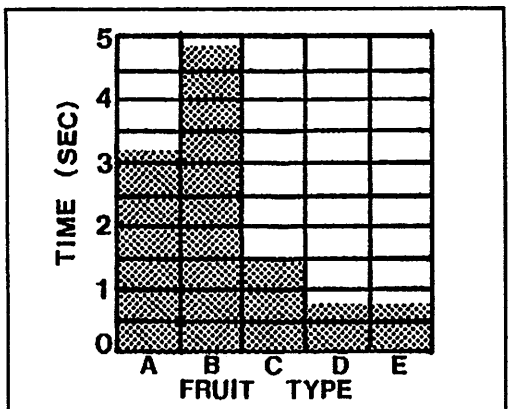


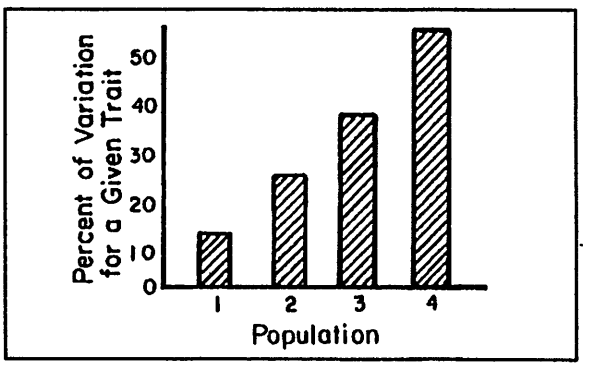
FIGURE 2-6. A BAR GRAPH.

REVIEW QUESTIONS

1. Which fruit type took the longest time to fall?_____

2. Which fruit type fell in 1.5 seconds?_____

3. The graph below represents the percent of variation for a given trait in four different populations of the same species. These populations are of equal size and inhabit similar environments. Which population has the greatest percentage of variations for the trait?_____



♦ **The Line Graph.** A **line graph** is used to show relationships between two variables. One variable, called the **independent variable,** is placed along the horizontal (bottom), or **X-axis.** The other variable, the **dependent variable,** is placed on the vertical (side), or **Y-axis.** The data for the dependent variable depends on the changes in the independent variable. The data points are then plotted and the points are connected by a line (Figure 2-7).

Data Table

Light Intensity (footcandles)	Number of Bubbles Per 5 Minutes
100	2
200	4
300	6
400	9
500	10
600	13
700	17

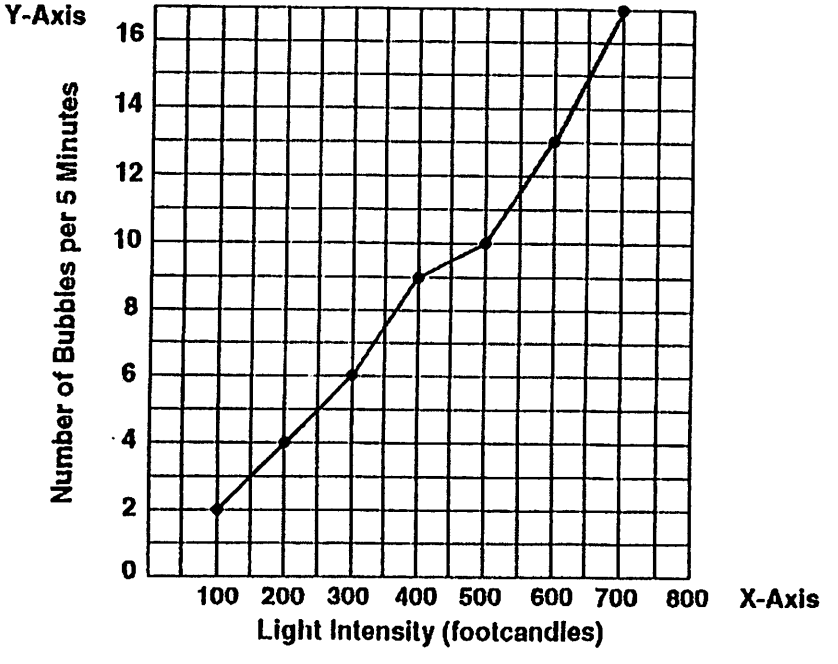


FIGURE 2-7. A LINE GRAPH.

REVIEW QUESTIONS

1. A line graph is used to show relationships between _____.

2. Name the independent variable in the line graph shown in Figure 2-7.

3. As the light intensity increases, does the number of bubbles increase or decrease?

_____

Directions (4-6): Base your answers to questions 4 through 6 on the information below that shows the average amount of grain in bushels per acre produced by a farm each year from 1979 to 1985. The table also shows the amount of rainfall received during the early growing season of each year.

Data Table

Year	Amount of Rain (Inches)	Bushels of Grain per Acre
1979	13	60
1980	7	50
1981	10	65
1982	9	60
1983	11	70
1984	15	20
1985	12	65

4. Rearrange the above data by completing both columns of the data table provided, so that values of **Amount of Rain (Inches)** are ***increasing*** from the top of the table to the bottom.

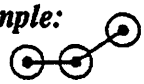
Data Table

Amount of Rain (Inches)	Bushels of Grain per Acre

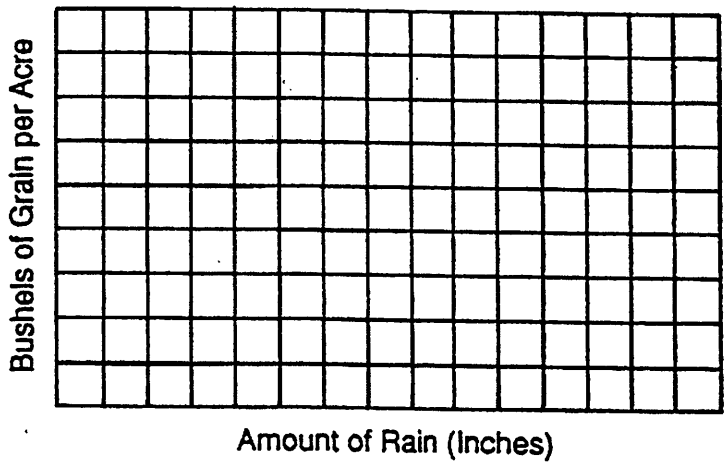
Name_____ Class_____ Date_____

5. Using the information in the preceding data table, construct a line graph on the grid that follows. Then: *Mark an appropriate scale on each labeled axis and plot the data for bushels of grain per acre. Surround each point with a small circle and connect the points.*

Example:



Line Graph



6. Based on the data presented, what amount of rain will produce the most bushels of grain?

_____

Living Environment Name:_____

Graphing with M&M's or Skittles

Problem: Are M&M's or Skittles packaged randomly or by a machine that puts the same distribution of colors into the bag every time?

Hypothesis: _____.

Materials:

* A regular sized package of M&M's (or Skittles)
* Graph paper
* Ruler
* Compass
* Pencil
* Colored pencils/markers

Procedure:

1. Separate your bag of candy into the different colors.
2. Count how many candies of each color there are and record the information in the data table. (you may eat the candies from this point forward)
3. Calculate the % of the whole bag represented by each color and record in the data table.
4. Use the different colors and # of candies of each color to make a bar graph. Be sure to include a graph title, labels for the x and y axes, and an easily readable scale. Use an entire sheet of graph paper and attach to this sheet.
5. Use the different colors and the %'s of each color to make a circle graph. Be sure to include a graph title, and the numerical %'s of each color in the graph. Use an entire sheet of graph paper and attach to this sheet.

Data: **Total Number of Candies**_____

Color	Number of Candies	Percent of Whole Bag

Analysis (MUST USE COMPLETE SENTENCES!!):

1. What would you expect to see if the candies were packaged mechanically?
2. Were there about the same number of each color or did the number or candies vary from color to color?
3. Compare your data with the data from another group (with your same kind of candy). Does your data agree?

Conclusion:

_____

_____

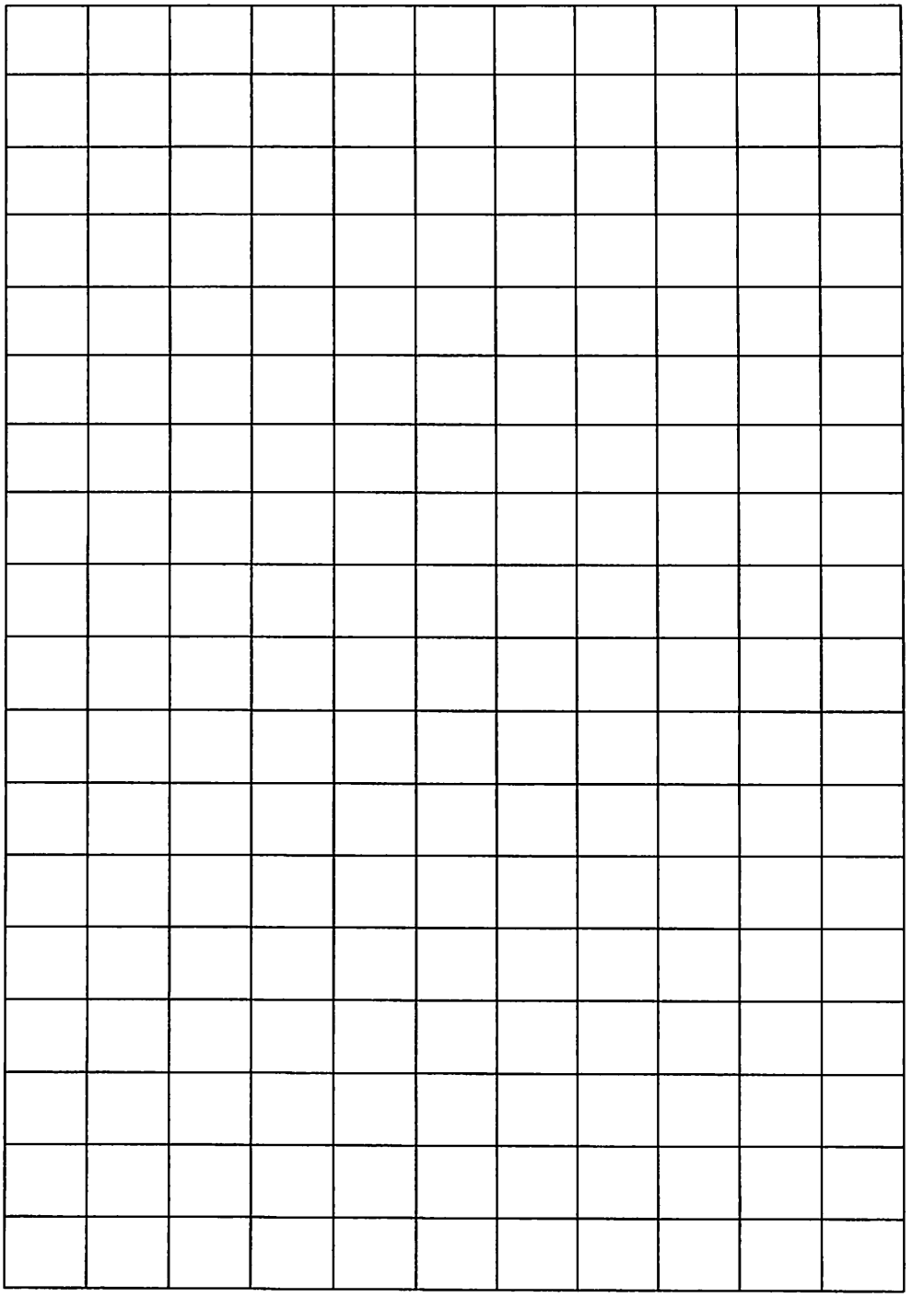
_____

Living Environment

Name:_____

Lab Title

_____



Living Environment Name:_____

A Line Graph

Daphnia (water fleas) are sensitive to many changes in pond ecosystems. For this reason they are often used in bioassays, tests in which organisms are exposed to various levels of a chemical to determine what levels are safe. The results of these tests determine whether or not the chemical being tested will affect other pond organisms. An experiment was designed to determine the toxicity of different salt solutions on cultures of daphnia. Five fish tanks were each filled with the same amount of water containing different concentrations of salt. Ten daphnia were placed into each tank. After 48 hours, the number of daphnia that had survived and the number of daphnia that had died in each tank were recorded and the percent mortality was calculated. The results of the experiment are shown in the data table below.

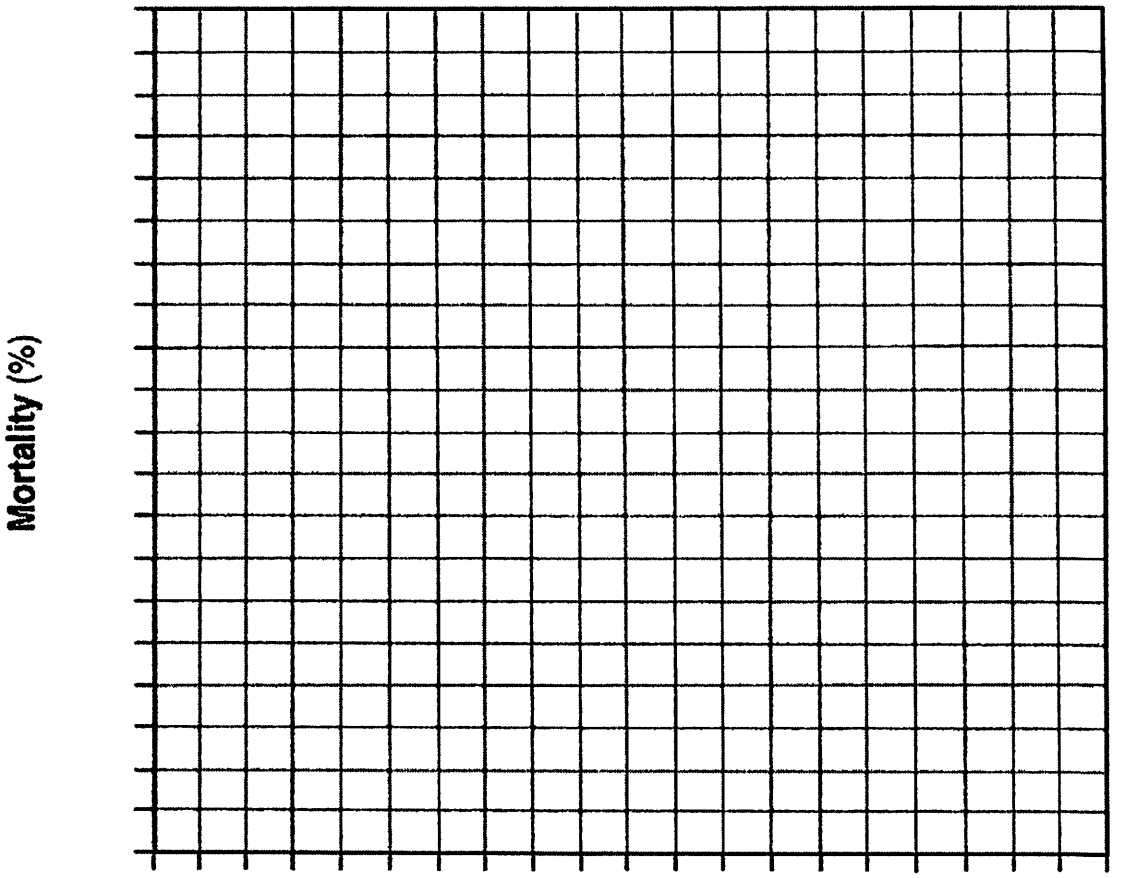
Effect of Salt Concentration on Daphnia After 48 Hours

Salt Concentration (g/L)	Number that Survived	Number that Died	Mortality (%)
0.63	8	2	20
1.25	7	3	30
2.5	10	0	0
5.0	3	7	70
10.0	0	10	100

1. Label the x-axis. Be sure to include units.
2. Mark an appropriate scale, without any breaks, on each axis.
3. Plot the data for mortality on the grid. Surround each point with a small circle and connect the points.

Living Environment Name:_____

Effect of Salt Concentration on Daphnia
After 48 Hours



_____

4. Which salt concentration was most toxic to the daphnia in this experiment?

(1) 1.25 g/L (3) 5.0 g/L

(2) 2.5 g/L (4) 10.0 g/L

5. Which salt concentration is most likely closest to the concentration of salt found in the natural environment of this species of daphnia? Support your answer.

Salt concentration _____

_____

_____

_____

Living Environment Name:_____

A Bar Graph

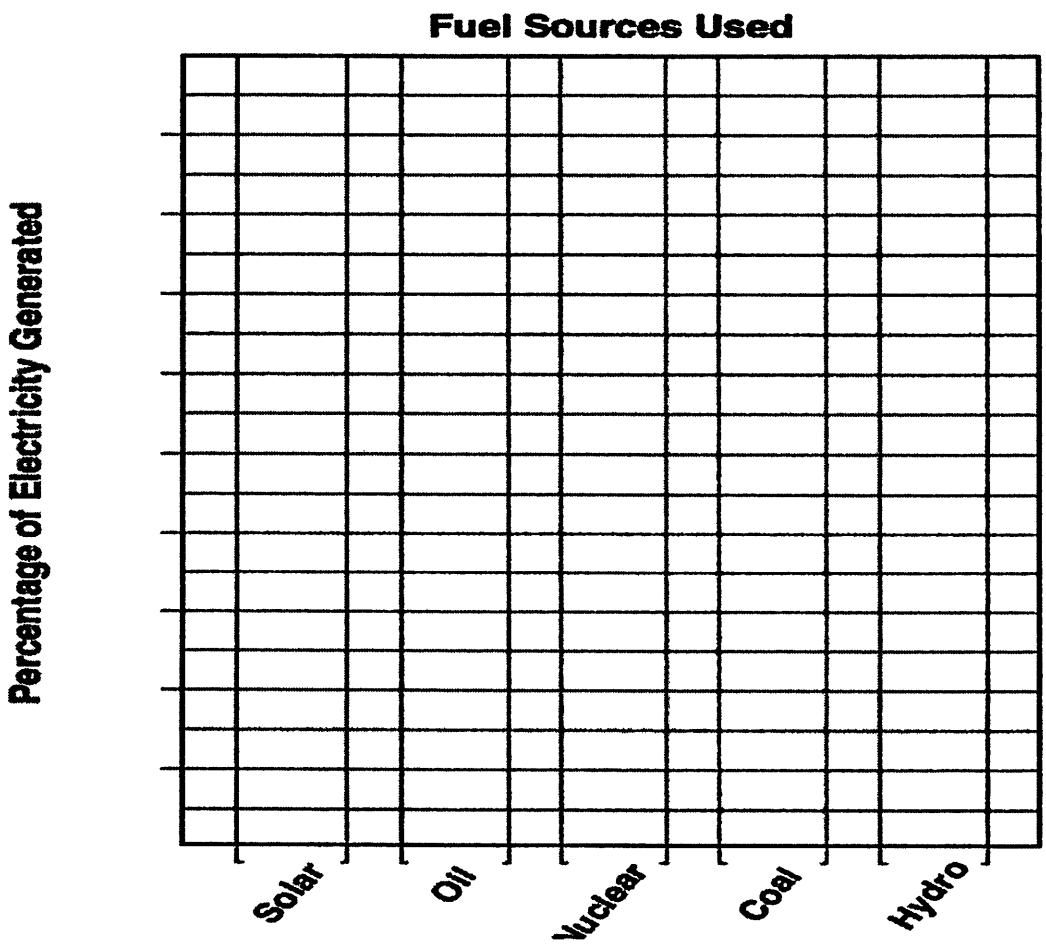
Each year, a New York State power agency provides its customers with information about some of the fuel sources used in generating electricity. The table below applies to the period of 2002–2003.

Fuel Sources Used

Fuel Source	Percentage of Electricity Generated
hydro (water)	86
coal	5
nuclear	4
oil	1
solar	0

1. Mark an appropriate scale on the axis labeled "Percentage of Electricity Generated."

2. Construct vertical bars to represent the data. Shade in each bar.



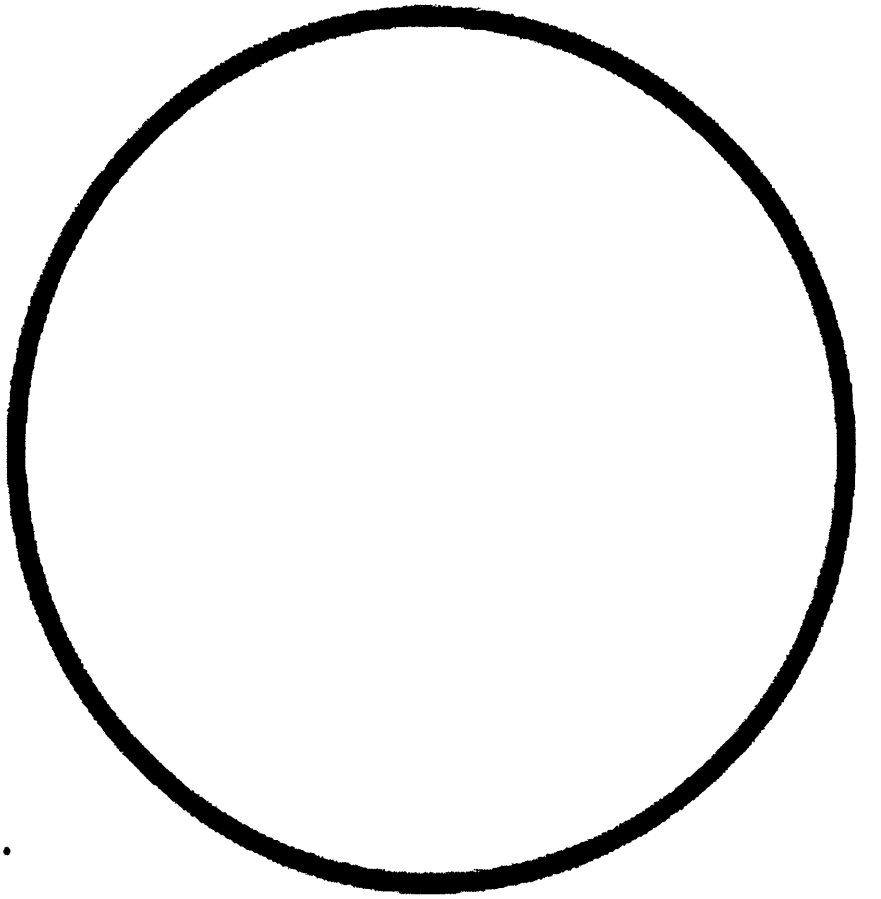
Living Environment Name:_____

A Pie Graph

Create a pie graph about 'Web Sites'. Make a pie graph for the set of data below.

1. Label segments by coloring each section of the graph and creating a key.
2. Give the graph a title.

Favorite Web Site	Votes
Facebook	40
Google	28
Echalk	2
BrainPop	5
Twitter	25



Title:_____

What are the two most popular websites?

_____

Which website is the least liked?

_____

Regents Biology Name_____

Graphing lab

Purpose: This lab is designed to test your graphing skills.

Materials: pencil / pen and ruler

Procedure: Use the attached graph paper to plot graphs for the following problems. Make sure to label all parts of the graph and title the graph.

1. Baby chickens require a constant source of food. As chicks grow, more energy is required for daily activities. The following table gives the grams of food eaten by a chick over a five day period:

Number of Days	Food Eaten (grams)
0	0.0
1	1.0
2	3.2
3	6.5
4	10.6
5	15.4

2. A water plant placed in bright light gives off bubbles of oxygen. In the lab, it was noticed that if the light were placed at different distances from the plant in the aquarium, the rate of bubbling varied. Plot a graph for the following data:

Distance from Light (cm)	Oxygen Bubbles/Minute
10	40
20	20
30	10
50	3

Questions:

1. How much grain will the chick eat on the sixth day?
2. How much grain will the chick eat on the seventh day?
3. How much oxygen would be released at 25 cm?
4. How much oxygen would be released at 35 cm?

Date _____ Name _____
Lab # _____ Teacher _____

Seed Germination

In order for a plant to grow, a seed needs the right environment. Seeds require the right temperature, oxygen, and moisture to allow the cells inside the seed to start actively carrying out the life processes and begin growth. When seeds begin to carry out the life processes and growth of a root and seedling begin to take place, we can say that germination has occurred. There are other environmental factors that could also affect whether or not germination has occurred. One of these factors is salt. What would you hypothesize about the effect of salt on the number of seeds that will germinate?

1. What is the question you are trying to answer by doing this experiment?

_____

_____

2. Remember, the independent variable is the factor that the experimenter purposely changes to find out what effect the change in the experimental factor will have on the outcome of the experiment.

Identify the independent variable in this experiment _____

3. The dependent variable is the factor that changes due to, or in response to, the change in the independent variable. In other words, what you are measuring is the dependent variable since it depends upon the changes in the independent variable.

Identify the dependent variable in this experiment _____

4. State a hypothesis: If the (independent variable) is (describe how you changed it), then the (dependent variable) will (describe the effect).

Hypothesis _____

_____

Now you are going to test the effect of a particular variable on the germination of a seed type of your choice.

Day 1 Procedure:

1. Get three Petri dishes. Label one as Control, one as 5 grams, and one as 10 grams.
2. Place 75 ml of water into a beaker. Take a paper towel and put it into the beaker, saturating it completely. Put this paper towel into the Control dish.
3. Add water to the beaker to get back to 75 mL. Now put 5 grams of NaCl into the beaker. Stir until dissolved. Put a paper towel into the beaker and saturate it. Put this paper towel into the 5 gram dish.
4. Empty the beaker. Refill with 75 mL of water. Put 10 grams of NaCL into the beaker. Put a paper towel into the beaker, saturate it, and place into the 10 gram dish.

5. Obtain a packet of seeds of your choice as provided by your teacher. Separate the packet into 3 equal numbers of seeds. Place the seeds into each dish by putting them between the layers of your paper towels.
6. Put the 3 dishes in the place designated by your teacher. Label your dishes with your name to be able to easily identify your own before going back to your desk.

Data Table: Typically, the independent variable is in the first column and the dependent variable is in the second column. Fill in the independent variable column with the amount of NaCl used in each dish.

Type of Seeds Used:_____

Amount of NaCl (in grams)	Number of Seeds Germinated

We want to keep all other environmental factors that could effect seed growth constant so that the only difference we see will be due to the salt concentration.
In this experiment, what factors are kept constant? _____
_____
_____

Describe the control in this experiment._____

Why is a control necessary?_____
_____

Describe some hidden variables in this experiment (other factors that might affect how many of the seeds germinated but were not controlled). _____
_____
_____

DAY 2 Procedure:

1. Get your dishes. Count the number of seeds that have germinated in each dish and record it in the data table. Return the dishes where you got them.

Analyze your results. Was there a difference in the number of seeds that germinated in each plate? Describe your results in a few sentences.

_____
_____
_____

State a conclusion for this experiment based on your data. Your conclusion will state whether your hypothesis was supported. Think of it as an answer to your original question.

_____

Date _____ Name_____
Lab #_____ Teacher_____

Designing a Controlled Experiment Using Germinated Seeds

Since you've had some experience setting up a simple controlled experiment testing a variable that was given to you, it is time for you to come up with your own idea to test in a controlled experiment. Using the germinated seeds from the last lab, you will design an experiment to test an environmental factor of your choice. You will determine what effect, if any, the variable has on seedling growth.

Preliminary Work:

1. List at least three factors that you think are necessary for proper seedling growth.
   _____ _____ _____

2. Now you need to pick a variable to test. Some possibilities are:
   - the amount of water
   - the amount of sunlight
   - fertilizer
   - oxygen exposure
   - soil amount

   Pick a variable from the list above or one that you can think of on your own that you will test in this experiment. Write it below.
   _____

3. State a hypothesis about what effect this variable might have on plant growth.
   _____

4. Identify your independent variable.
   _____

5. Identify your dependent variable.
   _____

6. Make some predictions about how you will know if your hypothesis is supported.
   _____
   _____

Procedure: You will have pots, soil, and your seeds at your disposal. Now you will need to describe what you will do before you actually do it.

1. Describe how you will set up your control pot in detail. Be sure to include how much soil you have, how much water you will add, how often, and describe every condition the plant will be exposed to.

2. Describe how you will set up your experimental pot(s) in as much detail as possible.

3. How do you plan to measure seedling growth? Be specific about the type of measurement and what part of the plant you will measure (root, stem, leaf, etc.)

Now do it. Get what you need and set it up. Put the germinated seeds into the soil no deeper than the length of your pinky to the first knuckle.

4. Describe any problems you had with the set up.

5. Write observations of the pots below.

6. Describe where you will place the place and what you will do during the next lab period. Be sure to carefully label your plants.

Taking Observations:

Create a data table that will chart your seedlings' growth over the next two weeks. Begin to take data.
Table Title: _____

Analysis:
1. You have taken data charting the growth of your seedlings over the last few weeks. Usually we would take the data from our table and place it into a graph. Get some graph paper and make a line graph that displays your data. Many times, the independent variable is placed on the x-axis. The dependent variable always goes on the y-axis. In this case, it might be best, to put Time (in days) on your x-axis and whatever you measured with the proper unit on the y-axis. Depending on how many experimental groups you had, you would have different lines representing the data from each group. Create a key that clearly differentiates the different groups your experiment had.

2. A scientist would then use statistics to analyze differences between groups. Here we will not do this since it is an introductory experience. If you choose to go on to research, you would use various statistical tests to see if there is a significant difference. However, from your graphs does there seem to be a statistical difference? Describe it.

Conclusions:

1. Has your hypothesis been supported?

2. Propose a possible reason for this variable that you tested to have caused the effect.

3. How could you improve this experiment?

4. How would you go further with this investigation if you were given more time and more resources?

Living Environment Name:_____

Scientific Method Lab

1. The purpose of this lab is to use the Scientific Method to solve a problem.
   A) Observe and ask questions that lead to a problem
   B) Form a hypothesis
   C) Test the hypothesis with a controlled experiment my making observations and gathering data.
   D) Analyze gathered data
   E) Reject or Accept your hypothesis
   F) Form a conclusion

2. Materials
2 small pieces of wax paper
1 meter long piece of string
1 meter stick
2 different pieces of bubble gun labeled A and B

3. READ directions carefully before starting the lab. Each group will need one piece of gum labeled A and one labeled B. Make 3 observations about each brand of gum.

Observations

Gum A	Gum B
1._____	1._____
2._____	2._____
3._____	3._____

Problem: Which piece of bubble gum blows the biggest bubble?

Hypothesis: Predict which piece of gum will blow the biggest bubble and why.

_____
___

_____
___

Procedure:
1. The person with brand A will chew their piece of gum for 3 minutes. The person with brand B does not begin chewing until all the tests on brand A are completed.

2. Blow a bubble.

3. Using a string, your partner will measure the diameter (distance across) the bubble. Put the string on the meter stick to measure the distance in centimeters (cm).

4. Record the measurement in a data table. Repeat the process for trials 2 and 3.

5. Find the average bubble size for brand A (add all the distances up and divide by 3) and put in the data chart.

6. Repeat steps 1-5 with brand B gum.

Data Table: Design a data collection table to fit the data you will be investigating

Conclusion: Forming a theory
What brand of gum is the best at blowing bubbles and why? Support your answer with observations and your data.

PART 2

Combine with another group to complete this part of the lab.

Problem: How does gum strechability relate to bubble size?

Hypothesis: Make an educated guess that would answer the above question.

Procedure:
1. The person with brand A will roll their gum into a ball.

2. Hold the gum (brand A) by using the piece of wax paper. Another person in the group would hold the same piece of gum with another piece of wax paper. Hold the gum near your chest, begin to walk slowly backwards.

3. The third person in the group should hold the meter stick and measure the distance in centimeters the gum stretched before breaking.

4. Record the measurement in the data chart. ONLY DO ONE TRIAL

5. Repeat #1-4 for brand B gum.

Living Environment Name:_____

2. Data Table: Create a data table to fit the data you will be gathering

Conclusion:
COMPARE DATA FROM BOTH GROUPS IN PART 1 AND PART 2

How does gum stretchability relate to bubble size?

_____

_____

With your lab partner, list 5 variables that may affect the outcome of this experiment.

1. _____
2. _____
3. _____
4. _____
5. _____

3. Explain how the data you collected can be described as both qualitative and quantitative

_____

_____

Were SI units used in this lab? Explain. _____

_____

List any questions you still have about the scientific method.

_____

_____

_____

Teaching Notes and Tips

You need space to do part II of the lab. If you have carpet, you may want to do part II outside. But the stretched gum cleans up easily and the wax paper makes it possible for kids not to touch other students' gum. Depending on the age level and responsibility level of the students you can let each group come up with variables to test about the 2 types of gum. When I have done the lab in the past we used to give students data tables and lead them the entire way through. Now, each time I do the lab I let students make tables and test other variables....but this depends on the students I am working with.

Assessment

Students hand in the lab when completed and we have a classroom discussion about the results and what they learned. Also, on the first quiz I put questions about the lab.

Living Environment Name:_____

WHAT ARE THE NEEDS OF LIVING THINGS?

KEY QUESTION
What are the needs of living things?

MATERIALS
variety of gummy worms
earthworms

SAFETY
Always follow OCPS science safety guidelines.

ENGAGE

1. Observe the gummy worms and the earthworms provided by your teacher. Complete the chart to review the characteristics of earthworms and gummy worms. Stress the needs of living things during the discussion.

All About Worms	
Earthworms	**Gummy Worms**

2. *How could you tell that the earthworms were living?*
3. *Do the earthworms need water?*
4. *How do you know?*
5. *What other things, besides water, does the earthworm need in order to survive?*
6. *What would happen to the earthworm if it did not have any of these things it needs to live?*
7. *What do you need in order to survive?*

Unit 2: Organization and Patterns in Life

Guiding Question: How can we study the various aspects that make up living things?

Overview:

A. Life Processes
   a. Nutrition
      i. Autotroph/ heterotrophs
   b. Transport
      i. Unicellular and multicellular
   c. Excretion
      i. Metabolic waste vs. waste created through digestion
   d. Respiration
   e. Synthesis
   f. Regulation
      i. Response to changes internally and externally
   g. Growth and development
   h. Reproduction

B. Biochemistry
   a. Carbon, hydrogen, oxygen, and nitrogen (CHON)
   b. Organic compounds must contain both carbon and hydrogen
   c. Carbohydrates
      i. Building blocks: simple sugars
   d. Proteins
      i. Building blocks: amino acids
      ii. Shape!
   e. Lipids
      i. Building blocks: glycerol and fatty acids
   f. Nucleic acids
      i. Building blocks: nucleotides

C. pH
   a. pH scale
   b. Acids and bases
   c. Living organisms and pH

D. Enzymes
   a. Organic molecules (proteins)
   b. Shape specific based on amino acid sequence
   c. Catalyze chemical reactions (synthesis and digestion)
   d. Usually end in –ase
   e. Temperature and pH effect on action

E. Animal vs. Plant Cells
   a. Function of the organelles
      i. Nucleus
      ii. Mitochondria
      iii. Ribosome
      iv. Cytoplasm

v. Vacuole
vi. Cell membrane
vii. Cell wall (plant only)
viii. Chloroplast (plant only)

b. Diagrams of the plant and animal cells

F. Cell organization
   a. Organelle, cell, tissue, organ, organ system, organism

G. Cell membrane, Active and Passive transport, Cell Communication
   a. Phospholipid bilayer structure
   b. Receptors in the cell membrane
   c. Receptors shape specific (proteins)
   d. Molecule size related to movement across the membrane
   e. Difference between active and passive transport (concentration of molecules, molecule size)
   f. Difference between diffusion and osmosis

H. **NYS lab:** Diffusion Through the Membrane

I. Photosynthesis and Respiration
   a. Molecular formulas of each process
   b. Organelles associated with each process
   c. Leaf anatomy associated with photosynthesis
      i. Stomates and guard cells

Lesson Objectives:

Students will be able to:

- Identify and describe each of the eight life processes
- Describe why each of the life processes are essential to the maintenance of homeostasis in organisms
- Identify the building blocks of each of organic compounds
- Describe the function of each of the organic compounds
- Describe why each of the organic compounds is important for living things
- Compare organic and inorganic compounds
- Identify an acid or a base using the pH scale
- Describe why different enzymes have different shapes
- Describe why enzymes will only work with certain substrates
- Explain how temperature and pH can affect enzyme action
- Compare and contrast plant and animal cells
- Describe the function of each of the cell organelles
- Identify the cell organelles on a diagram
- Identify the cell organelles found only in plant cells
- Relate the cell organelles to the life functions
- Describe the structure of the cell membrane
- Describe the function of the cell membrane
- Identify the various components of the cell membrane
- Describe the how active transport, diffusion, and osmosis differ

- Describe how concentration and molecule size affect transport of molecules across the membrane
- Explain the role that receptor shape plays in cell communication
- Identify the molecules involved in both processes of photosynthesis and respiration
- Identify the organelles involved in each of the processes
- Describe how the processes of photosynthesis and respiration contribute to homeostasis
- Explain how photosynthesis and respiration are related
- Describe the role indicators play in the identification of molecules

Suggested Activities:

- Indicator lab
- pH lab
- Enzyme action cut out activity
- Effect of temperature and pH on enzyme action lab
- CO_2 in the air exhaled lab
- Photosynthesis and respiration in elodea lab
- Leaf anatomy lab
- Making root beer using anaerobic respiration lab
- Comparing plant and animal cell lab
- State lab- Diffusion through the membrane
- Have students make a brochure that tours all the parts of the cell

Key Vocabulary

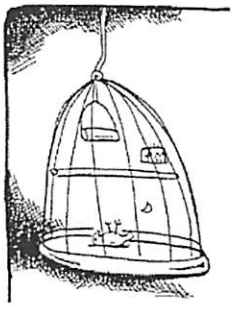
Active transport	amino acid	cell
Cell membrane	cell respiration	chloroplasts
Circulation	cytoplasm	diffusion
Digestion	enzymes	excretion
Homeostasis	hormone	inorganic
Metabolism	mitochondria	nucleus
Organ	organ system	organelle
Organic	receptor molecule	reproduction
Respiration	ribosome	simple sugar
Synthesis	tissue	vacuole
Stomata	guard cell	gas exchange
Organic catalyst	pH	photosynthesis
Dynamic equilibrium	ATP	carbohydrate
Lipid	protein	nucleic acid
Cell wall	biochemical	

Name _____ Date _____
Living Environment Period _____

Indicators

Why do we use indicators in the lab?

_____

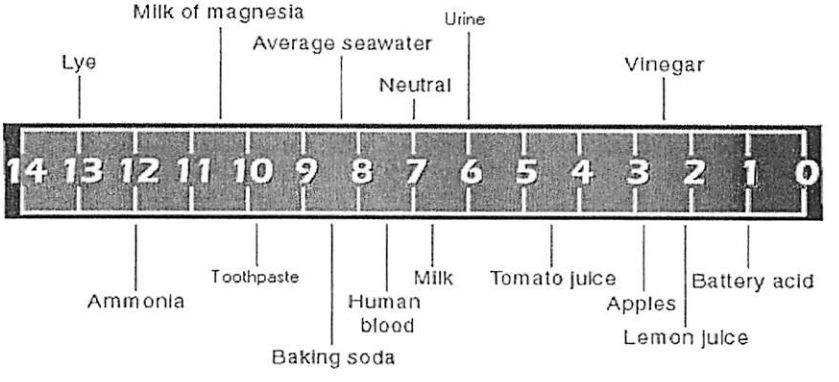


Indicators are used to test for the presence of a variety of different things. Before coal mines had ventilation systems, miners used to use a canary to indicate the presence of harmful gases (carbon monoxide). If the canary died, the miners knew to get out quick.

Acids and Bases

We will be using a couple of different types of indicators this year. One type of indicator tests for the presence of acids and bases. Litmus paper is used in this test.

Litmus paper will turn red in the presence of an acid and blue in presence of a base.



Nutrients

We also use indicators to test for the presence of certain nutrients in different things. Two of the indicators we will use this year are listed below.

2 indicators we will use:

1. **Benedict's solution** is a chemical used as a test for the presence of monosaccharides (such as glucose and fructose); it is also used for some disaccharides like maltose in a solution.

   Benedict's solution starts off blue in color. A positive test result will range from green, brown, red, or orange depending on how many monosaccharides are present.

2. **Lugol's iodine**, also known as **Lugol's solution**, first made in 1829, is a solution of iodine named after the French physician J.G.A. Lugol. Lugol's iodine

solution is often used as an antiseptic and disinfectant, a starch indicator, and to replenish iodine deficiency.

This solution will be used as an indicator to test for the presence of starches in organic compounds, Lugol's iodine starts off amber in color and turns dark-blue/black when it reacts with starches.

It can also be used as a cell stain, making the cell nuclei more visible.

What is the difference between a monosaccharide and a starch?

Name _____ Date _____

The Chemistry of Life
pH Lab

Problem: Are common household substances acidic, basic, or neutral?

Background Information
The pH scale is a numerical scale that goes from 0-14. Any number below 7 represents an acid. Any number above 7 represents a base. The number 7 represents a neutral solution. The pH of a solution can be measured with special paper that changes color at different pH levels. There are two different types of paper that can be used.

- Litmus paper can be used to identify a base, an acid, or a neutral solution. It does not measure the exact pH. Red litmus paper turns blue in the presence of a base. Blue litmus paper turns red in the presence of an acid. A neutral solution does not change the color of either blue or red litmus paper.
- Hydrion paper can be used to identify the actual pH value (from 1-14) of a solution. Hydrion paper turns different colors depending on the pH value of the solution being tested. A color scale is used to determine the exact number that the solution being tested falls at in the pH range.

Materials

dropper
red and blue litmus paper
water
shampoo
liquid antacid
lemon juice
vinegar
milk
orange juice
ammonia
liquid bleach
dishwashing liquid

Procedures

1. For this activity, use the data table provided.
2. Predict whether you think each substance listed in the table is an acid, a base, or a neutral substance. Write the word "acid," "base," or "neutral" in the **prediction** column of your data table.
3. Using a dropper, place one drop of water on the red litmus paper and one drop of water on the blue litmus paper. Note any color changes. Place an X in the proper column based on your observations.
4. Using the same dropper, place one drop of water on the hydrion paper. Note the color change. Use the color scale to determine the pH value of the water. Write the value in the proper column based on your observations.

5. **Repeat** step 3 and 4 for each substance that you are testing. Clean the dropper after testing each substance. **CAUTION**: Wear your safety goggles and lab apron. If any substances get on your skin, rinse them off immediately with plenty of water.
6. Clean your work area. Be sure to dispose of materials properly. Wash your hands thoroughly before leaving your work area.

Observations

Data Table:

		Litmus paper			Hydrion paper
Substances	Prediction	Acid	Base	Neutral	pH
Water					
Shampoo					
Antacid					
Lemon juice					
Vinegar					
Milk					
Orange juice					
Ammonia					
Bleach					
Dishwashing liquid					

1. Which substances are acids? Rank the acids from least to most acidic.

2. Which substances are bases? Rank the bases from least to most basic.

3. Which substances are neutral?

4. Compare your predictions to your actual results. Were your predictions correct?

5. Were you surprised to find out the pH of certain substances? If so, which ones? If not, why not?

6. Use the graph paper provided to construct a bar graph using the data from your observation table.

Conclusion

Determine the usefulness of each of the common household products. How does the pH of these substances compare to their usefulness.

Why are some of these products o.k. to drink and some are not?

Why are bleach and ammonia toxic if swallowed?

The pH of your skin and hair ranges between a pH of 4.5 to 5.5. Which substances did you test that could be harmful or damaging to your skin or hair? Explain why.

Name _____ Date _____

Living Environment Period _____

Enzymes and Chemical Reactions

During a chemical reaction, there are reactants and there are products. In order for life processes to occur as quickly as we require them, our cells need the assistance of **catalysts** to speed up reactions. **Enzymes** are specific proteins that act as catalysts to speed up a chemical reaction. A **catalyst** is any substance that can affect the rate of a chemical reaction without itself being changed or used up during a reaction.

Enzyme
(Catalyst)
REACTANTS ----------→ PRODUCTS

During a chemical reaction, a substance on which an enzyme acts is called a **substrate**. An enzyme is specifically shaped to work on a particular substrate. Typically, enzymes are named after the substrate it works on. Its name will end with -ase. For example, the enzyme *amylase* assists in the breakdown of starch to glucose.

amylase
STARCH ----------→ GLUCOSE

An enzyme's shape determines its activity. An enzyme is a LARGE protein with one or more deep folds on its surface. The folds form pockets called **active sites**. An enzyme's substrate fits into its active site.

ENZYMES ARE VERY SPECIFIC AND ONLY
WORK WITH CERTAIN SUBSTRATES

When an enzyme first attaches to a substrate during a chemical reaction, the enzyme's shape changes slightly so that the substrate fits more tightly in the enzyme's active site. The reaction is complete when products have formed. The enzyme goes back to its original shape and is now free to *catalyze* further reactions.

Use the context clues to define the following terms…

1. Substrate:

2. Active Site:

3. Enzyme:

4. Catalyst:

Questions for thought…

1. How is an enzyme's activity determined?

2. Describe how an enzyme does its job.

3. Protease is the enzyme responsible for breaking down proteins. What would protease break proteins down into?

Name _____ Date _____

Living Environment Period _____

ENZYME ACTION

Cut out the enzymes and substrates from the attached page. Be sure to IDENTIFY each piece of enzyme with an E and each piece of substrate with a S. Match the pieces together based on their shapes. Tape or glue them together in the space below...

Answer the questions on the next page based on the models above.

QUESTIONS

1. Which enzyme(s) match with substrate A? _____

2. If A is a complex carbohydrate, what would it break down into in your body?

_____

3. Why do complex molecules need to be digested?

_____

_____

4. If D and E are amino acids, what will they produce when they react together?

_____

5. Which enzyme would catalyze the reaction above?

_____

6. Define synthesis

_____

_____

7. Which enzyme-substrate complexes are synthesis reactions?

_____

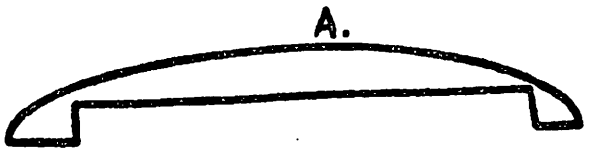
8. Which enzyme-substrate complexes are digestion reactions?

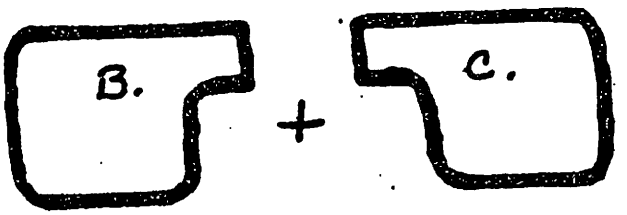
_____

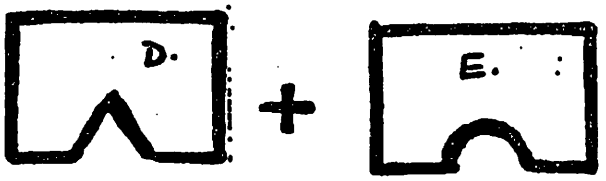
9. If B and C are simple sugars, what will they produce when reacted together?

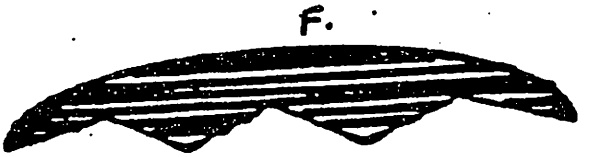
_____

Substrates

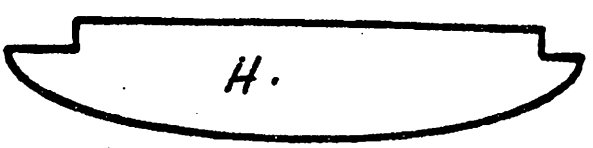


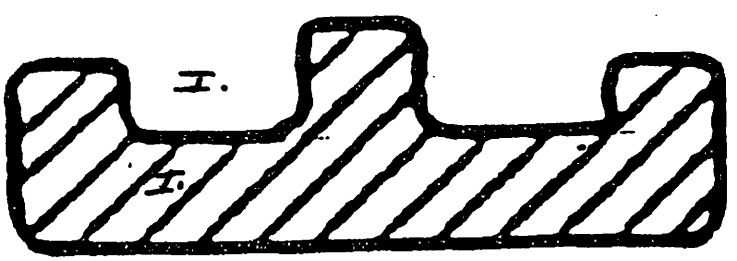


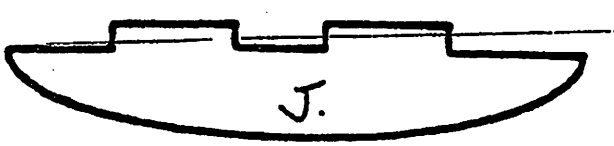


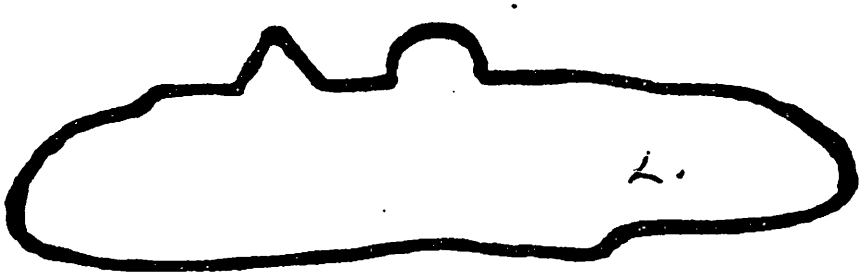


Enzymes









Enzyme-Catalyzed Reactions Lab

Name _____
Date_____
Partner: _____

Introduction:

Enzymes are <u>proteins</u> that function as biological catalysts. **Catalysts** are substances that speed up chemical reactions. Enzymes either:

1. Catalyze the *breakdown* of a substrate molecule into products.
2. Catalyze the *assembly* of substrate molecules (monomers) into a larger product (polymer)

This lab will use the enzyme **catalase** and the substrate **hydrogen peroxide.**
Catalase was one of the first enzymes discovered, and was named after its function – a catalyst.
The reaction:

$$H_2O_2 + \text{catalase} \rightarrow H_20 + O_2 + \text{heat} + \text{catalase}$$

Notice that catalase is not changed by the reaction, and that the reaction produces heat. Reactions that produce heat are called **exothermic**. Hydrogen peroxide will break down all by itself (spontaneously) at a slow rate. Catalase makes the reaction thousands of times faster and causes bubbling.
We will measure the reaction rate visually and assign a **qualitative** value;

0 = no bubbling 1= small bubble formation 2= bubbling fast 3= rapid bubbling/foamimg

All enzymes are proteins with **active sites** that have a shape that must exactly fit the substrate. Heat and strong acids can destroy the shape of the active site and make the enzyme nonfunctional. This is called **denaturization.**

SAFETY SAFETY SAFETY SAFETY SAFETY SAFETY

1. Goggles must be worn over eyes at all times during this lab.
2. Aprons must be worn since there is a danger of hot water spills.
2. Liver and hamburger can carry salmonella and E. coli, which is an infection risk. Hands must be washed AFTER COMPLETING THIS LAB.
3. Hydrogen peroxide will bleach some colors, and may irritate eyes.
4. Heating increases the risk of glass breakage.
5. Hot plates are hot! Heated test tubes are hot! Use test tube holders.

Part I: What Effect Does Heat Have on Enzyme Function?

Hypothesis: If catalase is heated, then the amount of oxygen bubbles will decrease.
IV= _____ DV = _____

Materials: liver, 2 test tubes, hotplate, 2 beakers, water, grad. cylinder, test tube holder, H_2O_2

Procedure:

1. Carefully place a small piece of raw potato in each of two test tubes.
2. Add 4mL of water (use dropper) to each test tube.
3. Place one test tube in the test tube rack. This is your control.
4. Place the other test tube in a beaker of simmering water. This is your experimental.
5. Let the potato cook in the water for 10 minutes.
6. Equalize the temperature of both test tubes by placing them in a beaker of cold water together for 3 minutes.
7. Add 3 mL of H_2O_2 to each test tube and observe.

Group	Reaction rate
Control (raw)	
Experimental (cooked)	

Conclusion for Part I: *(Restate hypothesis, summarize procedure, explain results, accept or reject hypothesis.)*

Part II: Does acid destroy an enzyme's ability to speed up a chemical reaction?

Hypothesis: If acid is added to catalase, then fewer bubbles of O2 will be produced.

IV= _____ DV = _____

Materials: dropper, liver, 2 test tubes, water, grad. cylinder, thermometer, test tube holder, H_2O_2

Procedure:

1. Carefully place a 5 drops of potato in each of two test tubes.
2. Add 5mL of lemon juice to one tube (experimental)
3. Add 5 mL of water to the other test tube. (control)
4. Swirl both test tubes for 3 minutes.
5. Add 5 mL of peroxide to each test tube.
5. Record your observations.

Group	Reaction rate
Control (water)	
Experimental (lemon juice)	

Conclusion for Part II: *(Restate hypothesis, summarize procedure, explain results, accept or reject hypothesis.)*

Part III: Questions

1. Draw a diagram that shows how catalase, H_2O_2, water, and O_2 relate to each other in this lab.

2. Where is the enzyme catalase naturally found?

3. What is the function of catalase in living cells?

4. What happens to an enzyme's ability to catalyze a reaction when they are heated?

5. Describe what happens to the active site of enzymes when they are exposed to high temperatures or strong acids.

6. What happened effect does lemon juice have on catalase enzyme?

7. What is the substrate catalase bonds with?

8. What is hydrogen peroxide changed into when catalase reacts with it?

9. Is catalase changed during the reaction?

10. What happens to enzymes when they are heated or exposed to acids?

11. How is a catalyst like platinum different from an enzyme?

12. Explain why peroxide bubbles when you put it on a cut.

Name..... Biology ..... Date.....

Work Sheet 3-8: Enzyme Graphing

Introduction

A **catalyst** is a substance that affects (usually increases) the rate of a chemical reaction but is unchanged by the reaction. **Enzymes** are catalysts that are proteins. The substance upon which an enzyme works is called the **substrate.**

Enzymes are usually named after their substrates. Most enzyme names end in "ase". For example, protease catalyzes the breakdown of proteins. Therefore, protease is named after its substrate, protein.

How fast the enzyme-catalyzed reaction occurs is referred to as the **rate of reaction.** The higher the rate of reaction, the more reactions occur per minute.

An enzyme's rate of reaction is affected by the concentration of the substrate and the concentration of the enzyme as well as by factors such as pH and temperature.

Objectives

At the completion of this work sheet a student will be able to:

1. Plot points on a chart.
2. Interpret a chart and answer questions regarding the information on the chart.
3. Explain the effect that temperature and pH have on enzyme reaction rates.

Exercise 1

The table below contains the rates of reaction for an amylase, an enzyme that breaks down carbohydrates. Plot the points on the blank chart below.

Table 1	
PH	**Reaction Rate**
4	1
5	30
6	70
7	95
8	96
8.5	91
9	50
10	1

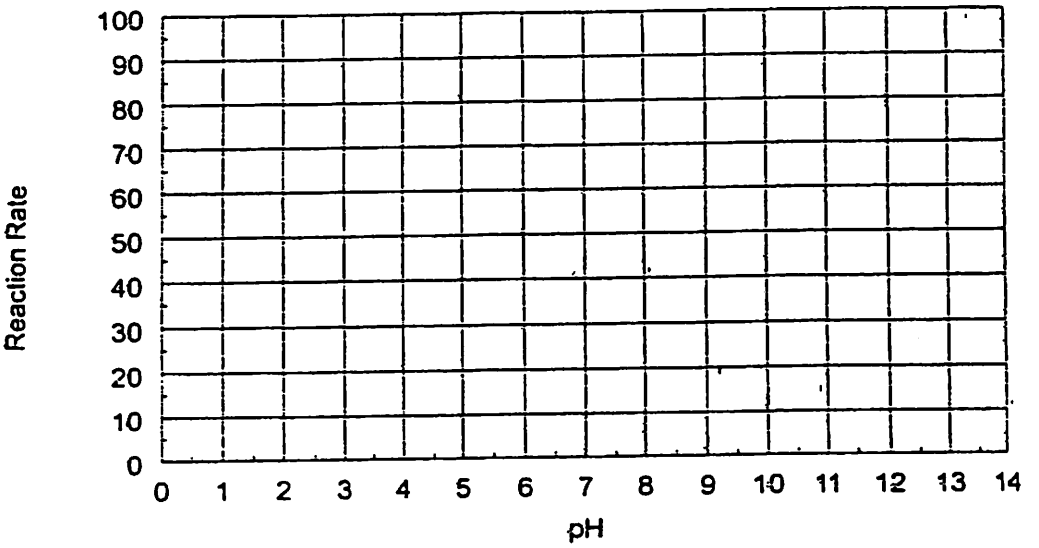


Chart 1. Amylase Reaction Rate vs. pH

The following questions refer to the chart that you just drew on page 1.

1. This amylase works best at a pH of about .....

2. This enzyme has the lowest reaction rates at <u>two</u> ranges of pH. The <u>first</u> range is pH 0 to pH4. The <u>second</u> range is pH..... to pH.....

3. The rate of reaction at pH 5.5 is about.....

4. The rate of reaction at pH 2 is about.....

5. The rate of reaction at pH 12 is about.....

6. A beaker contains the substrate carbohydrate and this amylase. If the pH of the solution is 9, should you add acid or base to increase the rate of reaction?.....

7. If a beaker containing amylase and the substrate starts at a pH of 4.8 and then basic solution is added to change the pH to 6.1, will the rate of reaction increase or decrease.....

<u>Exercise 2</u>
The following questions refer to chart 2, Pepsin Rate of Reaction vs. pH.

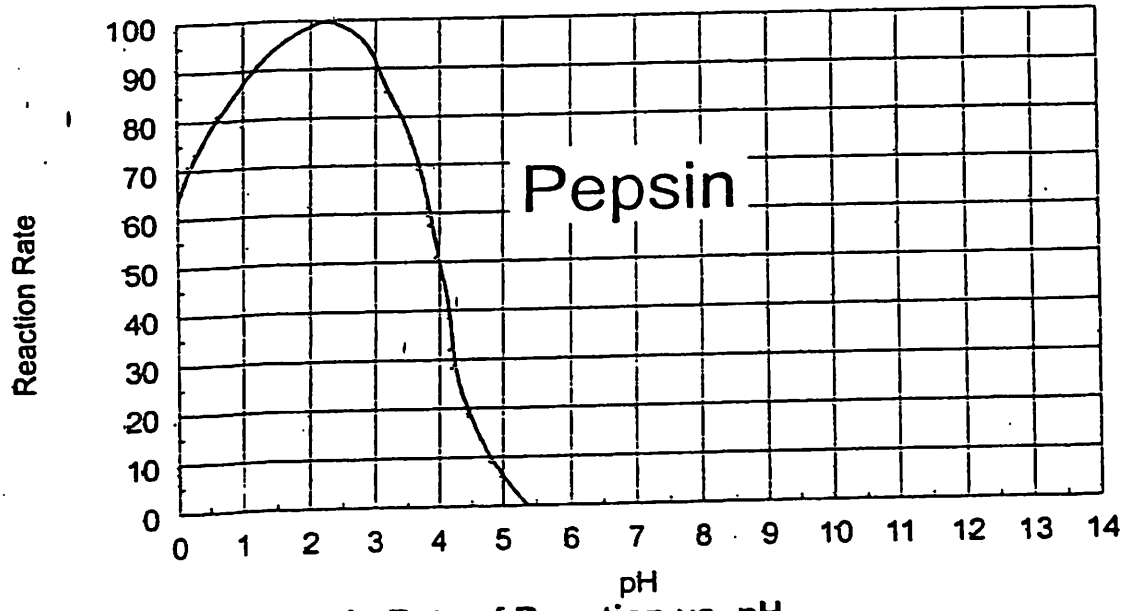


Chart 2. Pepsin Rate of Reaction vs. pH

8. Pepsin works best (has the highest reaction rate) at a pH of .....

9. Pepsin works best in a medium that is (acid, base, or neutral) .....

10. The reaction rate of pepsin at pH of 1 is about.....

11. The reaction rate of pepsin at pH of 4.5 is about .....

12. A beaker contains pepsin and its substrate. If the pH of the solution is 4, should you add acid or base to increase the rate of reaction?.....

13. If a beaker containing pepsin and its substrate starts at a pH of 4.8 and then basic solution is added to change the pH to 6.1, will the rate of reaction increase or decrease.....

14. Pepsin digests protein in the stomach. When the digesting food is moved from the stomach to the small intestine, will pepsin continue to digest protein? Why?

(Yes or No?)..... (Why?).....

.....

.....

Exercise 3

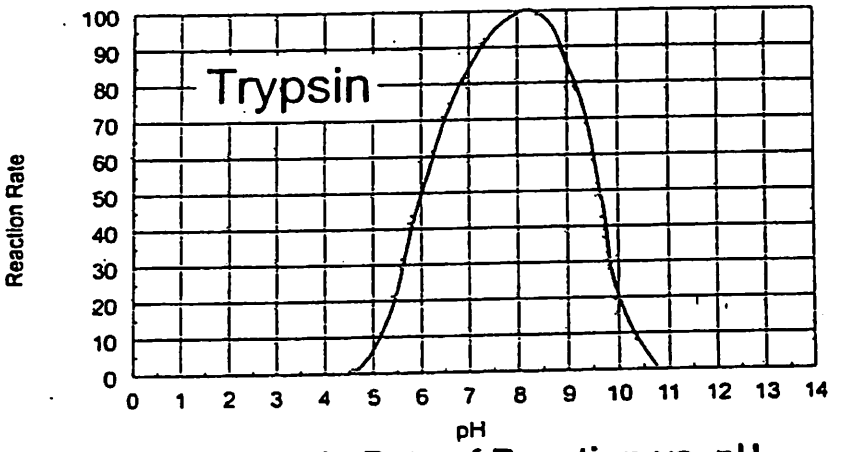


Chart 3. Trypsin Rate of Reaction vs. pH

The following questions refer to Chart 3.

15. Trypsin works best (has the highest reaction rate) at a pH of .....

16. Trypsin works best in a medium that is (acid, base, or neutral) .....

17. The reaction rate of trypsin at pH of 2 is about.....

18. The reaction rate of trypsin at pH of 4.5 is about .....

19. The reaction rate of trypsin at pH of 6 is .....

20 A beaker contains trypsin and its substrate. If the pH of the solution is 4, should you add acid or base to increase the rate of reaction?.....

21 If a beaker containing pepsin and its substrate starts at a pH of 4.8 and then basic solution is added to change the pH to 6.1, will the rate of reaction increase or decrease.....

22 Since the stomach has an acidic medium and the small intestine has a basic medium, trypsin works best in the (stomach or small intestine).....

Exercise 4

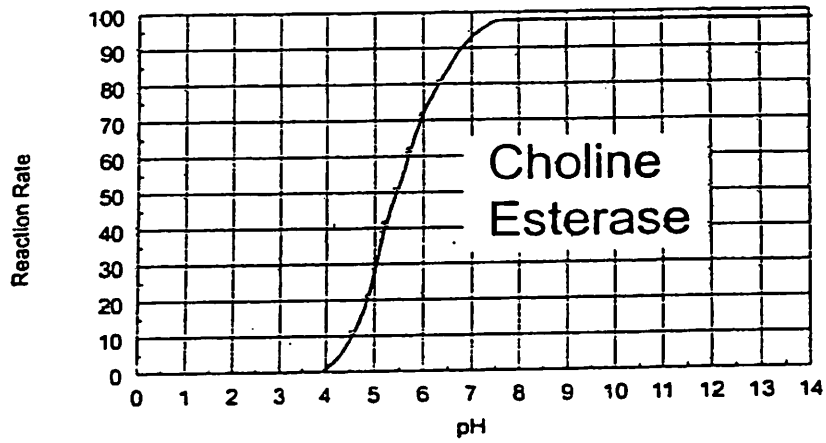


Chart 4. Choline Esterase Rate of Reaction vs. pH

The following questions refer to Chart 4.

Choline esterase is an enzyme that breaks down acetylcholine, which is a chemical messenger released by nerve cells.

23. Choline esterase has its highest reaction rate at a pH range of .....to.....

24. Choline esterase does not catalyze any reaction at a pH range of .....to.....

25. Will choline esterase breakdown acetylcholine in a pH of 6? .....

27. Will choline esterase work faster at a pH of 5.5 or at pH of 11?.....

28. Would choline esterase catalyze reactions in an acidic medium such as the stomach?.....

Exercise 5.

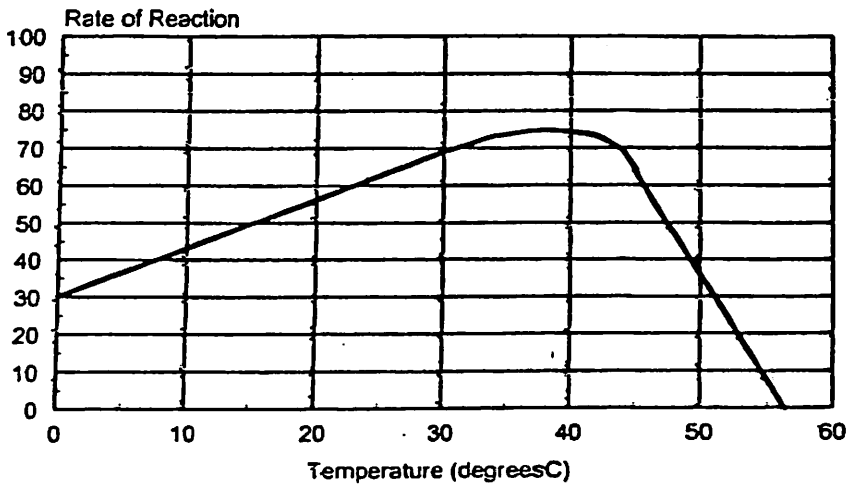


Chart 5. Enzyme Rate of Reaction vs. Temperature

The following questions refer to Chart 5.

29. Enzymes have the highest reaction rate at a temperature of .....

30. Cold-blooded animals, such as snakes, slow down their activities at night and speed up during the day. Use the information in Chart 5 to explain why ?

.....

.....

.....

.....

31. Humans have a body temperature of about 37° C. Use the information in Chart 5 to explain why a person will die if they have a fever that raises their body temperature too high.

.....

.....

.....

.....

Exercise 6

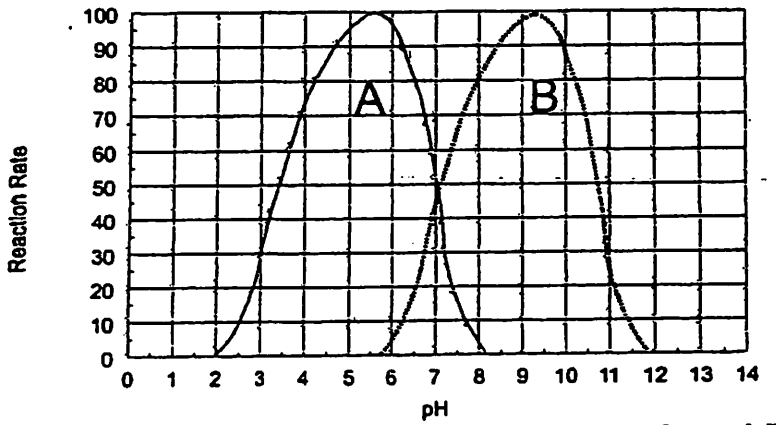


Chart 6. Rates of Reaction of Enzymes A and B vs. pH

The following questions refer to Charts 5 and 6.

32. Under which conditions is enzyme A most effective? a)at 38°C and a pH of 5.5 b) at 45°C and a pH of5.5 c)at 45°C and a pH of 9 d)at 50°C and a ph of 9 .....

33. The optimum environment for enzyme A is a)a basic medium b)an acidic medium c)either an acidic or a basic medium d)a neutral medium .....

34. The optimum environment for enzyme A is a)a basic medium b)an acidic medium c)either an acidic or a basic medium d)a neutral medium .....

35. Which enzyme, A or B, would work better in the small intestine?.....

Review Questions

36. Which of the following is characteristic of an enzyme? a) It is an inorganic catalyst. b) It is destroyed after each chemical reaction. c) It provides energy for any chemical reaction d) It regulates the rate of a specific chemical reaction.

37. An enzyme-substrate complex may result from the interaction of molecules of a)glucose and lipase b)fat and amylase c)sucrose and maltase d)protein and protease

38. True or False? All enzymes work best at the same pH. .....

39. True or False? All enzymes are catalysts .....

40. True or False? All catalysts are enzymes .....

Lab Activity: Is carbon dioxide present in the air you exhale?

Name_____

Team #_____

Team Members

Encourager_____

Data Collector_____

Materials Mngr._____

Recorder_____

Science Process Skills Needed:
Measuring, hypothesizing, and observing.

Background Information:
The job of the excretory system is to remove wastes from the body. Wastes are made as a result of chemical processes in your cells. The lungs work as both respiratory and excretory organs. In the lungs, oxygen (O_2) and carbon dioxide (CO_2) are exchanged. The CO_2 is released as a waste product when you exhale.

The presence of CO_2 can be shown by using an indicator such as bromthymol blue (BTB). An indicator is a chemical substance that reacts in the presence of another substance. A BTB solution changes color from blue to yellow in the presence of CO_2.

Materials:
BTB solution
Small clear plastic cup
Plastic straw.
Graduated cylinder.
Stop watch.
Group sheet.

ALL MATERIALS CHECKED.

OK _____ Not OK _____

Procedure

1) Using the graduated cylinder measure 50 ml of BTB solution.

2) Pour the BTB into the cup.

3) Create a **HYPOTHESIS** that answers the following questions in the space provided:
   a) What will happen to the color of the BTB solution when you exhale into it?
   b) Why?

_____

_____

_____

4) Using the plastic straw and the stop watch, exhale gently into the BTB solution noting the time it takes for color change to occur.

Time for Color Change _____

Observations:

1) What happened to the BTB solution after you exhaled into it?

_____

_____

_____

2) How long did it take for the solution to change color?

_____

_____

_____

Conclusions:

1) What gas is present in exhaled air?

_____

_____

2) Was your hypothesis correct? Use your observations to support your answer.

_____

_____

_____

Follow Up Activity:

What effect does exercise have on the amount of carbon dioxide you exhale?

Design an experiment to test your hypothesis.

Name: Date:
Living Environment Period:

How Do Plant and Animal Cells Differ?

Background: Although plant and animal cells have many structures in common, they also have basic differences. Plant cells have a rigid cell wall, and if they are green, contain chloroplasts. Animal cells lack both a **cell wall** and **chloroplasts**. They also lack a large central vacuole common to plant cells.

You will observe and compare animal cells and plant cells in this laboratory experiment. You will first examine epithelial cells from your skin. Epithelium is a type of tissue that covers many of the organs and cavities of the body.

You will then examine cells from a leaf of the freshwater plant elodea. Elodea is often used in home fish tanks. The cells of this plant are green because they contain the pigment **chlorophyll**. Chlorophyll, which is found in the chloroplasts with each cell, enables plants to do the process of **photosynthesis**, in which they make their own food.

Objectives:

- To observe human epithelial cells
- To observe elodea cells.
- To describe the differences between animal cell and plant cells.

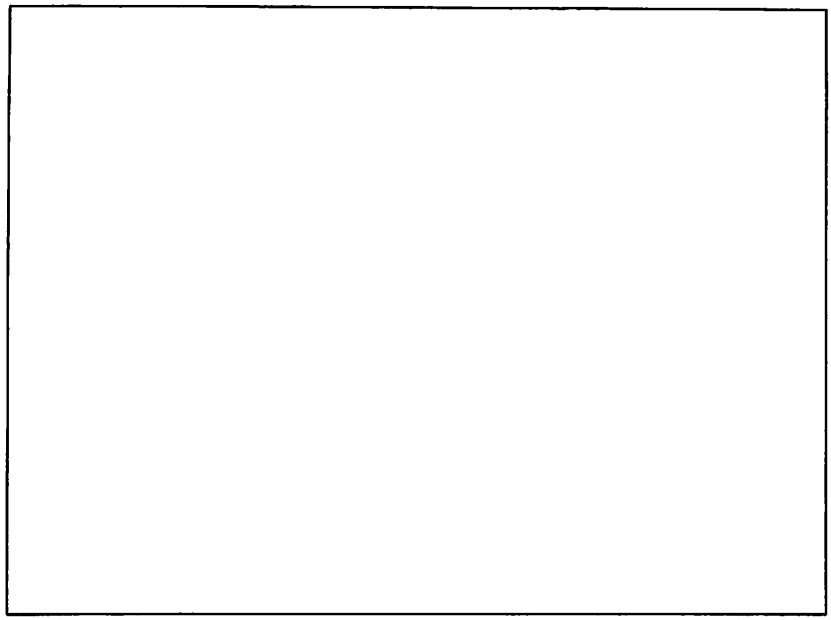
Materials: microscope, slides, coverslips, pipettes, elodea, lugols iodine solution, 1% Methylene blue stain, toothpick

Safety: Use methylene blue carefully. It will stain most items including skin, clothing, and table tops. Wash hands throroughly after you are finished.

Part 1: Human Epithelial Cells

Procedure:

1. Obtain a toothpick from your teacher.
2. **Lightly** scrap the inside of your cheek with the toothpick.
3. Wipe the end of the toothpick on a clean microscope slide to transfer the cells to the slide.
4. Stain the cells using 1% methylene blue solution and place a cover slip over the stained cells.
5. Observe the cells using the microscope. Begin on low power, and then switch to high power for more detail.
6. Draw two epithelial cells as seen under high power in the box on the next page. Label all the parts of the cell that you recognize.



What is the shape of the epithelial cells?

_____

_____

Are you able to see ribosomes or mitochondria under high power? Why or why not?

_____

_____

_____

Part 2: Elodea Leaf Cells

Procedure:

1. Break off a small leaf near the tip of the elodea plant.
2. Place the leaf on a clean microscope slide, add a drop of water and cover with a cover slip.
3. Examine the leaf under the low power objective. The boundary that you see around each cell is the cell wall. The numerous small, green bodies in the cells are chloroplasts.
    a. What is the shape of the cells? _____

4. Look for an area in the leaf where you can the cells most clearly. Examine these cells under high power, carefully focusing up and down with the fine adjustment.
    a. Describe the shape and location of the chloroplasts.

_____

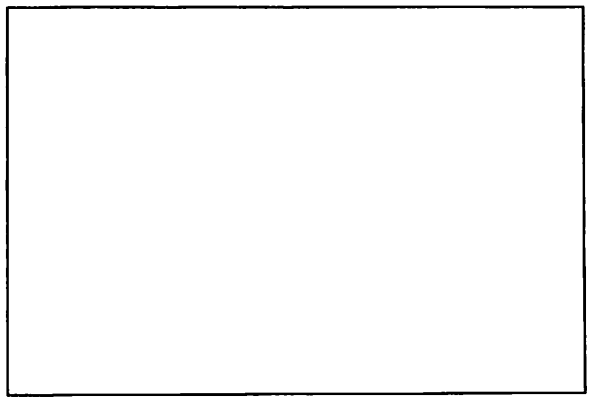
_____

5. As you examine the cells, you may see the chloroplasts moving around. If they are not moving, warm the slide in your hand or under the bright lamp for a few minutes. Then examine the slide under high power.
    a. Describe how the chloroplasts move in a cell.

_____

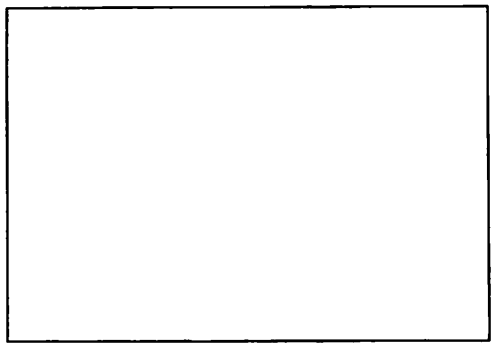
_____

6. Make a drawing of the elodea cell. Label the cell wall, cell membrane, chloroplasts, and any other structures you see.



7. Break off another piece of elodea leaf and place it on a clean microscope slide. Place one drop of lugols iodine on the leaf and cover it with a cover slip. Wait thirty seconds for the stain to sink in. Then examine the stained elodea cells under low and high power.

8. Make a drawing of the stained elodea. Label the cell wall, cell membrane, chloroplasts, nucleus, and large vacuole.



Conclusion Questions

1. What structures do human epithelial cells have in common with elodea cells?

2. How do human epithelial cells and elodea cells differ?

3. What does Lugol's Iodine stain do to the activity of the cell?

4. What organelles that we have learned were not visible with the microscope? Why were these not visible?

5. What is the function of the cell membrane?

6. Describe the function of the chloroplast.

7. The green pigment found in chloroplasts is called _____

Name: _____ Period: _____

Leaf Anatomy

Introduction:

Leaves are not all alike in appearance or structure. However, they all have the same function-food production for the plant. Parts within the leaf may help directly or indirectly in the process of food production. Those leaf parts which contain chlorophyll and are green aid directly in food production. Those leaf parts which are not green may aid indirectly by supplying a pathway for needed raw materials to the green cells.

In this investigation, you will:

a. use a diagram to identify and label the main parts of a leaf cross section.
b. observe a leaf cross section slide under the microscope.

Materials:

microscope prepared slide of leaf cross section

Procedure:

Part A

1. Examine the diagram of a cross section of a leaf.

2. Identify and label the following leaf structures:

    a. cutin: thin, waxy layer which covers the leaf (not composed of cells). Cutin may be present on both top and bottom or just on the top surface of the leaf. Cutin helps prevent water loss.

    b. upper epidermis: single protective layer of cells along top edge of leaf

    c. palisade layer: rectangular photosynthetic cells directly below the upper epidermis (normally green)

    d. spongy layer: loosely arranged photosynthetic cells below palisade layer (normally green)

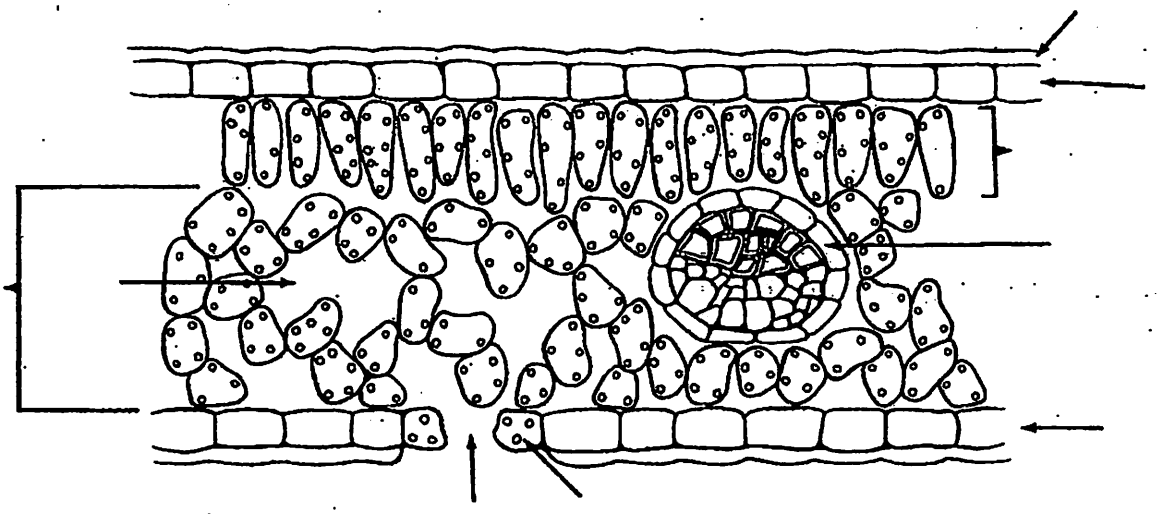
e. lower epidermis: thin, protective single layer of cells along bottom edge of leaf

f. stomata: openings along lower epidermis that allow gas exchange

g. guard cells: cells surrounding the stomata (green) that control stomata opening and closing

h. veins: groups of thick-walled cells forming round tubes within the spongy layer, usually surrounded by a single layer of cells forming a tube which transports needed materials throughout the leaf

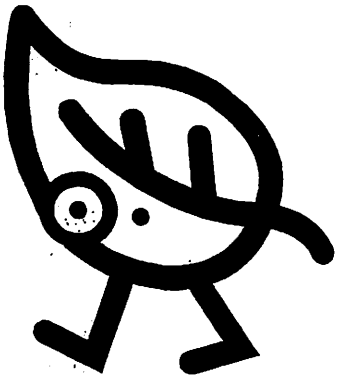
i. air space: large empty spaces within spongy layer



Part B

1. Obtain a prepared slides of a 2 different leaf cross sections.

2. Sketch and label the components of each leaf as they appear under high power. Indicate the total magnification and field of view.



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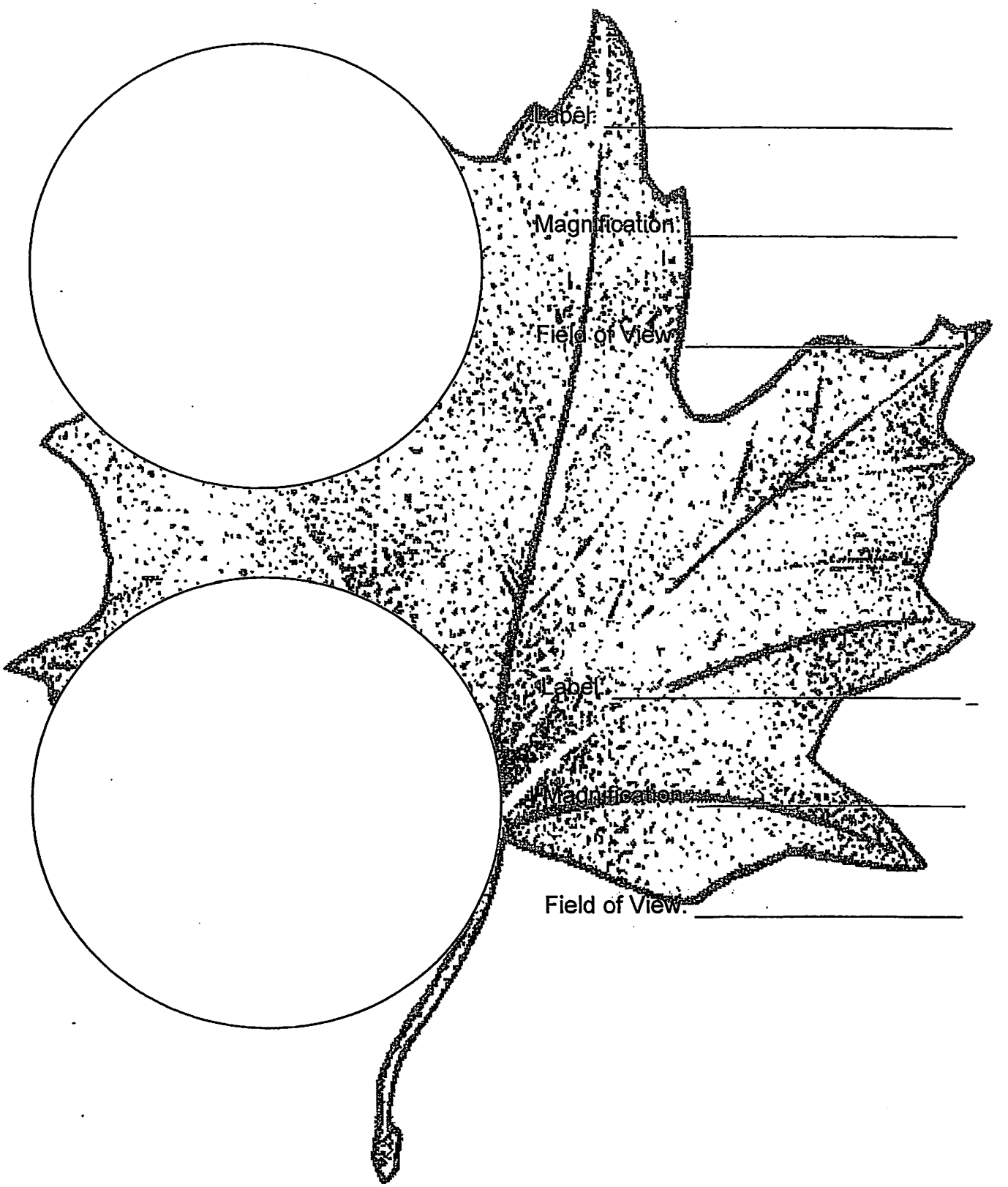


Label: _____

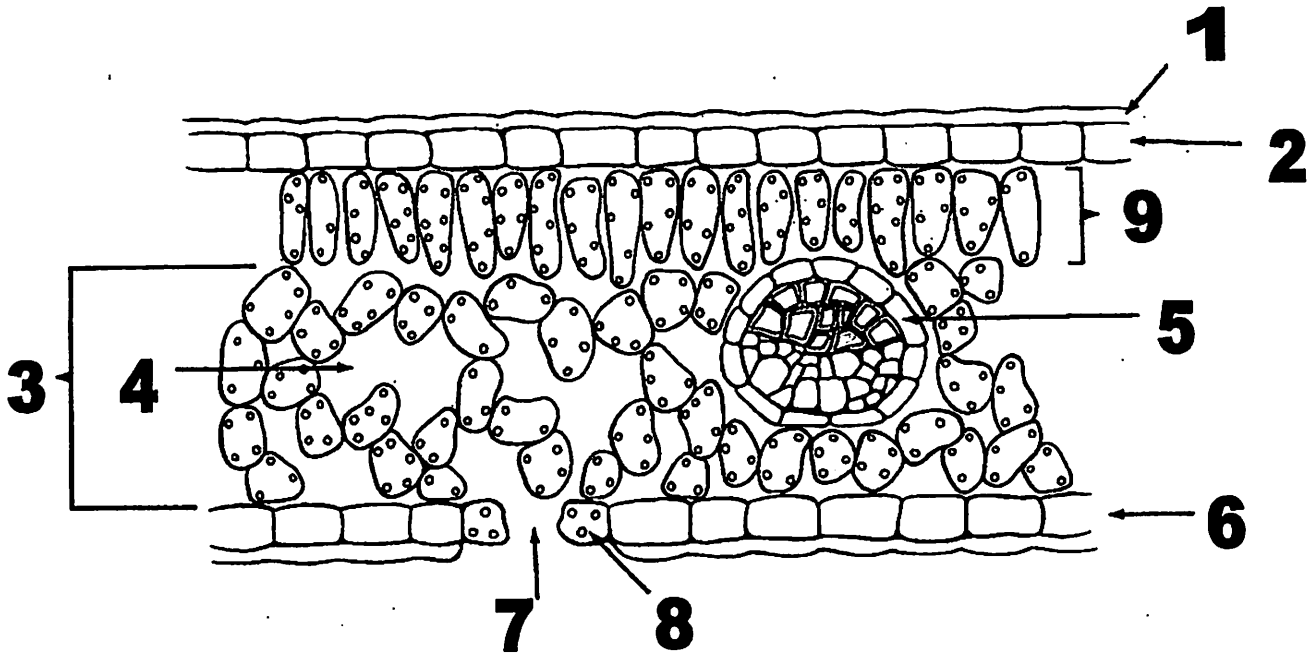
Magnification: _____

Field of View: _____

Label: _____

Magnification: _____

Field of View: _____



#	Name of Part	Description/ Function
1		
2		
3		
4		
5		
6		
7		
8		
9		

Name: Date:

Living Environment Miller

Observing Stomata

Introduction: Plants and animals both have a layer of tissue called the **epidermal layer**. Plants have special pores called stomata to allow passage of material. The **stomata** pores are surrounded on both sides by jellybean shaped cells called guard cells. Unlike other plant epidermal cells, the guard cells **contain chlorophyll** to do photosynthesis. This allows the cells to expand/ contract to open or close the stomata. Guard cells also close when dehydrated. This keeps water in the plant from escaping. The opening or closing of guard cells can be viewed in a microscope by adding different water concentration to the leaf tissue.
Most stomata are on the **lower epidermis** of the leaves on plants (bottom of the leaf). The number of stomata on the epidermal surface can tell you a lot about a plant. Usually, a high concentration of stomata indicates fast growth and wet climate. Lower concentrations of stomata indicate lower rates of photosynthesis and growth or adaptations for dry weather.

Purpose: To observe stomata from the underside of a plant

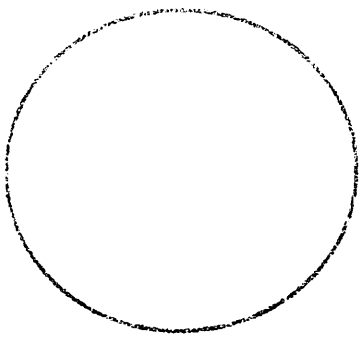
Materials: clear nail polish, tape, microscope slide, microscope

Procedures:

1) Obtain leaf from teacher.
2) Spread a small amount of the clear nail polish on the underside of the leaf and wait for it to dry completely.
3) Once dry, press a piece of tape over the nail polish and gently peel the tape, along with the nail polish off the leaf.
4) If done correctly, the nail polish will remove the epidermal layer of the leaf with the stomata attached.
5) Press the tape onto a microscope slide. Be careful not to smudge the slide with your fingers.
6) Focus the slide on low power and then switch to medium power. Draw the image of what you see in the observations section below.
7) While focused, switch to high power and focus. Draw the image under high power in the observation section below.

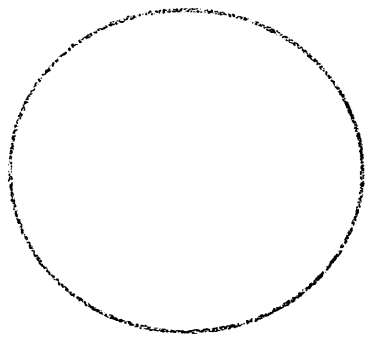
Observations:

Medium Power



Magnification: _____ x

High Power



Magnification: _____ x

Conclusion Questions:

1) Explain, in detail, how guard cells open and close stomata?

2) At what time of day would stomata be closed and why?

3) Why does the lower epidermis have more stomata than the upper epidermis of a leaf?

4) Define transpiration.

5) What two gases move in and out of the leaf stomata?

6) What does a larger number of leaf stomata indicate about the growing climate of that plant?

Name: Date:

Living Environment Period:

Photosynthesis and respiration in freshwater Elodea

Plants can carry out both photosynthesis and respiration simultaneously. During photosynthesis, plants are using the energy of the sun to build molecules which effectively store this energy (glucose). Chemically, the photosynthetic reaction looks like this:

$$6H_2O + 6CO_2 + \text{Light Energy} \longrightarrow C_6H_{12}O_6 + 6O_2$$

During respiration, plants are using this stored energy (glucose), to fuel their metabolic processes. Chemically, the respiratory process looks like this:

$$C_6H_{12}O_6 + \longrightarrow 6O_2 6H_2O + 6CO_2 + \text{Energy}$$

Remember that plants respire all the time. Among other things, the converted energy from respiration is used to synthesize molecules, move materials around within the organism, grow (create new cells) and reproduce. Notice that in **photosynthesis**, CO2 (carbon dioxide) is being used up as it is "fixed" into glucose molecules. During **respiration** the opposite is true. As the plant releases the energy stored in glucose by breaking it down, CO2 is being given off into the surrounding water or atmosphere. The relationship between these two processes is special in that it allows plants to recycle some of their by-products. (While CO2 is being given off during respiration, it can be re-utilized during photosynthesis.)

Purpose:

In this lab, you will try to demonstrate the net change in carbon dioxide when the common fresh water plant *Elodea* is placed under different conditions. You will be using a **chemical indicator, Bromothymol blue (BTB)**, as a means of determining the presence or absence of CO2. This solution changes color when CO2 is introduced. Bromothymol blue changes color due to a change in pH. When CO2 is dissolved in water, it forms carbonic acid. This lowers the pH of the solution and causes the Bromothymol blue to change its appearance.

PROCEDURES:

1) In a graduated cyclinder, measure out 100 mL of bromthymol blue solution. Caution: Goggles should be worn as bromthymol blue solution is toxic.
2) Obtain four test tubes and a wax pencil from your teacher. Number each test tube (1,2,3,4) and also put your initials on each tube.
3) Obtain two sprigs of elodea from your teacher and place a sprig in test tubes 1 and 3.
4) Pour some bromthymol blue into test tubes 1 and 2.
5) Using a drinking straw, create bubbles in the remaining bromthymol blue solution until the solution turns yellow.
6) Pour the bromthymol yellow into test tubes 3 and 4.
7) Cover each test tube using parafilm.
8) Wrap test tubes 1 and 2 in tin foil so no light may hit the plant inside.
9) Place test tubes 3 and 4 in the light box.

DATA:

Test Tube #	Elodea Present?	CO_2 Present?	Foil Used?	Solution Color Day 1	Solution Color Day Final	Biological Process
1						
2						
3						
4						

DAY 1 QUESTIONS:

1) What was the color of the bromthymol blue solution before you exhaled into it? After you exhaled into it?

_____

_____

2) What substance is released into bromthymol blue solution when you exhale into it? How is this substance produced?

_____

_____

_____

3) Why did the bromthymol blue solution change color when you exhale into it? (Be specific)

4) Which test tubes are used as controls in this experiment? Why do we use a control?

DAY 2 QUESTIONS

5) What was the color of the bromthymol blue solution in the test tube 1? Why do you think you are seeing these results?

6) What was the color of bromthymol blue solution in test tube 3? Why do you think you are seeing these results?

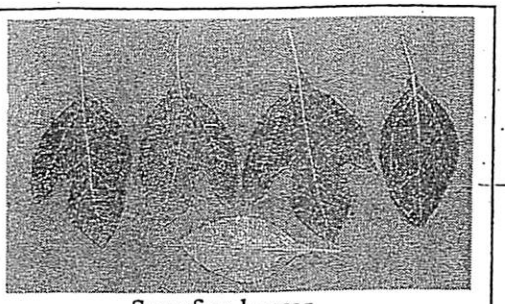
7) How are photosynthesis and respiration related?

8) How would the results of this experiment be different if a green light bulb were used instead of a white light bulb?

9) How would determine that Elodea carries out photosynthesis at a faster rate than it carries out respiration?

Name: _____ Date: _____
Living Environment

Using Cell Respiration to Make Root Beer:


Sassafras leaves

Brief History of Root Beer: Root beer was made in the past by soaking Sassafras (a type of tree) root in water, and adding sugar and yeast (yeast for carbonation). In the early 1900's however, scientists discovered that safrole, a chemical found in Sassafras root, was a carcinogen (which means it is a cancer causing agent.) Now, a mixture of other herbs and spices makes up "root beer extract" which is what we will use to make homemade root beer.

In this laboratory you will be demonstrating the action of yeast on a mixture of sugar, water and flavorings through both aerobic and anaerobic respiration. Yeast are microbes that will break down sugar into water and carbon dioxide: it is the carbon dioxide that causes the root beer to become carbonated. Eventually, all of the oxygen becomes depleted and the yeast start performing anaerobic respiration.

There are two types of respiration: aerobic (requiring oxygen) and anaerobic (without oxygen.)Yeast cells (a type of fungus) obtain energy from glucose (sugar) by a specific anaerobic process called fermentation. Anaerobic respiration, or fermentation, has been used by mankind for thousands of years for raising bread, fermenting wine and brewing beer. The products of the fermentation of sugar by baker's yeast *Saccharomyces cerevisiae* (a fungus) are ethyl alcohol and carbon dioxide. Carbon dioxide causes bread to rise and gives effervescent drinks their bubbles. This action of yeast on sugar is used to 'carbonate' beverages, as in the addition of bubbles to champagne.

Materials:

Clean, empty, 2 liter plastic bottles + caps
Large Bowl, funnel, mixing spoon
Water (preferably spring water)
Bakers yeast
Root beer extract
Sugar, Measuring spoons and cups

Procedure:

1. In a Styrofoam cup, dissolve 1/8 teaspoon of yeast in ½ cup of very warm water. Let stand for 5 minutes. Being in warm water activates the yeasts, and "wakes them up" from being dried out. Spring water makes better root beer than tap water.

2. Using a funnel, place 200 grams of sugar into your 2L bottle. Add 10ml of root beer extract to the bottle and add enough warm water to the bottle to dissolve the sugar.

3. Add the yeast mixtures to the bottle and add warm water to bring the level of the liquid up to two liters. (Be sure to use very warm water).

4. Fill the bottles with warm water to within 1 ½ to 2 inches to the top. Close tightly and hold upside down to check for leaks. Make a label out of plain white paper, and put your names on it. Tape the label to the bottle.

5. Age root beer for 3 or 4 days in a warm, dark place. Then store in a cool, dark place for 2 more days. Refrigeration will stop the fermentation process and kill the yeast. Total aging of at least one week is recommended. Two weeks will improve the flavor. Be sure to check the bottles every day for tightness, if they get too pressurized, they will explode. Never use glass bottles!

Questions:.

1. Describe the appearance of the root beer during the bottling process.

2. What is fermentation?

3. Why were the yeast necessary in this experiment?

4. Why was the sugar necessary?

5. What is safrole? Why do we not use it anymore?

6. Why did we put the yeasts in the warm water for 5 minutes?.

7. Soda and other carbonated beverages are very bubbly. What is the gas that makes up those bubbles?

8. Explain how the root beer will become carbonated.

Name: Date:
Living Environment Period:

Anaerobic Cellular Respiration – Alcohol Fermentation in Yeast Demonstration

Cellular respiration is a life process that all living organisms must accomplish. It is the process in which organisms transfer the energy in the chemical bonds of sugar to the bonds of the energy molecule ATP. Respiration can occur both with and without oxygen present. When oxygen is present, it is called **aerobic respiration.** When it occurs without oxygen present, it is called **anaerobic respiration.**

If you recall, yeast are organisms that will only complete anaerobic respiration. In this demonstration we will be looking at how yeast break glucose down and the products they form as a result of this process. The equation for anaerobic respiration is below:

Glucose ⟶ ethyl alcohol + carbon dioxide + 2 ATP

Materials:

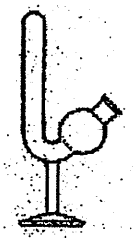
- 4 fermentation tubes
- Bakers yeast
- Glucose solution
- Equal artificial sweetener
- Splenda artificial sweetener
- Luke warm water (preferably around 88°-90° F)
- Parafilm or rubber stoppers

The fermentation tubes will be setup the following way:

Tube 1

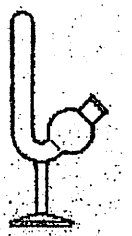
Yeast, warm water

Tube 2



Yeast, glucose solution, warm water

Tube 3



Yeast, Equal, warm water

Tube 4

Yeast, Splenda, warm water

Pre- Questions:

1) On the pictures above, shade in where the liquid is located in the tubes.

2) Which fermentation tube do you think there will be a change in? Why?

_____

_____

_____

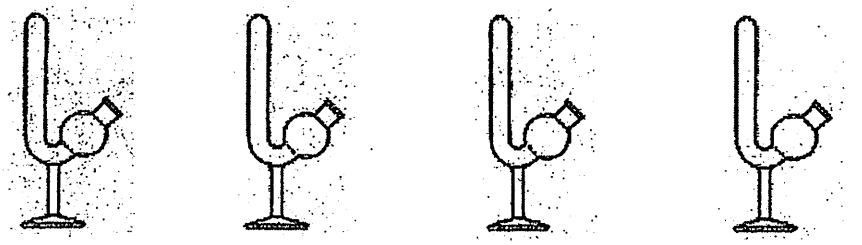
3) Do you think are yeast living things? _____

4) Which of the fermentation tubes is the control? Why do we use a control in this demonstration?

Post- Questions:

5) Which of the fermentation tubes experienced a change? _____
6) Shade in where the liquid is in the fermentation tubes now:

Tube 1 Tube 2 Tube 3 Tube 4



7) Look back at the equation for anaerobic respiration at the beginning. What gas is present in the tube that changed? _____

8) What substance would be found in the tubes if they were left in the same condition over a long weekend? How is this related to the way that beer is brewed all over the world?

9) How do we know for sure now that yeast are living things?

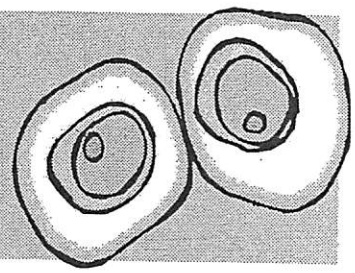
10) Briefly describe what happened inside each of the fermentation tubes.

Name _____ Period _____ Date _____

Laboratory Activity #5 — Student Laboratory Packet

Diffusion Through a Membrane

A Laboratory Activity for the Living Environment



Part 1—Diffusion Through a Membrane

Molecules are constantly moving. They move in straight lines unless they are deflected by other molecules or obstacles in their environment. *Diffusion* is the process by which the collisions between molecules cause them to continually spread apart from each other. Their overall movement can therefore be described as movement from an area of greater concentration to an area of lower concentration. Diffusion continues until the molecules are equally distributed, that is, their concentration is equal throughout the area that contains them. At this point, the molecules continue to move and collide, but their concentration remains the same throughout the area of containment.

When certain molecules encounter artificial membranes with pores, they may be able to pass through. If the molecules are small enough to pass through the pores, their movements eventually will cause the concentration of these molecules inside and outside of the membrane to equalize.

Living cells are surrounded by a membrane that acts as a selective barrier between the contents of the cell and its environment. The membrane is selectively permeable; it allows some molecules and other particles to enter and exit while blocking others. Even small molecules that could ordinarily pass through may be blocked. The permeability of the membrane can change depending on changes in the internal or external environment of the cell.

As a part of this activity, you will build a model cell using an artificial membrane. Remember that this membrane is only a model. Unlike a cell membrane, it will always have the same permeability to dissolved substances. Small molecules and water will be able to pass through easily while larger molecules will not.

Objectives

By the end of this activity, you should be able to:

- demonstrate how to test for simple sugars and starch using chemical indicators
- explain diffusion through a membrane
- describe the permeability of a model membrane for glucose, starch, and Starch Indicator Solution

Important Note: Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. You will also need to transfer your answers to a separate Student Answer Packet, which your teacher will use in grading your work. The school will retain that packet as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.

Materials

- dialysis tubing or plastic bags
- string or unwaxed dental floss
- Glucose Indicator Solution
- test tube rack
- concentrated glucose solution
- funnel
- tap water
- 7 test tubes
- starch solution
- paper towels
- droppers or pipettes
- safety goggles (1 pair per student)
- Starch Indicator Solution
- 250 mL beaker
- hot water bath (for class or several groups)
- test tube holder

Safety

- Avoid all direct contact with laboratory chemicals. The Glucose Indicator Solution is corrosive, and the Starch Indicator Solution will stain.
- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Be careful when using the hot water bath to avoid burns.
- Wear goggles whenever someone in your laboratory is using glassware or chemicals.

Procedures: *Make a "Cell"*

The directions below are for making a "cell" with dialysis tubing. If you are using plastic bags, follow the directions your teacher provides.

1. Take a 20 cm length of dialysis tubing and soak it in warm tap water for a few minutes. You should then be able to pull the ends apart gently, forming it into a tube. Rubbing the ends of the tubing between your fingers under water is sometimes helpful when attempting to open the tube.
2. Seal one end of the tube by folding the end over and tying it closed with a piece of string or dental floss. The goal is to make that end completely leak-proof.
3. Pour glucose solution into the tube until it is about 1/4 full. Next, add enough starch solution to fill the tube about halfway. You can use a funnel to make this easier.
4. Tie off the top of the tube in the same way you tied off the bottom. The tube should not leak from either end. Gently mix the contents of the tube by turning it upside down and back again. Check for leaks.
5. Rinse off the "cell" you've just made by holding it under running water.
6. Place the "cell" in a beaker and add water until the "cell" is just covered.
7. Add Starch Indicator Solution (containing iodine) to the water in the beaker. Add enough to make the water an amber color.
8. Label the "Initial State" part of the diagram found on page 4. Indicate the contents and color of the beaker and cell.
9. Based on your knowledge of diffusion, predict what will happen to the substances inside and outside of the "cell." Record your prediction here:

   _____

   _____

   _____

10. Set the beaker aside while performing the chemical tests described in the next section of this investigation. Leave it undisturbed for at least 20 minutes.

Chemical Testing

Table One — Chemical Test Procedures

When Testing a Sample with	Follow This Procedure:
Starch Indicator Solution	• place 10 drops of the substance to be tested in a clean test tube • add 10 drops of Starch Indicator Solution • carefully mix the contents of the tube • observe any color change • record results
Glucose Indicator Solution	• place 10 drops of the substance to be tested in a clean test tube • add 10 drops of Glucose Indicator Solution • heat in a hot water bath for 2 minutes • observe any color change • record results

Procedure

- Obtain 6 clean test tubes and use them when testing samples of distilled water, starch, and glucose with each of the two indicator solutions. Follow the procedures described in Table One.
- Record your results in Table Two below. Enter the color observed in the test tube after each test is completed.

Table Two — Chemical Test Results

Indicator Solution Used	Material Tested		
	Distilled Water	Starch	Glucose
Blue-colored Glucose Indicator Solution			
Amber-colored Starch Indicator Solution			

What test would you need to perform to prove that it is the *combination* of glucose and the Glucose Indicator Solution that changes color when heated and not just the glucose or the Glucose Indicator Solution alone? Support your answer with an explanation.

Model Cell Observations

- Carefully examine the "cell" and beaker you put aside earlier.
- Record any changes, including color changes, you observe in the "cell" and in the beaker.

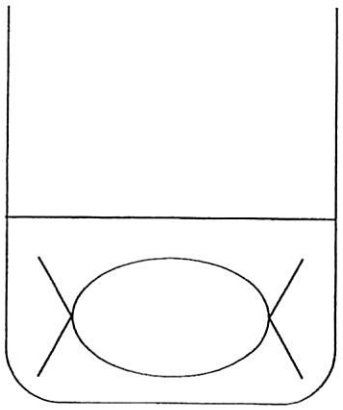
_____

_____

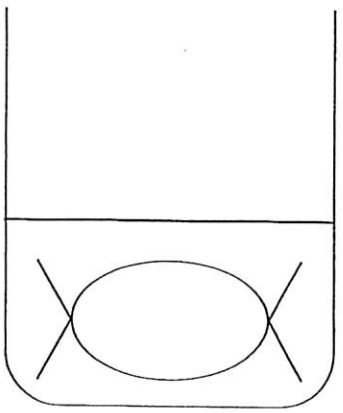
_____

- Use a pipette to transfer 10 drops of the solution in the beaker (outside the "cell") to a clean test tube. Test it with Glucose Indicator Solution. Did a color change occur? _____ Is this test result positive or negative? _____

- Label the contents and note the colors present in both the beaker and the cell of the "Final State" diagram below.



Initial State



Final State

- Clean up according to the directions given by your teacher.

Questions:

1. What is the best explanation for the color change that occurred inside the "cell"?

_____

_____

_____

2. Did any starch diffuse out of the "cell"? _____ Explain how you can tell.

_____

_____

_____

3. Did any glucose diffuse out of the "cell"? _____ Explain how you can tell.

_____

_____

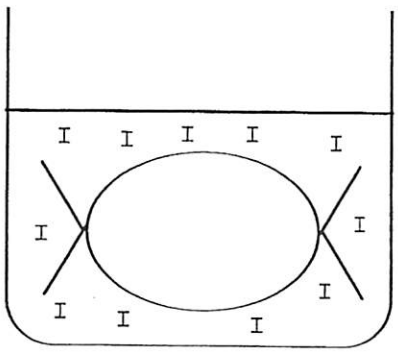
_____

4. Which substance(s) diffused through the membrane?

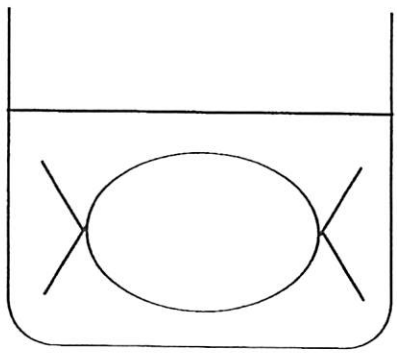
5. Which substance(s) did not diffuse through the membrane?

6. Explain why some substances were able to pass through the membrane while others were not able to.

7. In the "Initial State" diagram below, Starch Indicator Solution is indicated with the letter "I" because it contains iodine. Using the letters "S" for starch and "G" for glucose, indicate the areas where each of these molecules are located in both diagrams. Be sure you indicate the location of iodine molecules in the "Final State" diagram too.



Initial State



Final State

Part 2—Diffusion of Water Across a Membrane (Osmosis)

Osmosis is a special type of diffusion. Specifically, it is the diffusion of water across a membrane. Osmosis is a very important process because it enables cells to maintain the proper water balance. Generally water will diffuse across a membrane, resulting in equal concentrations of water on both sides. If the cytoplasm of a cell is 95% water, the remaining 5% is dissolved materials (solute). If the liquid that surrounds the cell has the same concentration of water as the cytoplasm, no net diffusion occurs in either direction. In other words, equal numbers of water molecules move into and out of the cell. If the liquid outside the cell has a higher concentration of water (less solute) than the cytoplasm, water will diffuse into the cell. If the liquid outside the cell has a lower concentration of water (more solute) than the cytoplasm, water will diffuse out of the cell. In this activity, you will place living cells in different solutions and observe the results.

Objectives

By the end of this activity, you should be able to:

- predict what would happen if cells are placed in solutions having different concentrations
- explain how the diffusion of water plays a role in several real-world situations
- prepare wet-mount slides and use appropriate staining techniques
- make observations of biological processes

Materials

- red onion
- cover slips
- water
- dropper/pipette
- glass microscope slides
- distilled water
- colored pencils (red)
- salt solution
- if the salt solution is not provided:
  - triple-beam or electronic balance
  - 10 mL graduated cylinder
  - salt
  - beaker

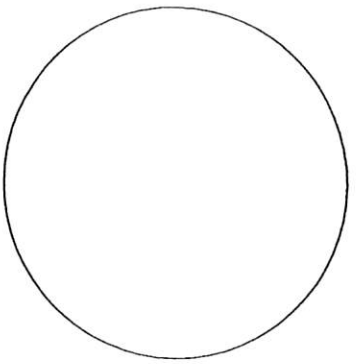
Safety

- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Handle slides and cover slips with care.

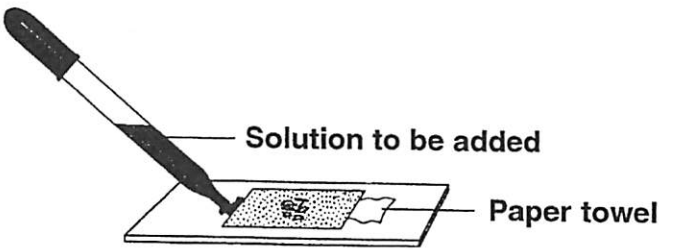
Procedures

1. If the salt solution is not provided by your teacher, use a balance to measure 1 gram of salt. Measure 10 mL of distilled water with a graduated cylinder. Add both the salt and the water to a 250 mL beaker and mix. This will be your prepared salt solution.
2. Your teacher will provide a small, curved section of an onion for you to use. Break the section in the middle and gently peel off the reddish outer membrane.
3. Position the membrane in a drop of water on a slide. Be careful not to allow the membrane to fold over on itself.
4. Add a cover slip and observe the cells using the low power of a microscope. Choose the magnification that will allow you to see individual cells and their contents. If you do not see any cells with red coloration, search on the slide for cells that do have it. You may need to make another slide.
5. Have your teacher observe your slide with the microscope to be sure you have a good preparation.

6. Based on your observations, draw and color a typical red onion cell mounted in water. Label the cell wall, cell membrane, and cytoplasm.



7. Next, without disturbing the slide, add salt solution. You can do this by placing a small piece of paper towel against one edge of the cover slip and adding several drops of the salt solution to the other side. (See diagram below.) The paper towel will soak up the liquid already on the slide and draw the salt solution through. Remove the paper towel before it soaks up too much liquid and dries out the slide.



8. Observe the cells for several minutes. You should see a change in the cells from your previous observation. If not, add more salt solution. Describe the changes you observed in the red onion cells.

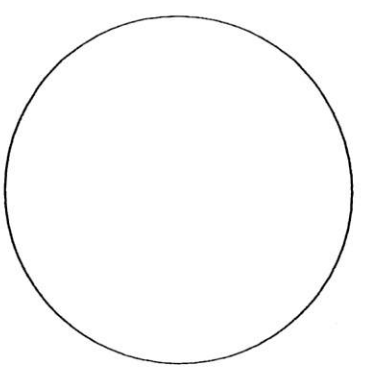
_____

_____

_____

9. Have your teacher check your slide with the microscope to be sure you are able to observe the effects of salt on cells.

10. Based on your observations, draw and color a typical red onion cell mounted in salt solution. Label the cell wall, cell membrane, and cytoplasm.



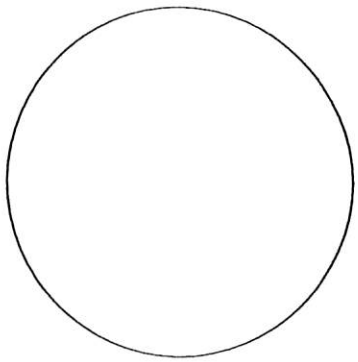
11. Describe what happens to the water content of the red onion cells when they are placed in a salt solution.

12. Replace the salt solution with distilled water. Use the same technique you used in Step 7, but use distilled water instead of salt solution. It may require 20 or more drops to wash all the salt away.

13. Observe the cells for several minutes. Describe the changes that occurred in the red onion cells.

14. Have your teacher check your slide with the microscope to be sure the effects of distilled water are visible.

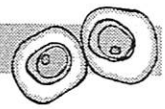
15. Based on your observations, draw and color a typical red onion cell mounted in distilled water.



Analysis Questions

1. During Part 1 of this laboratory activity, one group of students followed the directions incorrectly. They poured the Starch Indicator Solution into the "cell" and filled the beaker with starch and glucose solution. State how their results would differ from those obtained by students in their class who followed the directions correctly.

2. Some state roads are salted heavily in the winter, creating an environmental problem. Based on observations you made in this laboratory activity, explain how organisms could be harmed by high levels of salt from roadways.



3. When a person in the hospital is given fluid intravenously (an I.V.), the fluid is typically a saline (salt) solution with about the same water concentration as human body tissues. Explain how the use of distilled water in place of this saline solution would be expected to upset the patient's homeostasis. Your answer should refer to the process of diffusion.

4. Many fresh-water one-celled organisms have structures called *contractile vacuoles*. These structures collect and pump out excess water that accumulates in the cell. Name the process that causes water to flow into these organisms. _____ Explain why contractile vacuoles would be of little value to one-celled organisms living in the ocean (salt water).

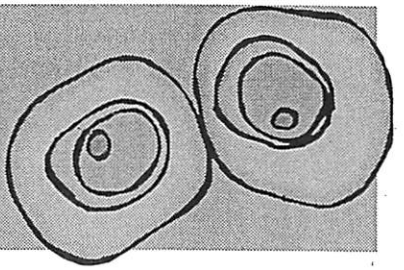
5. Popcorn sold at most movie theaters is very salty, causing people to become thirsty and buy soft drinks. Describe in scientific terms why the salty popcorn causes this thirst. You should mention changes in specific body cells in your answer.

6. In many animals, glucose, rather than starch, is transported by the blood through the body to all the cells. Starches in many foods are digested to yield glucose. Based on what you learned in this laboratory activity, explain why the digestion of starch to glucose is necessary.

Laboratory Activity #5 — Teacher's Guide

Diffusion Through a Membrane

A Laboratory Activity for the Living Environment



ABSTRACT

This activity is designed to help students learn about the process of diffusion. In Part 1, students will build a model "cell" using dialysis tubing or a plastic bag and use simple chemical tests to investigate the selective permeability of the membrane. In Part 2, students will add salt and distilled water to red onion cells and observe the effects.

TEACHER INFORMATION

Instructional Use

This laboratory exercise can be used during a study of cell processes or when homeostasis is discussed. Scheduling this activity to coincide with the study of diffusion as it relates to nutrition (Standard 4, 1.2h) would also be appropriate.

Time Requirements

Parts 1 and 2 each require about 40 minutes. The two parts can be completed during a double period or on separate days. Students are expected to answer the analysis questions for homework.

Safety

Any chemicals students work with in science laboratory activities are potentially harmful. Students should be reminded to avoid direct contact with the chemicals used in this laboratory activity. The Benedict's Solution used in this laboratory activity is corrosive, and the iodine will stain. As with all science activities, tell students not to eat or drink in the laboratory. They should wear goggles whenever chemicals and glassware are used in the laboratory. They should wear protective gloves when they use the Glucose Testing Solution (Benedict's Solution). To avoid burns, caution them to use care with the hot water bath. Instruct them to wash their hands and clean their work area when the laboratory is completed.

Preparation

Students do not need any knowledge of diffusion before this laboratory activity. However, this activity does require that students have a working knowledge of basic microscope techniques, cells, cell membranes, and cell walls. The activity can be done by individual students or in groups of 2, 3, or 4, depending on the classroom situation.

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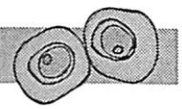


Materials for Parts 1 and 2

Dialysis tubing or plastic bags	Each group of students will need 20 cm of tubing or one plastic bag. Inexpensive plastic sandwich bags are an acceptable substitute for dialysis tubing. More expensive plastic bags typically do not work as well.
String or unwaxed dental floss	Provide enough to tie the tubing or bags closed.
Concentrated glucose solution	"Dextrose" and "corn sugar" are equivalent. Each group of students will need about 25 mL. An easy way to make this solution is to mix corn syrup (Karo® brand or equivalent) with water, 2:1.
Starch solution	Prepare by mixing corn or potato starch in cold water and then adding the mixture to boiling water. This solution can be stored for several weeks.
Starch Indicator Solution	Prepare a Lugol's Solution* and pour it into a container. Label it as "Starch Indicator Solution." Properly mixed, it will look like tea (a medium amber color). Exact proportions are not essential.
Glucose Indicator Solution	Pour Benedict's Solution into containers and label them as "Glucose Indicator Solution." Also label them as "Corrosive: Handle with Care!"
250 mL beakers (1 per team)	Plastic cups or 150 mL beakers may be substituted.
Test tubes (7 per team)	These will be used for the glucose and starch tests.
Hot water bath	Very hot water in an insulated container may be substituted.
Funnel	This may aid students when they add solutions to their "cells" in Part 1.
Dropper or pipette	Provide 10 per team to avoid cross contamination.
Safety goggles and protective gloves	Provide one pair of each for each student.
Red onion section**	Give each student a section of a red onion that has an outside that is clearly colored red.
Salt (NaCl), water, graduated cylinder, triple-beam or electronic balance***	These are to make a 10% salt solution that is used to *plasmolyze* the onion cells. If laboratory time is limited, make up the salt solution ahead of time and provide it to the teams.
Distilled water	Dispense in small beakers or dropping bottles.
Test tube holders & test tube racks	Provide one of each per team.
Student Laboratory Packet and Student Answer Packet	Provide one for each student. Masters are provided at the end of this guide for you to duplicate as needed.

* Lugol's Solution is prepared by mixing 10g of potassium iodide (KI) with 100 mL of water and 5g of iodine crystals. Pour off the liquid so that unused iodine crystals are not in the Starch Indicator Solution.

** Slice onions, then cut each ring to make four curved sections. Keep these in a closed container until used to prevent them from drying out. Only distribute pieces that have red coloring on the outer edge. This will make it more likely that students will observe many cells containing red pigment.

*** These items are necessary only if the students prepare the salt solution.

Part 1—Diffusion Through a Membrane

1. It is helpful to have the dialysis tubing and string pre-cut and to demonstrate to students how to make the "cell."
2. Have students test the water outside of the "cell" at the beginning, to be sure glucose is not already present.
3. Make sure students leave the setup running long enough for detectable levels of glucose to be present in the water around the "cell." Using warm water will speed the rate of diffusion.

Part 2—Diffusion of Water Across a Membrane (Osmosis)

1. Students can make the 10% salt solution instead of having it provided. This will allow them to become more skilled with the use of the balance and graduated cylinder. If this is not feasible, provide the salt solution.
2. Demonstrate to students how to make the slide to observe red onion cells:
   - Cut the onion as described in the Materials section (page 2).
   - Bend a piece of onion until it snaps, then gently peel off the reddish outer membrane.
   - Place the membrane in a drop of water on a slide, being careful to keep the membrane from folding over on itself. Trapping some air bubbles is nearly unavoidable in this process.
   - Add a cover slip. The slide is now ready to observe with the microscope.
3. View each student-prepared slide (once the slide is on the microscope stage and in focus) to be sure that students are not looking at air bubbles and mistaking the bubbles for onion cells. The students should ask you to check their slides at Steps 5, 9, and 14. (Refer to the Student Laboratory Packet for more information.)

Correlation of This Investigation to the *Living Environment Core Curriculum* and the *Mathematics, Science, and Technology Learning Standards*

Learning Standard 1

S1.1a Scientific explanations are built by combining evidence that can be observed with what people already know about the world.

Learning Standard 4

1.2g Each cell is covered by a membrane that performs a number of important functions for the cell. These include: separation from its outside environment, controlling which molecules enter and leave the cell, and recognition of chemical signals. The processes of diffusion and active transport are important in the movement of materials in and out of cells.

1.2h Many organic and inorganic substances dissolved in cells allow necessary chemical reactions to take place in order to maintain life. Large organic food molecules such as proteins and starches must initially be broken down (digested to amino acids and simple sugars respectively) in order to enter cells. Once nutrients enter a cell, the cell will use them as building blocks in the

synthesis of compounds necessary for life.

Learning Standard 4 Process Skills Addressed

i Follows safety rules in the laboratory

ii Selects and uses correct instruments
- Uses graduated cylinders to measure volume
- Uses triple-beam or electronic balance to measure mass

iii Uses a compound microscope/stereoscope effectively to see specimens clearly, using different magnifications
- Identifies and compares parts of a variety of cells
- Compares relative sizes of cells and organelles

vii Follows directions to use and interpret chemical indicators correctly

Testable Skills and Concepts

- knowing that during diffusion particles move from regions of high concentration to regions of low concentration
- knowing at least two examples of how diffusion affects cell contents and/or functioning
- knowing at least two examples of where diffusion occurs in the human body, including what diffuses and what is accomplished by the process
- knowing at least one example of an indicator and how it is used
- being able to explain how molecular concentration and size can affect diffusion through a membrane

Extensions

Many possible extensions to the concepts in this laboratory can enrich the classroom experience. One suggestion is to substitute a sports drink such as Gatorade® or Powerade® for the salt solution in Part 2. Students could be assigned the task of designing a formula for their own sports drink. They should discover, if they understand the concepts of this laboratory, that fluid replacement and nutrient replacement require different concentrations and that finding the perfect formula is very difficult. Another extension could be to test the effects of varying salt concentrations on cells.

Sample Student Answers

Part 1—Diffusion Through a Membrane

Make a "Cell"

9. Based on your knowledge of diffusion, predict what will happen to the substances inside and outside of the "cell." Record your prediction here:

   Students should predict that glucose will move out of the "cell" and may predict that starch will move out too.

Table Two - Chemical Test Results

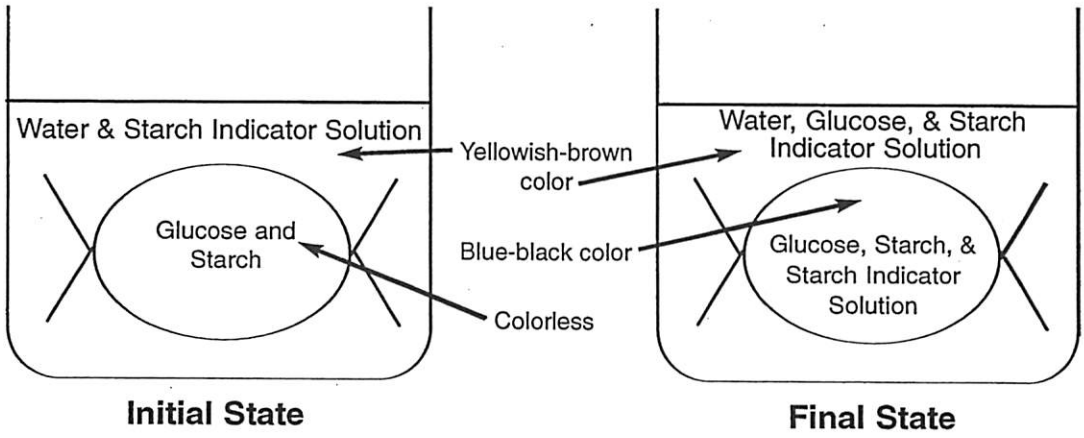
Indicator Solution Used	Material Tested		
	Distilled Water	Starch	Glucose
Blue-colored Glucose Indicator Solution	*blue*	*blue*	*green, brown, red, or orange*
Amber-colored Starch Indicator Solution	*amber*	*blue-black*	*amber*

What test would you need to perform to prove that it is the *combination* of glucose and the Glucose Indicator Solution that changes color when heated and not just the glucose or the Glucose Indicator Solution alone? Support your answer with an explanation.

Students should state that they would need to heat a clean test tube of the Glucose Indicator Solution by itself and another test tube of the glucose by itself. Students should explain that heating the solutions by themselves would prove whether or not either of them change color when heated.

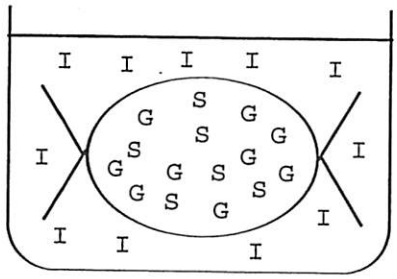
Model Cell Observations

- Record any changes, including color changes, you observe in the "cell" and in the beaker. *Students should observe a change in the color of the "cell" (from colorless or milky white to blue-black).*
- Use a pipette to transfer 10 drops of the solution in the beaker (outside the "cell") to a clean test tube. Test it with Glucose Indicator Solution. Did a color change occur? *yes* Is this test result positive or negative? *positive*
- Label the contents and note the colors present in both the beaker and the cell of the "Final State" diagram below.

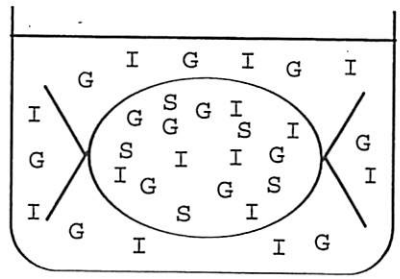


Questions:

1. What is the best explanation for the color change that occurred inside the "cell"?
   Iodine diffuses into the "cell," causing the starch to change colors.
2. Did any starch diffuse out of the "cell"? *No* Explain how you can tell.
   The contents of the beaker (containing Starch Indicator Solution) did not change color.
3. Did any glucose diffuse out of the "cell"? *Yes* Explain how you can tell.
   When the water surrounding the "cell" was tested after 20 minutes, the result was positive.
4. Which substance(s) diffused through the membrane.
   Iodine (Starch Indicator Solution) and glucose. (Students might also mention that water diffused across the membrane.)
5. What substance(s) did not diffuse through the membrane? *Starch*
6. Explain why some substances were able to pass through the membrane while others were not able to.
   The membrane would allow small particles to pass through. Large particles such as starch could not pass through.
7. In the "Initial State" diagram below, Starch Indicator Solution is indicated by the letter "I" because it contains iodine. Using the letters "S" for starch and "G" for glucose, indicate the areas where each of these molecules are located in both diagrams. Be sure you indicate the location of iodine molecules in the "Final State" diagram too.



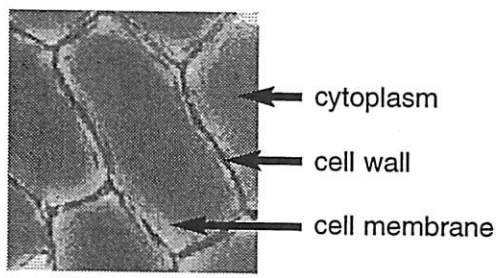
Initial State



Final State

Part 2—Diffusion of Water Across a Membrane (Osmosis)

6. Based on your observations, draw and color a typical red onion cell mounted in water. Label the cell wall, cell membrane, and cytoplasm.
   The cell(s) the students draw should resemble the one shown below.



3. When a person in the hospital is given fluid intravenously (an I.V.), it is typically a saline (salt) solution with about the same water concentration as human body tissues. Explain how the use of distilled water in place of this saline solution would be expected to upset the patient's homeostasis. Your answer should refer to the process of diffusion.

   The process of diffusion would cause water to enter the person's blood cells, causing them to swell. This could lead to the destruction of the blood cells. (Students might also mention damage to other cells).

4. Many fresh-water one-celled organisms have structures called *contractile vacuoles*. These structures collect and pump out excess water that accumulates in the cell. Name the process that causes water to flow into these organisms. *diffusion* Explain why contractile vacuoles would be of little value to one-celled organisms living in the ocean (salt water).

   Diffusion causes excess water to enter the cells of fresh-water organisms. The excess water must be removed. In salt water, the concentration of water outside is either the same as or less than the concentration of water in the cells, so there is no excess water to be removed.

5. Popcorn sold at most movie theaters is very salty, causing people to become thirsty and buy soft drinks. Describe in scientific terms why the salty popcorn causes this thirst. You should mention changes in specific body cells in your answer.

   The salt may cause water to leave the cells of the mouth and throat due to diffusion. This causes a person to be thirsty.

6. In many animals, glucose, rather than starch, is transported by the blood through the body to all the cells. Starches in many foods are digested to yield glucose. Based on what you learned in this laboratory activity, explain why the digestion of starch to glucose is necessary.

   Starch must be digested because its molecules are too large to diffuse across cell membranes. The starch would not be able to diffuse from the intestine into the blood and from the blood into the cells. Glucose is small and soluble, so it is able to diffuse.

Unit 3: Homeostasis and Immunity

Time Frame: 5-6 weeks

Guiding Question: How do organisms constantly monitor and respond to changes in their environment in order to maintain homeostasis?

Overview:

1. Homeostasis
    a. Dynamic Equilibrium
    b. Feedback mechanisms
        i. Negative feedback and examples
        ii. Positive feedback and examples
2. Human Body Systems
    a. Respiratory System
        i. Structures and functions: nasal passage, trachea, bronchi, bronchioles, alveoli
        ii. Gas exchange
        iii. Diseases and disorders
    b. Digestive System
        i. Structures and functions: mouth, esophagus, stomach, small intestine, large intestine, rectum, liver, gall bladder, pancreas
        ii. Digestion of nutrients and absorption
        iii. Diseases and disorders
    c. Circulatory System
        i. Structures and functions: heart, blood vessels, blood
        ii. Transport of materials including; digested food, oxygen, wastes, hormones
        iii. Diseases and disorders
    d. Excretory System
        i. Structures and functions: lungs, kidneys, sweat glands
        ii. Removal of metabolic waste products
        iii. Diseases and disorders
    e. Skeletomuscular System
        i. Structures and functions: skeletal muscle, bone, cartilage, tendons, ligaments
        ii. Body movement
        iii. Diseases and disorders
    f. Nervous System
        i. Structure and function of the neuron
        ii. Message relay center
        iii. Diseases and disorders
    g. Endocrine System
        i. Structure and function of glands; pancreas, ovaries, testes, adrenal, thyroid
        ii. Regulation of body systems
        iii. Diseases and disorders

3. Body systems that work together to maintain homeostasis

4. The Immune System
    a. Non-specific defenses
    b. Specific defense
    c. Anitbody/antigen complex
    d. Types of immunity (passive vs. active)
    e. Diseases and disorders: allergies, immunodeficiency, autoimmune, cancer

NYS- Living Environment Standards:
Key Idea 1: Living things are both similar to and different from each other and from nonliving things.
Performance Indicator 1.2: Describe and explain the structures and functions of the human body at different organizational levels (e.g., organelles, cells, tissues, organs, systems)
1.2a Important levels of organization for structure and function include organelles, cells, tissues, organs, organ systems, and whole organisms.
1.2b Humans are complex organisms. They require multiple systems for digestion, respiration, reproduction, circulation, excretion, movement, coordination, and immunity. The systems interact to perform the life functions.
1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.
1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.
1.2e The organs and systems of the body help to provide all the cells with their basic needs. The cells of the body are of different kinds and are grouped in ways that enhance how they function together.
1.2h Many organic and inorganic substances dissolved in cells allow necessary chemical reactions to take place in order to maintain life. Large organic food molecules such as proteins and starches must initially be broken down (digested to amino acids and simple sugars respectively), in order to enter cells. Once nutrients enter a cell, the cell will use them as building blocks in the synthesis of compounds necessary for life.
1.2j Receptor molecules play an important role in the interactions between cells. Two primary agents of cellular communication are hormones and chemicals produced by nerve cells. If nerve or hormone signals are blocked, cellular communication is disrupted and the organism's stability is affected.

Key Idea 5: Organisms maintain a dynamic equilibrium that sustains life.
Performance Indicator 5.2 Explain disease as a failure of homeostasis.
5.2a Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
5.2b Viruses, bacteria, fungi, and other parasites may infect plants and animals and interfere with normal life functions.
5.2c The immune system protects against antigens associated with pathogenic organisms or foreign substances and some cancer cells.
5.2d Some white blood cells engulf invaders. Others produce antibodies that attack them

or mark them for killing. Some specialized white blood cells will remain, able to fight off subsequent invaders of the same kind.
5.2e Vaccinations use weakened microbes (or parts of them) to stimulate the immune system to react. This reaction prepares the body to fight subsequent invasions by the same microbes.
5.2f Some viral diseases, such as AIDS, damage the immune system, leaving the body unable to deal with multiple infectious agents and cancerous cells.
5.2g Some allergic reactions are caused by the body's immune responses to usually harmless environmental substances. Sometimes the immune system may attack some of the body's own cells or transplanted organs.
5.2h Disease may also be caused by inheritance, toxic substances, poor nutrition, organ malfunction, and some personal behavior. Some effects show up right away; others may not show up for many years.
5.2i Gene mutations in a cell can result in uncontrolled cell division, called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.
5.2j Biological research generates knowledge used to design ways of diagnosing, preventing, treating, controlling, or curing diseases of plants and animals.
Performance Indicator 5.3 Relate processes at the system level to the cellular level in order to explain dynamic equilibrium in multi-celled organisms.

Performance Indicator 5.3: Relate processes at the system level to the cellular level in order to explain dynamic equilibrium in multi-celled organisms.
5.3a Dynamic equilibrium results from detection of and response to stimuli. Organisms detect and respond to change in a variety of ways both at the cellular level and at the organismal level.
5.3b Feedback mechanisms have evolved that maintain homeostasis. Examples include the changes in heart rate or respiratory rate in response to increased activity in muscle cells, the maintenance of blood sugar levels by insulin from the pancreas, and the changes in openings in the leaves of plants by guard cells to regulate water loss and gas exchange

Objectives- Students will be able to:

1. Homeostasis
   - A. Define homeostasis
   - B. Define dynamic equilibrium
   - C. Identify and explain real-life examples of how the human body maintains homeostasis throughout daily activities.
   - D. Predict how each body system contributes to the homeostasis of the organism.
2. Human Body Systems
   - A. Digestive System
     1. Explain how food provides energy
     2. Identify the essential nutrients your body needs.
     3. Describe the organs of the digestive system and explain their functions.
     4. Explain what happens during digestion.
     5. Describe how nutrients are absorbed into the bloodstream.

B. Gas Exchange
    1. Identify the structures of the respiratory system and describe their functions
    2. Describe gas exchange
    3. Describe how breathing is controlled

C. Circulation
    1. Identify the functions of the human circulatory system
    2. Describe the structure of the heart and explain how it pumps blood through the body.
    3. Name three types of blood vessels in the circulatory system
    4. Explain the functions of blood plasma, red blood cells, white blood cells and platelets

D. Excretion
    1. Describe the structures of the excretory system and explain their functions.
    2. Explain how the kidneys clean the blood.
    3. Describe how the kidneys maintain homeostasis.

E. Skeletomuscular system
    1. List the structures of the skeletal system
    2. Describe the mechanism of muscle contraction
    3. Describe the interaction of muscles, bones, and tendons to produce movement.

F. Nervous System
    1. Identify the functions of the nervous system.
    2. Describe the function of neurons.
    3. Describe how a nerve impulse is transmitted.
    4. Discuss the functions of the brain and spinal cord

G. Endocrine System
    1. Describe the structures and function of the endocrine system
    2. Explain how hormones work
    3. Identify the functions of the major endocrine glands
    4. Use an example from the body to describe how negative feedback works

3. Explain disease as a failure of homeostasis and give examples of diseases that affect each body system

4. Explain how the human body systems work together to maintain homeostasis

5. Human Immune System

A. Types of Immunity
    1. Describe the body's nonspecific defenses against invading pathogens
    2. Describe the function of the immune system's specific defenses
    3. Distinguish between active and passive immunity

B. Allergies, Antibodies, Vaccines, and Autoimmune Disease
    1. Describe how public health measures and medications fight disease
    2. Explain what happens when the immune system overreacts to harmless pathogens
    3. Describe how HIV is transmitted and how it affects the immune system

Suggested Activities:

- **New York State Lab: Making Connections**
- The Digestive System Structures and Functions (cut and paste)
- H.I.V. Transmission
- Antigen-Antibody Activity (cut and paste)
- Reaction Time
- Body System Research (Homework Assignment)

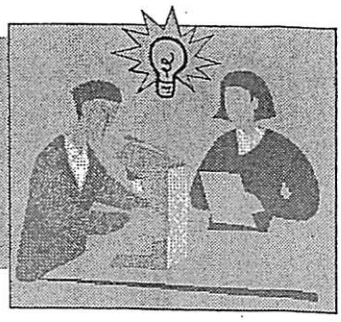
Key Vocabulary:

Accessory Organs	Disease	Dynamic Equilibrium
Feedback Mechanism	Homeostasis	Organelle
Cell	Tissue	Organ
Organ System	Organism	Circulation
Artery	Vein	Capillary
Blood	Plasma	Platelet
Red blood cell	White blood cell	Digestion
Ingestion	Mouth	Salivary gland
Amylase	Esophagus	Peristalsis
Stomach	Pepsin	Ulcer
Small intestine	Liver	Bile
Gall Bladder	Emulsify	Lipase
Protease	Large Intestine	Colon
Excretion	Kidney	Urine
Urea	Uric Acid	Ureters
Urinary Bladder	Urethra	Endocrine
Hormone	Receptor molecule	Pancreas
Insulin	Glucagon	Gland
Respiration	Trachea	Bronchi
Bronchioles	Alveoli	Diffusion
Diaphragm	Neuron	Axon
Dendrite	Synapse	Neurotransmitter
Secretion	Reabsorption	Bone
Cartilage	Tendon	Ligament
Skeletal Muscle	Cardiac Muscle	Smooth Muscle
Active Immunity	Passive Immunity	AIDS
Autoimmune	Allergy	Antibiotics
Antibodies	Antigen	Pathogen
Bacteria	Virus	Vaccine

Laboratory Activity #2 — Teacher's Guide

Making Connections

A Laboratory Activity for the Living Environment



ABSTRACT

"Making Connections" is a laboratory activity with two parts. Part A introduces students (working in pairs) to two simple techniques: taking a person's pulse and squeezing a clothespin to measure muscle fatigue. Once the students have mastered the two techniques and have collected relevant data, they proceed to Part B, which describes a situation in which conflicting claims are made. (The situation relates to the techniques learned in Part A of the activity.)

In Part B, the students evaluate the conflicting claims by designing and performing a controlled experiment. They will then report their results in written form. In addition, some students will make an oral presentation of their results to the class for peer review. Educationally, Part B is actually the more important part of the activity, because students learn how to design and use a controlled experiment as a means of evaluating claims that may not be supported by scientific evidence.

TEACHER INFORMATION

Instructional Use

Since the investigation involves aspects of human physiology, this laboratory activity may be scheduled in association with that topic. The content knowledge required is minimal; the activity could easily be used as an introduction to the topic or even at the beginning of the school year when introducing the concept of experimental design.

The purpose of Part A is to introduce two simple techniques that students will need for Part B, where students will design and carry out a controlled experiment. Part B should be the primary focus of "Making Connections."

Time Requirements

This entire activity requires approximately four 40-minute periods, which can be spread over several days. Part A requires one 40-minute period. The Part A questions should be assigned for homework.

Part B may be started the same day that students finish Part A or on another day. After students design their experiment for Part B (which they could start in class and finish for homework), they will need about two periods of laboratory time to complete it.

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Safety

- Tell students ahead of time to speak with you privately if they have any health problems that would make the exercise activities inadvisable. In such cases, pair these students with others who can do the exercise components; both can record the same data. Check student health reports at the start of the year to be aware of possible disabilities that students may be reluctant to disclose. Pay special attention to students who have asthma or are currently excused from physical education class.
- Be prepared to intervene if students begin using the clothespins inappropriately.

Materials Needed

- 1 or more clocks, stopwatches, or other timing devices for students to measure 20-second and 1-minute intervals
- 1 spring clothespin per student
- 1 Student Laboratory Packet and 1 Student Answer Packet for each student. A Student Answer Packet is provided at the end of this booklet to duplicate as needed.
- A large chart or several overhead transparencies where students can record their results. Students will need the data for the entire class from the pulse rate activity.

Preparation

- See safety notes above regarding prior notification of students about the nature of the activities required for this laboratory investigation.
- Provide each student with one spring clothespin and a Student Laboratory Packet.

Procedure

- Because the primary emphasis in this laboratory activity is on designing and carrying out a controlled experiment, grading of Part B should be weighted more heavily than Part A.
- Classmates can cooperate so that each team has "subjects" from other teams to test, or arrangements can be made for other subjects, such as students in a physical education class. *Note: At some point, discuss with students the number of test subjects that would be ideal* vs. *what is practical for this experiment.*
- Students are often reluctant to participate in physical exercise in a classroom situation. Allowing students to dance vigorously may be an acceptable alternative.
- Help students with the design of their experiment as needed. The critical factor is to determine how exercise affects each person's ability to squeeze the clothespin. A successful experiment should show that an *individual's* results are better after exercise than before. This is due to the increased circulation produced by the exercise. The increased circulation helps remove the lactic acid in the muscle tissues that can cause fatigue.

- After students have prepared their laboratory reports (assigned as homework), allow one period to enable some groups to present their findings to the class. The presentation part is important in fulfilling the Math, Science, and Technology requirements of Learning Standard 2, Key Idea 1.
- Check to be sure that students have completed both the Student Laboratory Packet and the Student Answer Packet. Collect the Student Answer Packets and the *Part B laboratory report* for grading and to keep as evidence of laboratory work for fulfilling the laboratory requirement. To review for Part D of the Living Environment Regents Examination, students must have access to their completed laboratory packet and *a copy of their Part B laboratory report.*

Correlation of This Investigation to the *Living Environment Core Curriculum* and Mathematics, Science, and Technology Learning Standards

Learning Standard 1 Process Skills Addressed

S1.1a combine evidence that can be observed with what people already know about the world

S1.3a accept scientific explanations only when they
- are consistent with experimental and observational evidence
- can be used to make accurate predictions

S2.3b use hypotheses for determining what data to collect and as a guide for interpreting the data

S2.3c develop a research plan for testing a hypothesis that avoids bias (*e.g.*, repeated trials, large sample size, and objective data-collection techniques)

S2.4 carry out a research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations, as necessary

S3.1 use various methods of representing and organizing observations (*e.g.*, diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data

S3.3 assess correspondence between the predicted result contained in the hypothesis and the actual result and reach a conclusion as to whether the explanation on which the prediction was based is supported

S3.4b question claims if the data are based on samples that are very small, biased, or inadequately controlled or if the conclusions are based on the faulty, incomplete, or misleading use of numbers

S3.4c question claims if fact and opinion are intermingled, if adequate evidence is not cited, or if the conclusions do not follow logically from the evidence given

S3.5a demonstrate and understand that one basic assumption of science is that other individuals could arrive at the same explanation if they had access to similar evidence; further understand that scientists must make the results of their investigations public in ways that enable others to repeat the investigations

S3.5b recognize that peer review is an effective process to evaluate the results of scientific investigations and the explanations proposed by other scientists, and understand that the process includes the analysis of experimental procedures, examination of evidence, identification of faulty reasoning and statements that go beyond the evidence, and suggest alternative explanations for the same observations

Learning Standard 2 Process Skills Addressed

Key Idea 1: Students prepare presentations demonstrating a clear sense of audience and purpose. (Part of Key Idea 1)

Learning Standard 4

Key Idea 1: The components of living systems, from a single cell to an ecosystem, interact to maintain balance. Different organisms have different regulatory mechanisms that function to maintain the level of organization necessary for life. (From 4th paragraph of Introduction)

1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.

1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.

5.3b Feedback mechanisms have evolved that maintain homeostasis. Examples include the changes in heart rate or respiratory rate in response to increased activity in muscle cells, the maintenance of blood sugar levels by insulin from the pancreas, and the changes in openings in the leaves of plants by guard cells to regulate water loss and gas exchange.

Learning Standard 4 Process Skills Addressed

i Follows safety rules in the laboratory

ix Designs and carries out a controlled, scientific experiment based on biological processes

x States an appropriate hypothesis

xi Differentiates between independent and dependent variables

xii Identifies the control group and/or controlled variables

xiii Collects, organizes, and analyzes data, using a computer and/or other laboratory equipment

xiv Organizes data through the use of data tables and graphs

xv Analyzes results from observations/expressed data

xvi Formulates an appropriate conclusion or generalization from the results of an experiment

xvii Recognizes assumptions and limitations of the experiment

Testable Skills and Concepts

- relationship between pulse rate and circulation of blood through the body
- relationship between activity and pulse rate
- circulatory system's role in transporting various materials to and from cells of the body
- concept that individuals have different resting pulse rates and muscle performance
- need for evidence before accepting claims made by others

References

Pulse rate information and diagrams of the methods of determining pulse rate came from:

- *Probing Levels of Life: A Laboratory Manual* by Hummer, Kaskel, Kennedy, and Oram, Charles E. Merrill Publishing Co., 1979.
- *Biology Investigations,* Teacher Edition, by Otto, Towle, Otto, and Madnick, Holt Rinehart and Winston, 1977.

Student Answers

The next four pages duplicate the Student Answer Packet and provide sample student data and possible answers in italics. They can provide a scoring guide for students' papers. However, ***please note that student data and the wording of answers will vary; also, alternative answers may be acceptable.*** The last four pages are the masters for the Student Answer Packet. Each student must be provided with a copy of the Student Answer Packet.

Name _____ Period _____ Date _____

A1. What is your pulse rate?

- Record your pulse rates for three trials below:

  Trial 1 (20-second count) *24* X 3 = *72* per minute

  Trial 2 (20-second count) *26* X 3 = *78* per minute

  Trial 3 (20-second count) *20* X 3 = *60* per minute

- Calculate and record your average pulse rate per minute: *70*

Complete a Data Table:

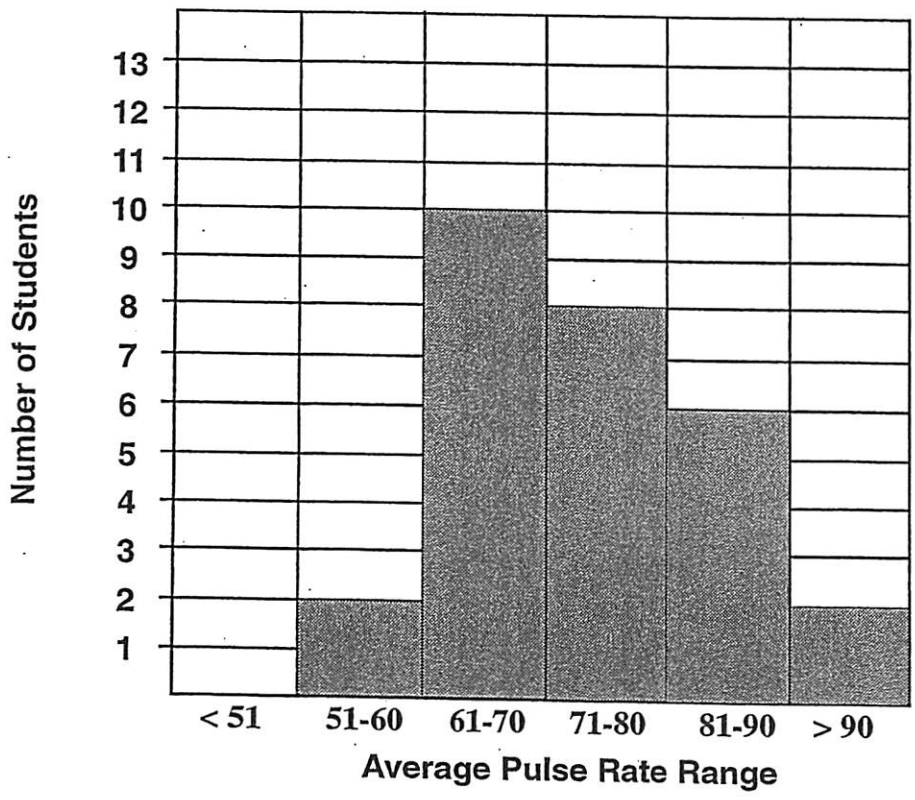
Use the average pulse rate for each student in the class to fill in the data table below.

Class Results: Average Pulse Rates

Pulse rate per minute (range of averages)	< 51	51-60	61-70	71-80	81-90	> 90
		Possible pattern is shown. Data will vary.				
Number of students in this range	0	2	10	8	6	2

Prepare a Histogram:

Histogram Title: *Average Pulse Rates*



Name_____ Period _____ Date _____

A2. How Does Fatigue Affect Muscle Performance?

Record the number of times you could squeeze the clothespin in one minute: *24*

Try the activity again, doing it the same way and using the same two fingers as before.

Record the number of times you could squeeze the clothespin the second time: *18*

Answer the Following Questions:

Some people are able to squeeze the clothespin more times in a minute than others. Suggest a possible explanation for this.

One person has stronger muscles than another. Or, *Some people are in better condition than others.*

Could you do as many in a minute the second time as you could do the first time? *No*

Provide a biological explanation for these results.

My muscle cells got tired. They ran out of oxygen or became fatigued due to waste products building up in them.

Part A. Questions:

1. What does an increased pulse rate indicate about the heart rate and flow of blood in someone's body?

   An increased pulse rate indicates the heart is beating at a higher rate. A higher pulse rate means that blood is moving more rapidly throughout the body.

2. When muscles are active, cells use nutrients and oxygen at a higher rate and produce waste chemicals and heat more rapidly. Describe how the interaction of two or more body systems helps to maintain homeostasis during periods of high muscle activity. (Be sure to identify the two systems you refer to in your answer.)

   The respiratory system takes in oxygen, which is transported to cells by the circulatory system. As cells use oxygen at a higher rate, an increased heart rate would get the oxygen to the cells more quickly.

   Or,

   As muscle cells increase their activity, they produce waste products at a higher rate. These wastes are carried to the excretory system by the blood (circulatory system) more efficiently when the heart rate increases.

Name_____ Period _____ Date _____

3. A student in your class suggests that when most people watch exciting sporting events on television, their pulse rates increase. What is a reliable way to find out if this statement is correct?

   They should conduct a controlled experiment to determine if the student is right.

4. What specific evidence would you need in order to determine if what the student suggests in question #3 can be supported?

   You would need to see the results of an experiment where a group of people had their pulse rates measured while they watched both exciting sporting events and other (less exciting) television shows. The results would have to show a significant difference in pulse rates between the two groups.*

   Note: It may be useful to discuss the meaning of the word "significant" with the class at this time and to explain how the use of statistics can help determine if differences between results are meaningful. A detailed explanation is not necessary.

5. If you wanted to increase your clothespin-squeezing rate, would you suggest exercising or resting before you did it? Explain why you think your explanation is the correct one.

   Student answers will vary, but the prediction should be for more or less ability to pinch the clothespin. The explanation is expected to relate to the effects of exercise, either leading to fatigue and slowing down or increased circulation somehow improving the ability to do more.

Part B: Investigating Claims

Which of the two students do you agree with? _A or B_ How could you find out for sure which claim is correct?

Do an experiment.

Name _____ Period _____

Regents Biology Date _____

LAB _____. DIGESTIVE SYSTEM

1. **Separate** the papers with the illustrations of the human digestive system organs.

2. **Color** the parts of the human digestive system in the following way:

   a. BLUE — Mouth, Esophagus, Stomach, Small Intestines

   b. PINK or RED — Digestive Glands: Salivary Glands, Pancreas

   c. BROWN — Digestive Gland: Liver

   d. GREEN — Digestive Glands: Gall Bladder, Bile Duct

   e. YELLOW — Large Intestines, Appendix

3. **Cut out** the organs of the Human Digestive System and **place** them on your poster paper. Have your teacher check for proper placement before you tape or glue the pieces.

4. **Cut out** the organ labels — names of the digestive system organs — and **place** them correctly on your poster. Have your teacher check for proper placement before you tape or glue the labels.

5. **Cut out** the digestive enzyme processes and **place** them correctly on your poster. Have your teacher check for proper placement before you tape or glue the pieces.

6. Put your name on the front of the poster. Have your teacher **sign off** that your poster is complete.

   SIGNATURE: _____

7. Answer the Summary Questions.

Summary Questions

1. Why is digestion a necessary process for animals? _____

_____

_____

2. Digestion starts in the mouth. What 2 digestive processes occur there?

   a. _____

   b. _____

3. Name the connecting organ between the mouth and the stomach _____

4. Name the involuntary wave-like muscle movement that moves food through the digestive system _____

5. List the organic compound (nutrient) and building block that each enzyme helps to speed up the digestive rate:

Nutrient digested	ENZYME	Building Block
	amylase	
	protease	
	lipase	

6. What is the <u>main</u> function of the stomach? _____

_____

8. Why are the salivary glands, pancreas, liver, and gall bladder considered accessory organs? _____

_____

9. Can we live without out gall bladder? _____What is the main function of the gall bladder? _____

_____

10. What is the main function of the small intestines?_____

_____

11. What structure lines the small intestines to aid in absorption? _____

12. By what process does food move from the small intestines to the blood stream, so it can be circulated to the rest of the body? _____

13. What is the function of the large intestines? _____

_____

14. By what process does water move from the large intestines to the blood stream, so it can be circulated to the rest of the body? _____

15. What happens when too little water is reabsorbed back into the body from the large intestines? Can this be a dangerous condition? Why?_____

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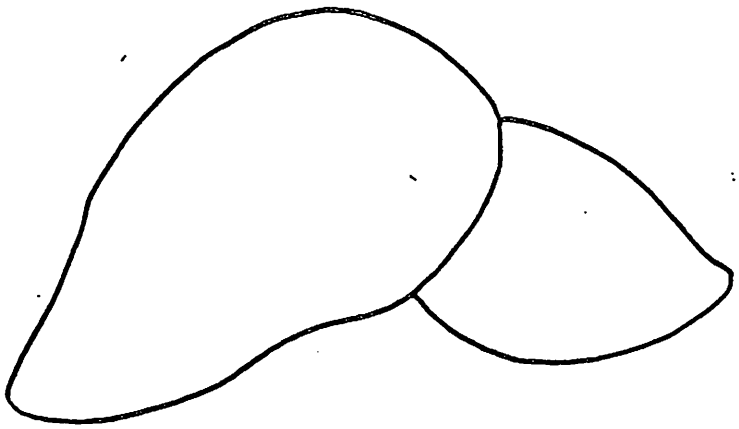

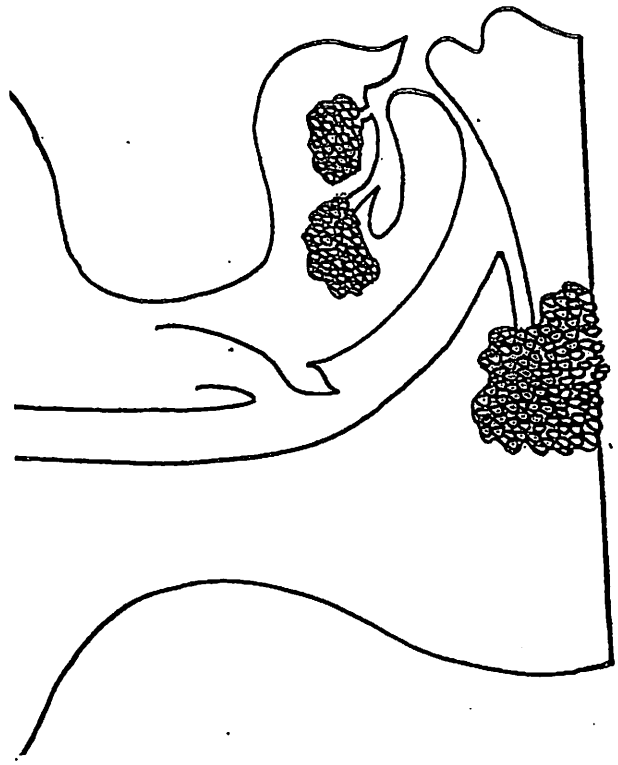

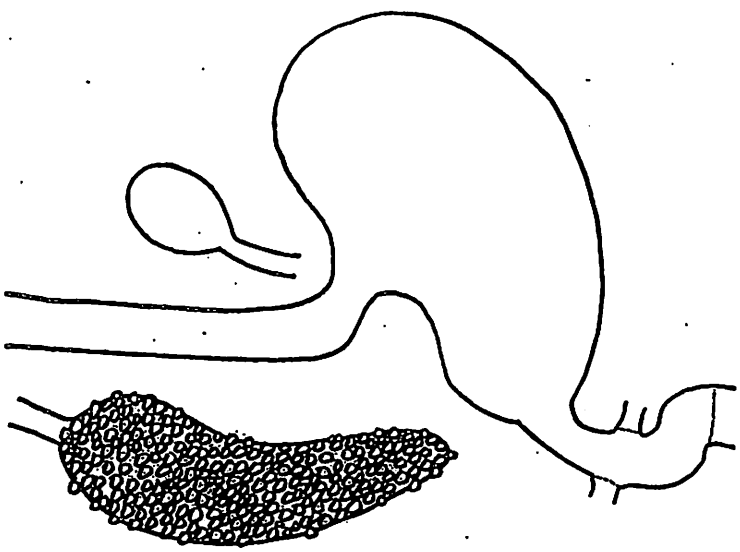

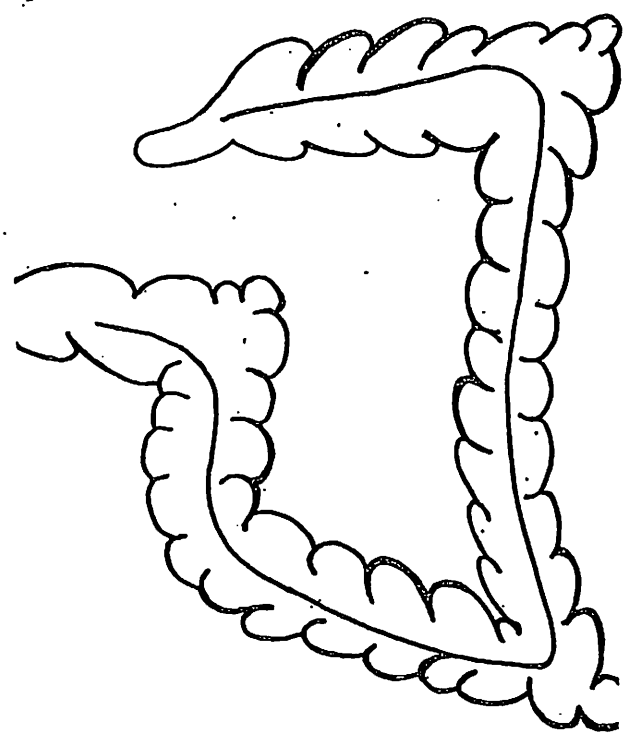

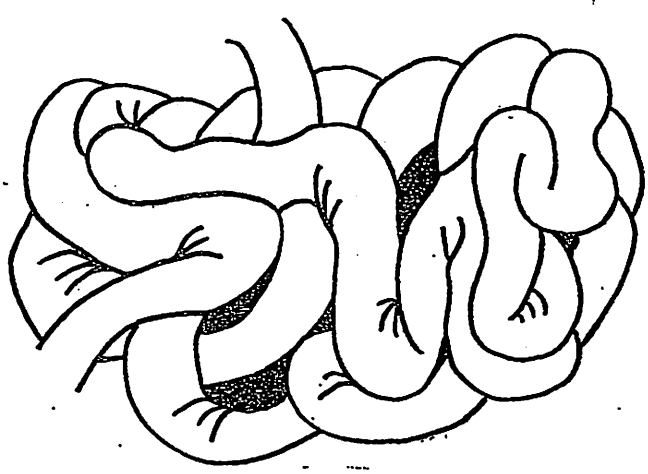

Name _____ Date _____
Living Environment Period _____

Lab Activity: AIDS Transmission

Background: AIDS, Acquired Immune Deficiency Syndrome, is a dramatic example of what happens when cells of the immune system are weakened by infection. In 1981, health care workers in the United States noticed an increasing number of cases of a rare skin cancer and of pneumonia caused by a protozoan. Besides being rare, theses diseases were known to occur mainly in severely **immune-suppressed** individuals. The spread of the disease made scientists suspect that it was caused by a virus. In 1983, that virus – now known as **HIV** (human immunodeficiency virus) was identified.

Rules of the Activity:

1. Each student gets a test vial half filled with fluid. The fluid represents body fluids (blood, semen, or vaginal secretion). One of the vials contains the "**HIV virus**" and the rest contain water.

2. A role card is attached to each vial. This identifies a behavioral role (telling when/with whom you can exchange body fluids)

3. When you exchange body fluids, use your pipette to remove some of your fluid and deposit it in the vial of the other person. You should receive back an equal amount of their fluid.

4. You must ask the other person for permission to exchange fluids. You may NOT tell the other person what your role is.

5. You can exchange fluids only if the exchange is in keeping with your behavioral role.

6. After a short period of time exchanging fluids, it will be time to "**Get tested for HIV**". The teacher will assume the role of a doctor who will administer an "**AIDS test**" to each student at the end of the activity.

Observations and Analysis:

1. What was your behavioral role? _____

2. Did you test positive for HIV? _____

3. Were you able to trace the route of infection back to its original source? _____

4. If this had been an actual experiment, what would you have changed to make the results (data) more accurate and valid? _____

_____

_____

5. From the class data, fill in the following table and determine the risk for each of the roles.

Role	Number who practiced this behavioral role	Number who tested "HIV positive"	Risk of contracting AIDS (low risk, some risk, or high risk)
Practice abstinence			
Monogamous			
Promiscuous			
Bisexual			
Intravenous drug/ steroid user			
Prostitute (male or female)			

Conclusion/Checking for Understanding:

1. List 3 social behaviors that increase the risk of contracting HIV.

_____

_____

2. When HIV, which causes AIDS, invades the body of a person, that person often develops diseases. These diseases are caused by organisms that usually do not harm people who are not infected with HIV. Explain why the organisms are more harmful to people with HIV than to people without HIV.

_____

_____

_____

3. Describe the nature of AIDS and identify two ways to prevent or control the spread of this infectious disease. In your response, be sure to include:

- The type of pathogen that causes AIDS
- The system of the body that is attacked by that pathogen
- The effect on the body when this system is weakened by AIDS
- Two ways to prevent or control the spread of infectious diseases, such as AIDS

_____

_____

_____

_____

_____

_____

_____

Name Date
Living Environment LAB

Antigens and Antibodies

Background: An antigen is any substance or organism that invades the body. Antibodies are proteins that are produced by certain types of white blood cells in response to an invader. Antibodies are part of the body's defense system against disease and infection.

Procedure:

1. Cut out the shapes representing antigens and antibodies.
2. Find the 2 shapes that fit together like pieces of a puzzle.
3. Glue the shapes onto posterboard.
4. Repeat until you have matched up all the shapes and glued them onto the posterboard.

Critical Thinking and Analysis

1. Is the relationship between antigens and antibodies specific or non-specific?

   Explain

   .....

   .....

   .....

2. What molecule are most antigens made of? .....

3. Describe the difference between active and passive immunity.

   .....

   .....

   .....

4. Sometimes it takes time for WBCs to produce antibodies needed to attack an antigen. If this were the case in your body, what would you be experiencing while waiting for antibodies to be produced?

   .....

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5. Sometimes WBCs "remember" how to make a certain type of antibody, and thus produce antibodies immediately. If this were the case in your body, what would happen if you were exposed to the disease that these antibodies were designed to fight?

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6. *The following question was given on the January 2008 Regents exam*
Smallpox is a disease caused by a specific virus, while the common cold can be caused by over 100 different viruses. Explain why it is possible to develop a vaccine to prevent smallpox. In your answer be sure to:

- identify the substance in a vaccine that makes the vaccine effective
- explain the relationship between a vaccine and WBC activity
- explain why the response of the immune system to a vaccine is specific

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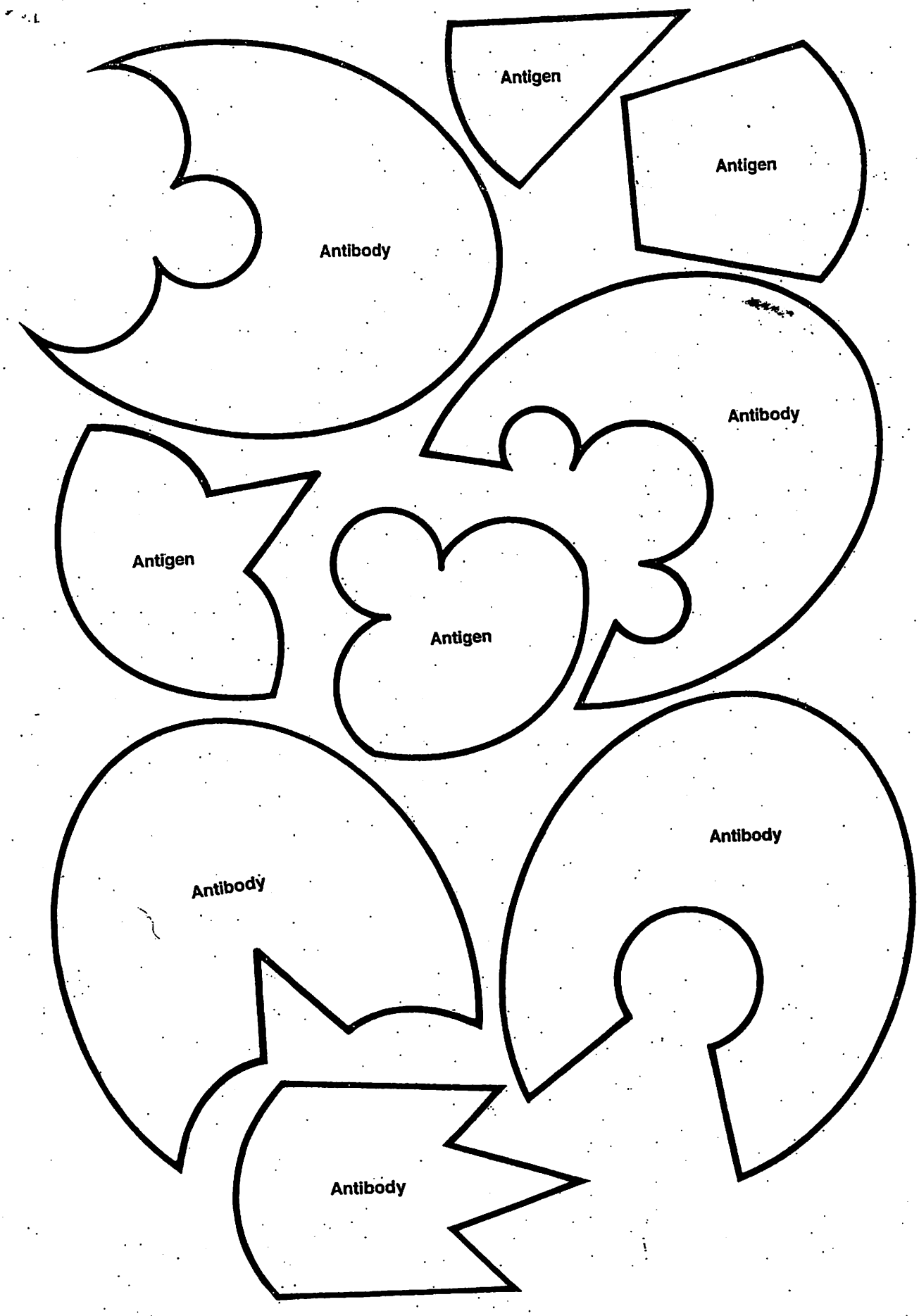
Antigen
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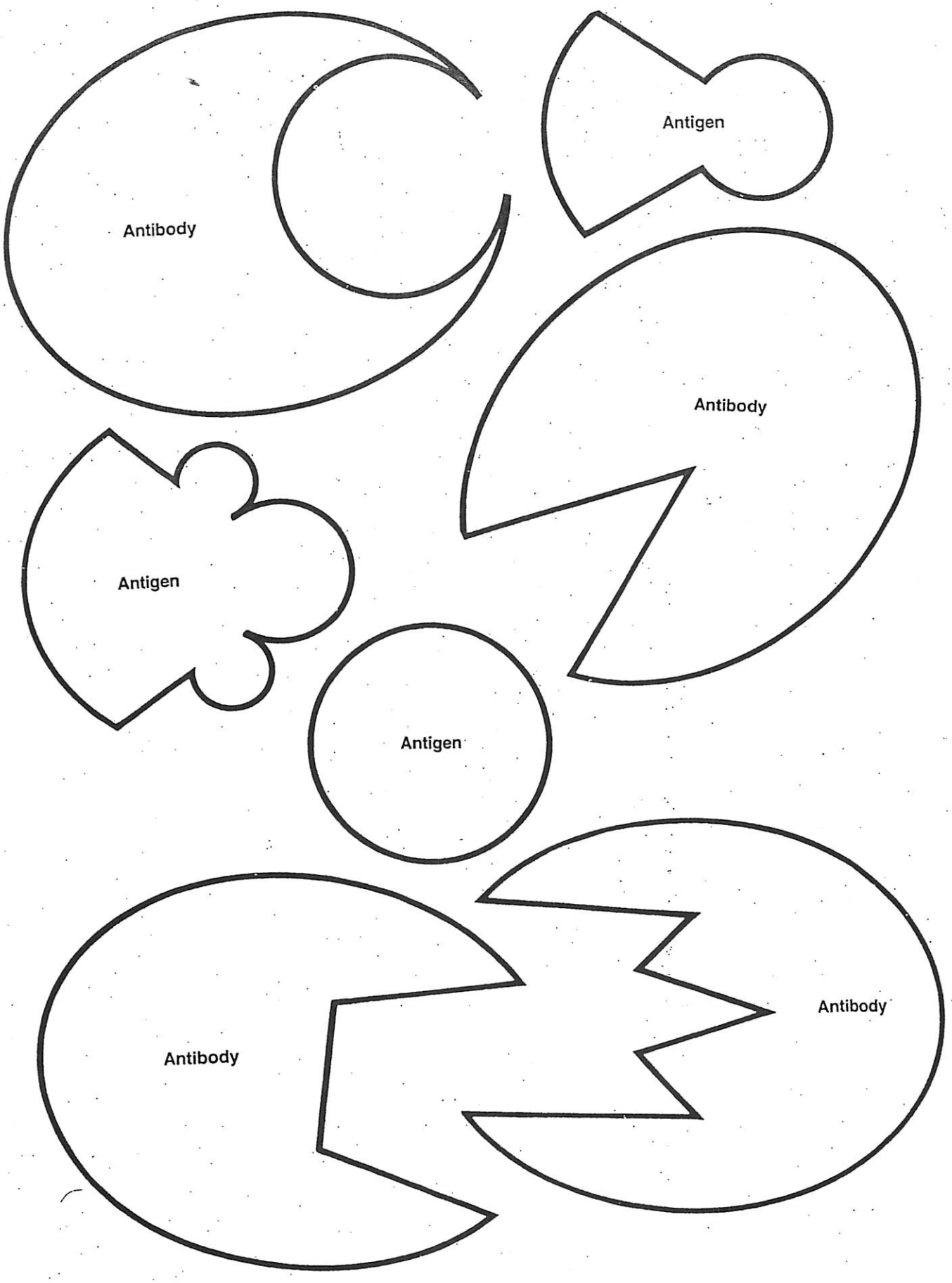
Name _____ Class _____



Name: Period:
Date: Living Environment

Lab: Reaction Time

Introduction:

We have been looking at the nervous system and how electrical impulses are transmitted in your nerve cells. Your reaction to certain stimuli can be used to see how fast neurons transmit impulses throughout the body.

Question:

Is there a relationship between handedness and reaction time? (Do right handed people have a shorter reaction time for their right hand than their left? Do left handed people have a shorter reaction time for their left hand than their right?)

Procedure:

1) Drop a ruler between your lab partner's fingers (left and right hand) and measure the distance dropped (in cm).
2) Repeat for all five trials for each hand.
3) Using the mathematical equation:

$$t=\sqrt{(2d/a)}$$

Where...
t = reaction time
d = average distance of fall
a = acceleration due to gravity = 980 cm/s^2

4) Use data to discuss analysis questions in following section.

Results:

Raw data

Person's name: Right or Left Handed? _____

Trial	Hand	Distance (cm)	Reaction Time (s)
1	Right		
2	Right		
3	Right		
4	Right		
5	Right		

Calculations:

Trial	Hand	Distance (cm)	Reaction Time (s)
1	Left		
2	Left		
3	Left		
4	Left		
5	Left		

Calculations:

Calculated Data

What was the average reaction time for the subject's right hand? _____

What was the average reaction time for the subject's left hand? _____

Construct a bar graph using the data from all the students in the class. (Each student will have two bars, one for the left hand and one for the right)

Analysis Questions

1) Describe the relationship between handedness and reaction time from the data you accumulated in this lab.

_____

_____

_____

_____

_____

_____

_____

2) Name three sports or occupations where having a fast reaction time is important.

_____

_____

_____

_____

_____

3) Give three examples of things that could slow down your reaction time or reflexes.

_____

_____

_____

_____

4) Say that a person catches a meter stick very slowly when their hands are cold. If that person was able to average catching the meter stick at 93 cm, what is their reaction time? Show your work below.

Reaction Time_____

Living Environment
Weekly HOMEWORK Assignment

System Disease/Disorder Assignment #1:
Choose from Digestive or Respiratory systems

Be sure to include the following in your paper;

- Name of the disease or disorder
- What organs are affected?
- What are the signs or symptoms?
- How is the disease/disorder diagnosed?
- How is the disease/disorder treated?
- Does it affect one ethnic group or gender more than another?

Assignment may be in paragraph, question/answer or PowerPoint form. ALL work must be typed and works cited. You should include pictures/diagrams.

Living Environment
Weekly HOMEWORK Assignment

System Disease/Disorder Assignment #2:
Choose from Excretory or Circulatory systems

Be sure to include the following in your paper;

- Name of the disease or disorder
- What organs are affected?
- What are the signs or symptoms?
- How is the disease/disorder diagnosed?
- How is the disease/disorder treated?
- Does it affect one ethnic group or gender more than another?

Assignment may be in paragraph, question/answer or PowerPoint form. ALL work must be typed and works cited. You should include pictures/diagrams.

Living Environment
Weekly HOMEWORK Assignment

System Disease/Disorder Assignment #3:
Choose from Skeletal or Muscular systems

Be sure to include the following in your paper;

- Name of the disease or disorder
- What organs are affected?
- What are the signs or symptoms?
- How is the disease/disorder diagnosed?
- How is the disease/disorder treated?
- Does it affect one ethnic group or gender more than another?

Assignment may be in paragraph, question/answer or PowerPoint form. ALL work must be typed and works cited. You should include pictures/diagrams.

Living Environment
Weekly HOMEWORK Assignment

System Disease/Disorder Assignment #4:
Choose from Endocrine or Nervous systems

Be sure to include the following in your paper;

- Name of the disease or disorder
- What organs are affected?
- What are the signs or symptoms?
- How is the disease/disorder diagnosed?
- How is the disease/disorder treated?
- Does it affect one ethnic group or gender more than another?

Assignment may be in paragraph, question/answer or PowerPoint form. ALL work must be typed and works cited. You should include pictures/diagrams.

Living Environment
Weekly HOMEWORK Assignment

System Disease/Disorder Assignment #5:
Choose a disease or disorder from the Immune System

Be sure to include the following in your paper;

- Name of the disease or disorder
- What organs are affected?
- What are the signs or symptoms?
- How is the disease/disorder diagnosed?
- How is the disease/disorder treated?
- Does it affect one ethnic group or gender more than another?

Assignment may be in paragraph, question/answer or PowerPoint form. ALL work must be typed and works cited. You should include pictures/diagrams.

Unit 4: Reproduction and Development

Time Frame: 4 weeks

Guiding Question: How do organisms reproduce cells for growth, development and the production of offspring?

Overview:

1. Asexual Reproduction
    - **a.** Vegetative propagation
    - **b.** Binary Fission
    - **c.** Regeneration
    - **d.** Sporulation
    - **e.** Budding
    - **f.** Mitosis
        - **i.** Body cell and tissue growth and repair
        - **ii.** Stages of mitotic cell division
        - **iii.** Cancer- uncontrolled mitotic division of cells due to mutation in DNA
    - **g.** Meiosis
        - **i.** Spermatogenesis
        - **ii.** Oogenesis
        - **iii.** Stages of meiotic cell division
2. Human Reproductive Systems
    - **a.** Male reproduction system
        - **i.** Organs and glands; testes, vas deferens, urethra, seminal vesicle, prostate, penis
        - **ii.** Hormone produced is testosterone
    - **b.** Female reproductive system
        - **i.** Organs and glands; ovaries, fallopian tubes, uterus, cervix, vagina
        - **ii.** Hormones produced are estrogen and progesterone
        - **iii.** Stages of the menstrual cycle
        - **iv.** Mother's choices affect on fetal development
3. Sexual Reproduction
    - **a.** Fertilization
    - **b.** Differentiation
    - **c.** Development in uterus
        - **i.** Structures to form; placenta, umbilical cord, amniotic fluid
    - **d.** Reproductive technology

NYS- Living Environment Standards:
Key Idea 2: Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.

Performance Indicator 2.1: Explain how the structure and replication of genetic material result in offspring that resemble their parents.
Major Understandings
2.1d In asexually reproducing organisms, all the genes come from a single parent. Asexually produced offspring are normally genetically identical to the parent.
2.1e In sexually reproducing organisms, the new individual receives half of the genetic information from its mother (via the egg) and half from its father (via the sperm). Sexually produced offspring often resemble, but are not identical to, either of their parents.

Key Idea 4: The continuity of life is sustained through reproduction and development.

Performance Indicator 4.1 - Explain how organisms, including humans, reproduce their own kind.
Major Understandings
4.1a Reproduction and development are necessary for the continuation of any species.
4.1c The processes of meiosis and fertilization are key to sexual reproduction in a wide variety of organisms. The process of meiosis results in the production of eggs and sperm which each contain half of the genetic information. During fertilization, gametes unite to form a zygote, which contains the complete genetic information for the offspring.
4.1d The zygote may divide by mitosis and differentiate to form the specialized cells, tissues, and organs of multicellular organisms.
4.1e Human reproduction and development are influenced by factors such as gene expression, hormones, and the environment. The reproductive cycle in both males and females is regulated by hormones such as testosterone, estrogen, and progesterone.
4.1f The structures and functions of the human female reproductive system, as in almost all other mammals, are designed to produce gametes in ovaries, allow for internal fertilization, support the internal development of the embryo and fetus in the uterus, and provide essential materials through the placenta, and nutrition through milk for the newborn.
4.1g The structures and functions of the human male reproductive system, as in other mammals, are designed to produce gametes in testes and make possible the delivery of these gametes for fertilization.
4.1h In humans, the embryonic development of essential organs occurs in early stages of pregnancy. The embryo may encounter risks from faults in its genes and from its mother's exposure to environmental factors such as inadequate diet, use of alcohol/drugs/tobacco, other toxins, or infections throughout her pregnancy.

Objectives: **Students will be able to:**

1. Asexual Reproduction
    a. Compare asexual and sexual reproduction
    b. Describe how organisms use the process of asexual reproduction to produce offspring, as in budding, sporulation, binary fission and vegetative propagation
    c. Identify and describe what happens during the four stages of mitosis
    d. Describe the process of cytokinesis
    e. Contrast the number of chromosomes in body cells and gametes
    f. Summarize the events in meiosis
    g. Contrast meiosis and mitosis
    h. Explain how cancer cells are different from other cells

2. Human Reproductive Systems
    a. Name and discuss the sex hormones
    b. Describe the effects the sex hormones have on development
    c. Identify the structures of the female reproductive system and describe their functions
    d. Identify the structures of the male reproductive system and describe their functions
    e. Identify the 4 stages of the menstrual cycle
    f. Predict the stage in menstrual cycle based on hormone levels
    g. Explain how alcohol and drugs affect fetal development

3. Sexual Reproduction
    a. Describe fertilization and the early stages of development
    b. Describe the process of differentiation
    c. Identify the major events of the later stages of development including the development of the placenta and umbilical cord
    d. Describe some of the most common sexually transmitted diseases
    e. Discuss the pros and cons of reproductive technology

Suggested Activities:

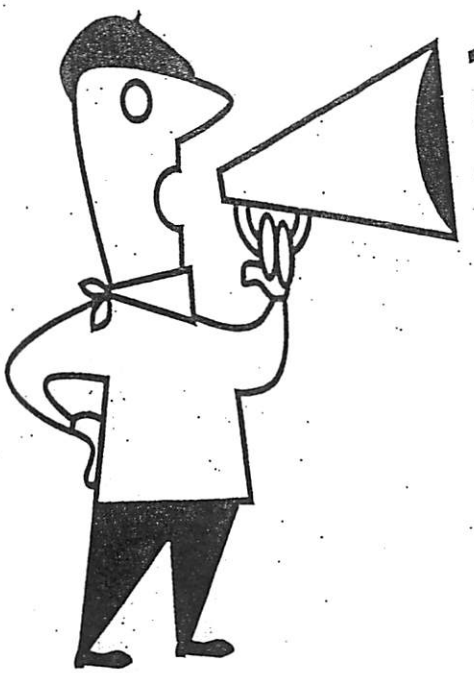
- "What's Next?"- Mitosis sequencing activity and booklet
- Mitosis Under the Microscope
- Menstrual Cycle graphing activity
- Fetal Development graphing activity

Key Concepts/ Vocabulary:

Asexual reproduction	Budding	Binary Fission
Vegetative propagation	Sporulation	Regeneration
Mitosis	Interphase	Prophase
Metaphase	Anaphase	Telophase
Cytokinesis	Cleavage	Chromosome

Cancer	Mutations	Metastasize
Meiosis	Gametogenesis	Oogenesis
Ovum	Polar bodies	Spermatogenesis
Sperm	2n vs. n	Crossing over
Sexual Reproduction	Puberty	Hormones
Estrogen	Progesterone	Testosterone
Ovary	Fallopian tubes/ Oviduct	Uterus
Cervix	Vagina	Testes
Vas deferens	Seminal Vesicle	Prostate
Urethra	Penis	Fertilization
Differentiation	Development	Zygote
Embryo	Fetus	Placenta
Umbilical cord	Amniotic Fluid	
Reproductive technology	In-vitro fertilization	Identical twins
Fraternal twins	Menstrual Cycle	Follicle stage
Ovulation stage	Corpus Luteal stage	Luteinizing hormone
Follicle stimulating hormone	Fetal Alcohol Syndrome	

Name: _____ Period: _____



What's Next?

Did you ever watch a movie and just know what was going to happen next? For example, isn't just like your typical date movie to have the guy meet the girl of his dreams only to have some "misunderstanding" that is ultimately resolved through a series of either comical or heartwarming occurrences that bring the fateful couple together. Or perhaps you've seen the horror flick wherein a dull witted male or female walks alone into a dark house calling for a friend (which you know is already dead) only to be surprised by the deranged psycho killer. The surprise is only on the dolt who walked into the house. You know, just like everybody else knows, that every dark domicile houses a maniacal murderer. Movies are just so predictable.

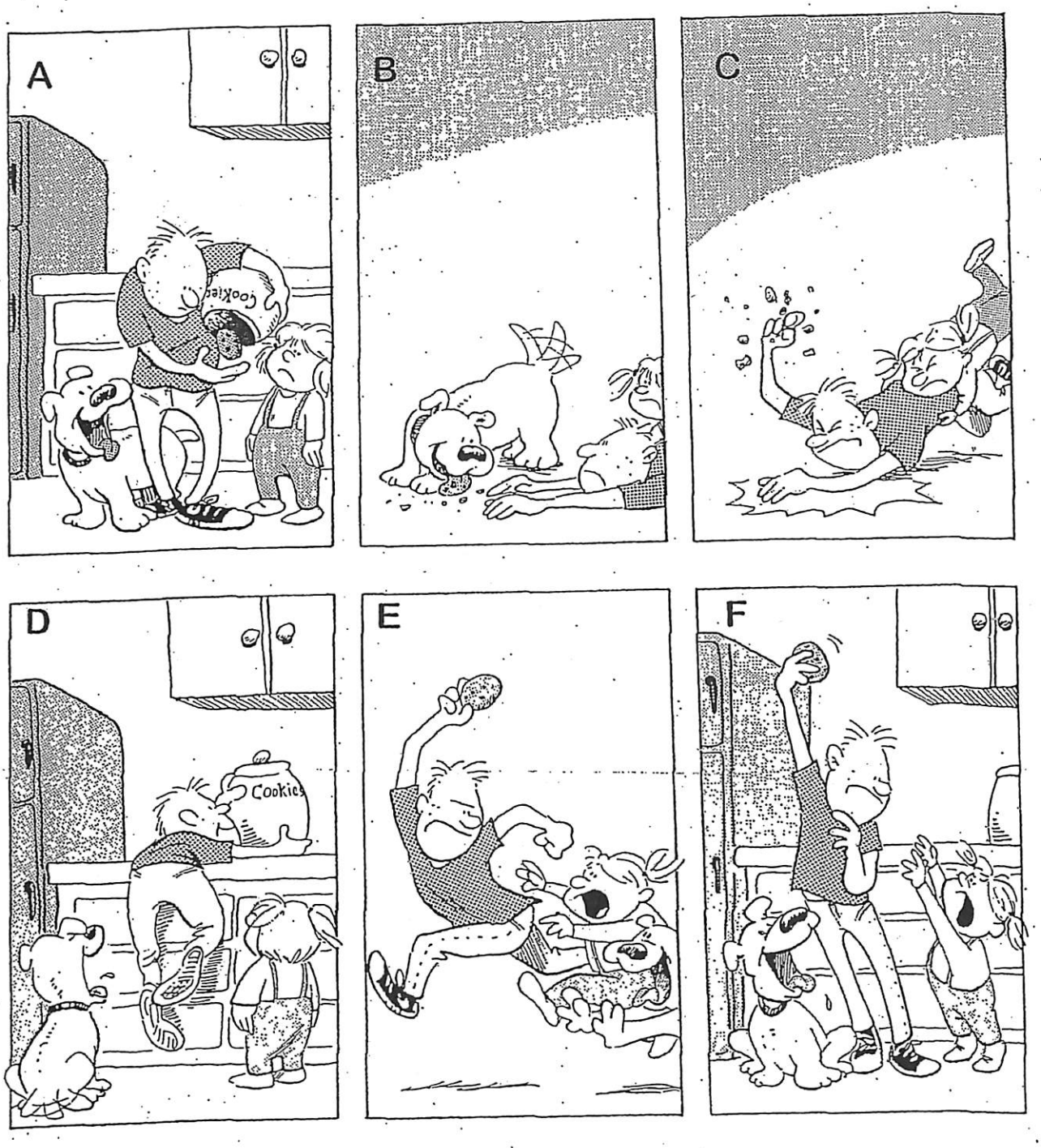
Well, it's my bet that mitosis (the process of asexual cell division) is just as predictable as the plot of any movie. And figuring in some your student savvy (yes you've got some) I bet you can make heads and tails of the great process that transformed each of us from our humble unicellular beginnings into the magnificent mass of collective cytoplasm that we are today.

In this lab you will perform several tasks:

1. Sharpen your sequencing skills by determining a logical order for a series of pictures.
2. Develop a reasonable order for the stages a cell passes through as completes the process of mitosis.
3. Describe the ordered process using specific vocabulary introduced in this lab.

Determine a logical order for the following pictures.

The Cookie

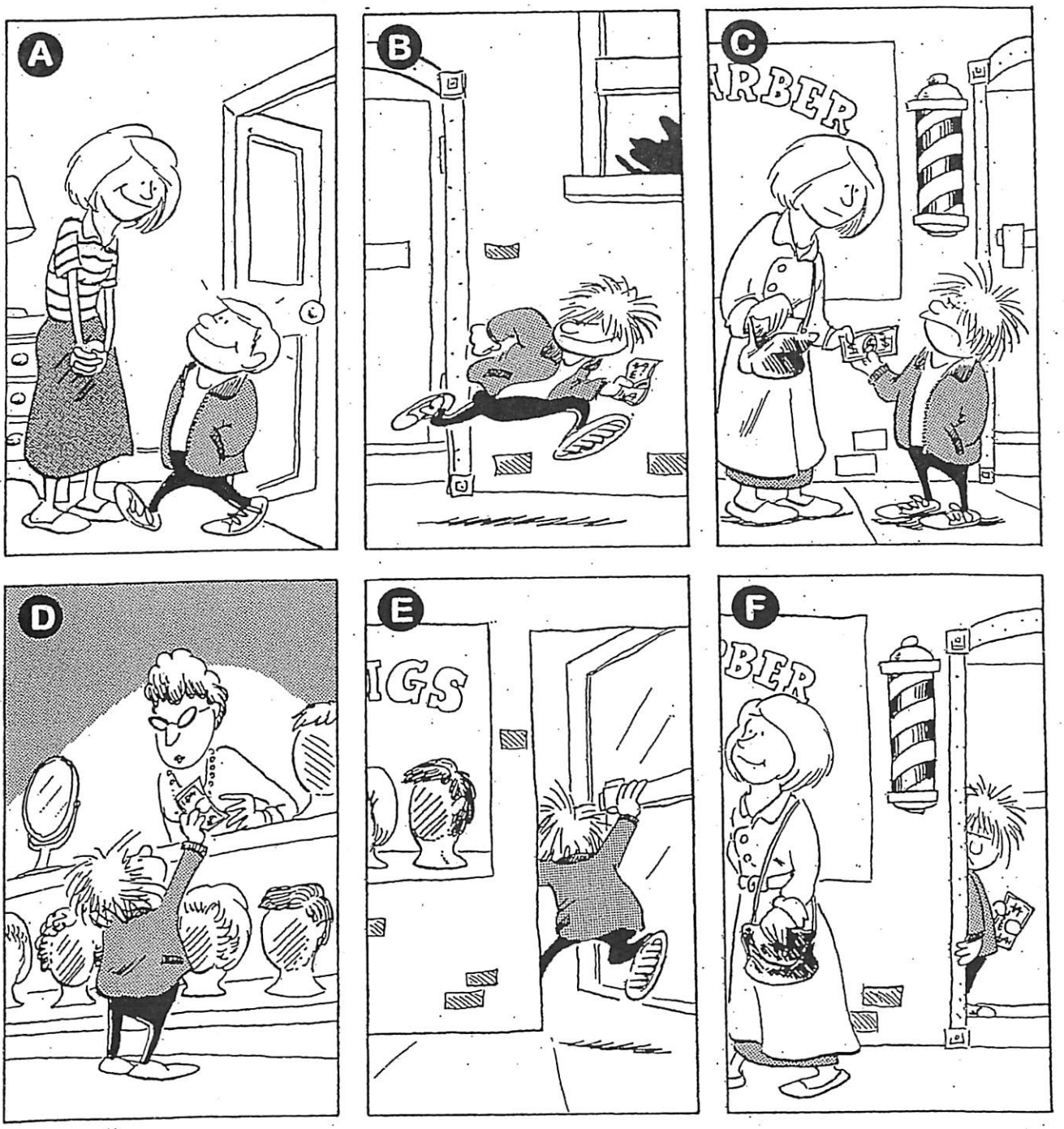


List the order of your sequence _____

Part 1: Sharpening Skills

Determine a logical order for the following pictures.

The Barbershop

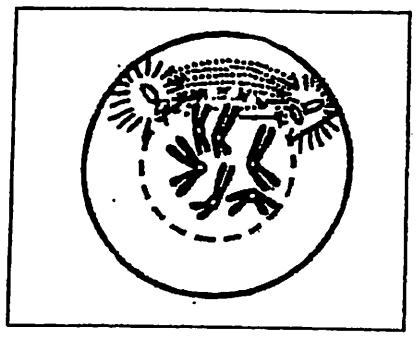


List the order of your sequence _____

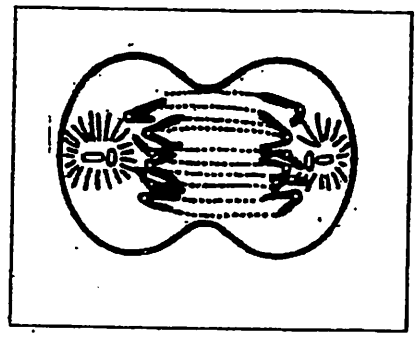
Mitosis Sequencing

Determine the logical order for the following pictures.

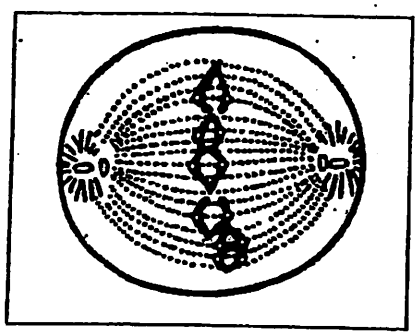
A



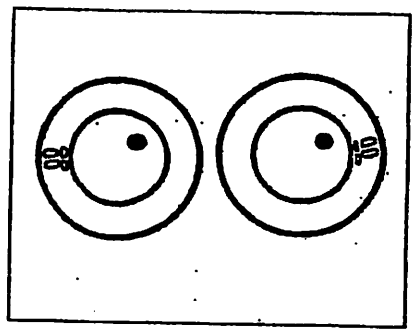
B



C



D



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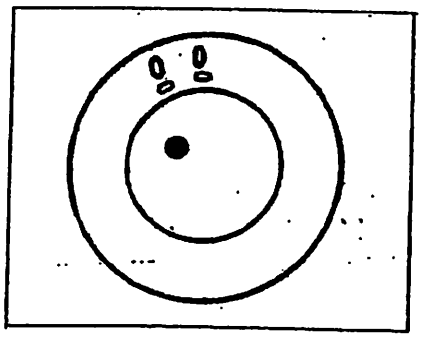
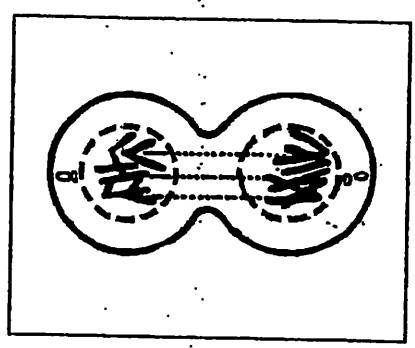


F



Name: _____ Date: _____

Living Environment

MITOSIS UNDER THE MICROSCOPE

Mitosis, also called, is division of the nucleus and its chromosomes. It is followed by division of the cytoplasm known as **cytokinesis**. Both mitosis and cytokinesis are parts of the life of a cell called the Cell Cycle. Most of the life of a cell is spent in a non-dividing phase called **Interphase**. During **interphase**, the cells grow in size, double their number of chromosomes, and makes enzymes & other cellular materials needed for mitosis.

Mitosis has 4 major stages --- **Prophase**, **Metaphase**, **Anaphase**, and **Telophase**. When a living organism needs new cells to repair damage, grow, or just maintain its condition, cells undergo mitosis.

In this lab you are going to determine the approximate time it takes for a cell to pass through each of the four stages of mitosis. You may use your textbook and class notes to help you identify the stages of mitosis as seen under the microscope.

Materials:

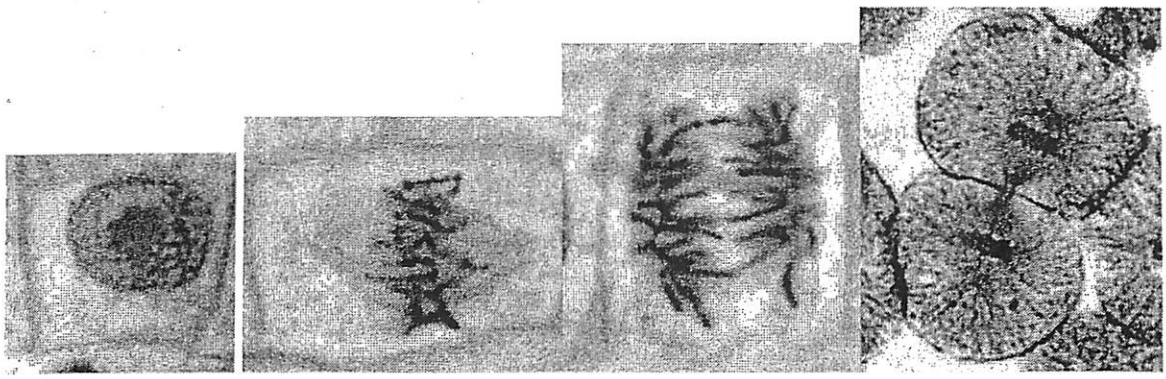
Microscope or magnifying glass
Prepared slide (Onion root tip)
Lab Paper

Prediciton: When you observe the cells under a microscope, which stage of the cell cycle do you think most cells will be in? _____

Procedure:

1. Set up a compound light microscope and turn on the light (if microscope not available use pictures below).
2. Place a slide containing a stained preparation of the onion root tip.
3. Locate the meristematic zone, which is just above the root cap at the very end of the tip.

4. Focus in on low power and then switch to medium or high power. Below find micrographs of the four stages of mitosis. Use them to help you identify the stages on the microscope slide.



Prophase **Metaphase** **Anaphase** **Telophase**

5. Now count the number of cells found in each stage of mitosis and place the data in the chart below.

6. Determine the percentage of time each cell will spend in each stage of mitosis. Divide the number of cells in each stage by the total number of cells and multiply by 100 to determine the percentage of time the cell spends in each stage. Place these values in the chart below.

Results:

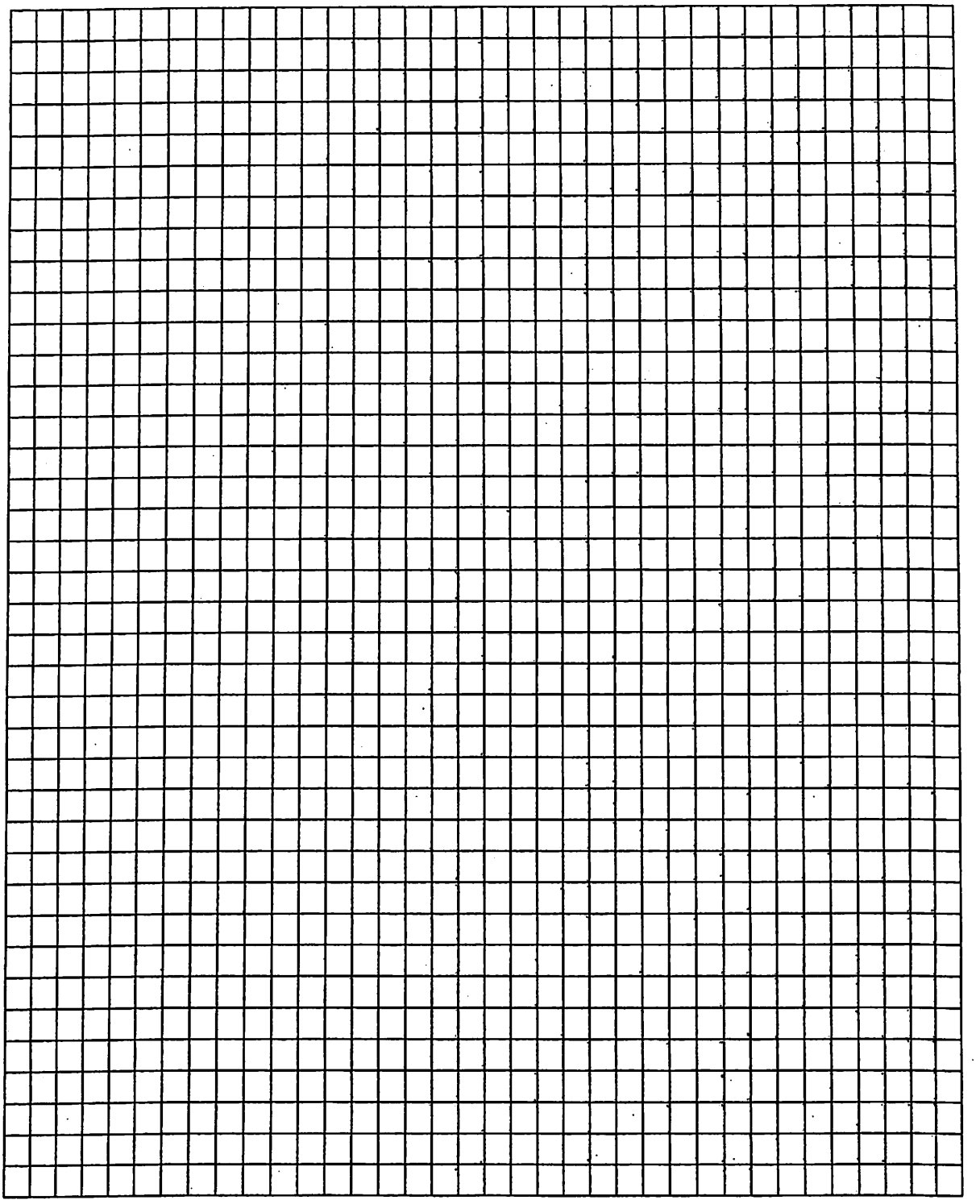
DATA TABLE:

Stage of Mitosis	Number of Cells	Percent of time in each stage
Prophase		_____ %
Interphase		_____ %
Metaphase		_____ %
Anaphase		_____ %
Telophase		_____ %
Total number of Cells		**100%**

7. Line graph the data you have just collected. Make sure you place an appropriate scale for each axis. Label each axis correctly. Include a title for the graph.

8. Answer the questions that follow.

Title: _____



Legend: _____

Analysis and Conclusion:

1. Based on the your graph and on the data collected, during which stage of the cell cycle does a cell spend most of its time? _____

_____

2. Of the four stages of mitosis, which one takes the most time to complete?_____

_____

3. Which is the shortest stage in duration?_____

_____

4. What would happen if the process of mitosis skipped metaphase?_____

_____

_____

5. What disease can possibly occur if there is a disruption in the cell cycle and cells start uncontrolled replication?_____

_____

6. You are told that the cell cycle in onions normally takes 25 hours to complete. Using the percentages you calculated in this lab, fill in the following table.

Stage in Cell Cycle	Percentage of Time Spent In That Stage	Number of Hours Spent in This Stage
Interphase		
Prophase		
Metaphase		
Anaphase		
Telophase		
Total:	100%	25 Hours

Name _____ Date _____

Graphing the Menstrual Cycle

Problem: How do the levels of reproductive hormones influence the human menstrual cycle?

Materials: Graph Paper, pencils, and the data table below.

The relative hormone levels vary greatly during the menstrual cycle. The table below shows the relative levels of the four major hormones by day.

Day	Luteinizing Hormone (LH)	Follicle Stimulating Hormone (FSH)	Estrogen	Progesterone
1	6	10	10	2
2	7	11	10	2
3	8	12	10	2
4	8	13	10	2
5	8	14	10	2
6	8	13	13	2
7	8	12	16	2
8	8	12	19	2
9	8	12	22	2
10	10	13	28	2
11	12	14	35	2
12	22	16	28	3
13	32	20	22	4
14	20	15	19	5
15	6	10	16	8
16	6	9	15	10
17	6	8	15	12
18	6	8	15	15
19	6	8	15	18
20	6	7	15	24
21	6	6	15	28
22	6	6	15	28
23	6	6	15	28
24	5	6	13	24
25	4	6	10	18
26	3	8	10	12
27	3	10	10	7
28	3	10	10	2

Procedure for Graphing:

1. You are going to plot points from the data table above to create 2 different line graphs.
   - Plot estrogen and progesterone on one of the graphs.
   - Plot FSH and LH on the other graph.

2. Make certain you **key** each graph, **label the axes**, and **title your graphs.** Answer the questions which follow using your knowledge of the menstrual cycle and your information on the graph you will construct. You will also need the information in the chart of endometrium thickness below.

Day of the Menstrual Cycle	Average Thickness of the Uterus Lining (endometrium) in millimeters
1	0.5
5	1.5
10	2.25
15	3.0
20	4.0
25	5.0
27	4.75
1	0.5

Conclusion Questions

1. Estrogen levels are highest on which day number? _____
2. LH levels are highest on which day number? _____
3. How does the increase in the estrogen level correspond to the change in thickness of the uterine lining in days 1 through 10 of the menstrual cycle? _____

_____

_____

4. Compare the change in thickness of the uterine lining with change in progesterone amount for days 10-27._____

_____

_____

5. What happens to the uterine lining between day 27 and day 1? What is this process called? _____

_____

_____

Name _____ Period _____

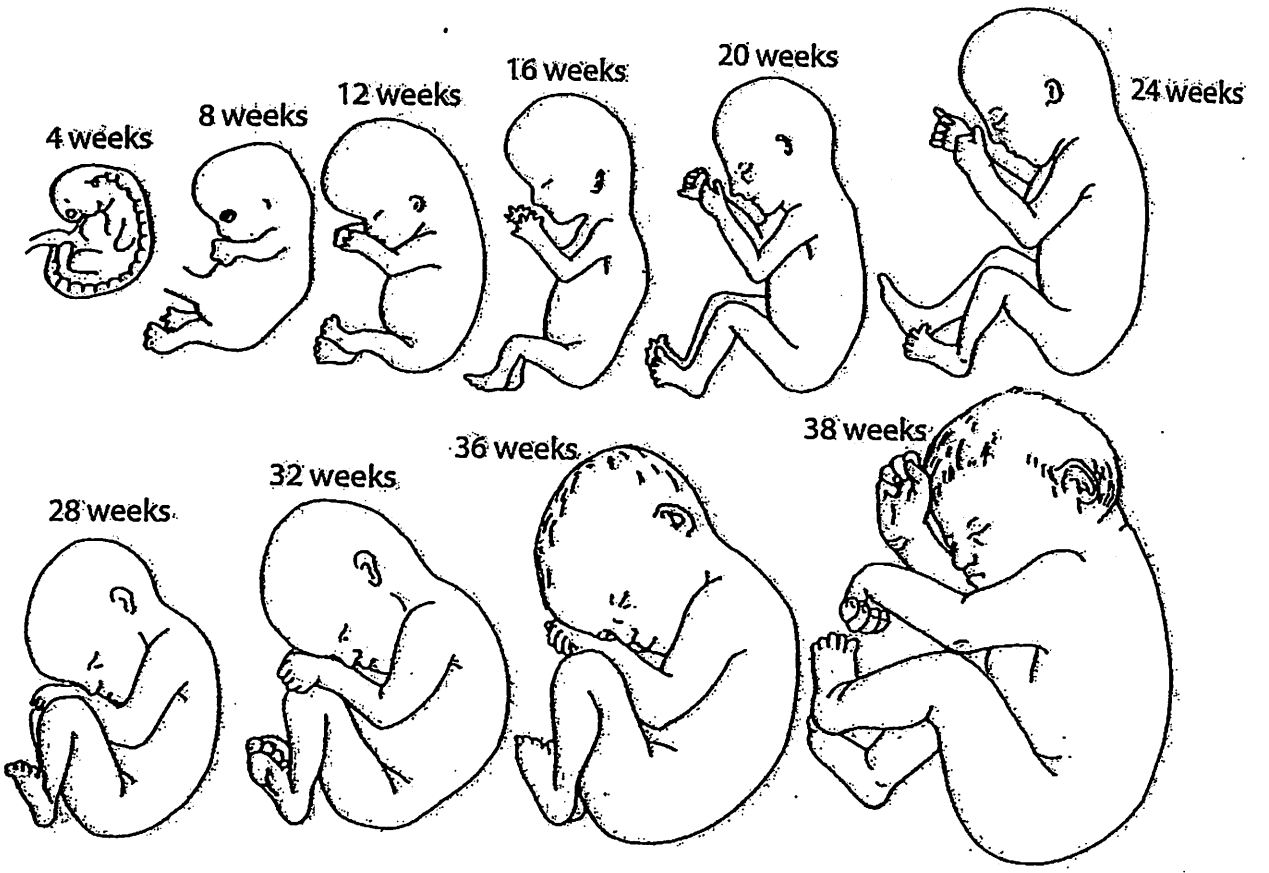
Regents Biology Date _____

LAB ____. DEVELOPMENT OF A HUMAN FETUS

After a human egg is fertilized with human sperm, the most amazing changes happen that allow a baby to develop. This amazing process, called **development**, normally lasts about 38 weeks. Let's look and measure some of the changes that occur during this human fetal development and learn about some of the chemicals that could disrupt this normal development.

1. Examine the diagrams below of the developing human baby.
2. On the graph below the table, plot the data in **Table 1. Change in Size of a Developing Baby**: label the axes, choose a proper scale, make a title.
3. On the graph below the table, plot the data in **Table 2. Change in Mass of a Developing Baby**: label the axes, choose a proper scale, make a title.
4. On the graph below the table, plot the data in **Table 3. Survival Rates of Babies by Developmental Age**: label the axes, choose a proper scale, make a title.
5. Read the articles on the effect of drugs, alcohol, and tobacco on developing babies.
6. Answer **Summary Questions**.

Developing Human Fetus

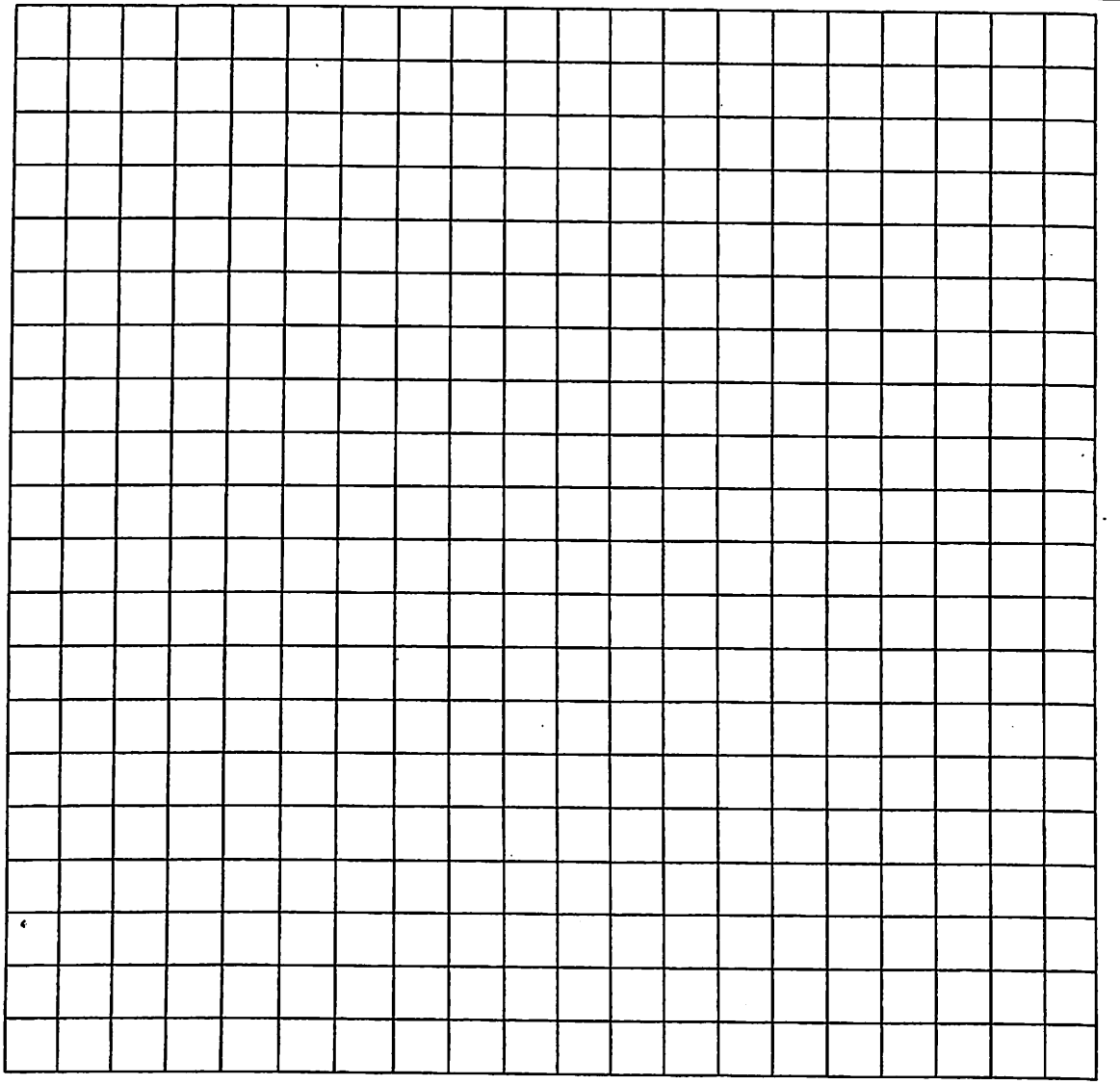


Name _____ Regents Biology

Table 1. Change in Size of a Developing Baby

Time (weeks)	Length (mm)		Time (weeks)	Length (mm)
4 (1 month)	7		24 (6 months)	300
8 (2 months)	14		28 (7 months)	350
12 (3 months)	75		32 (8 months)	410
16 (4 months)	160		36 (9 months)	460
20 (5 months)	240		38 (9.5 months)	500

Title. _____

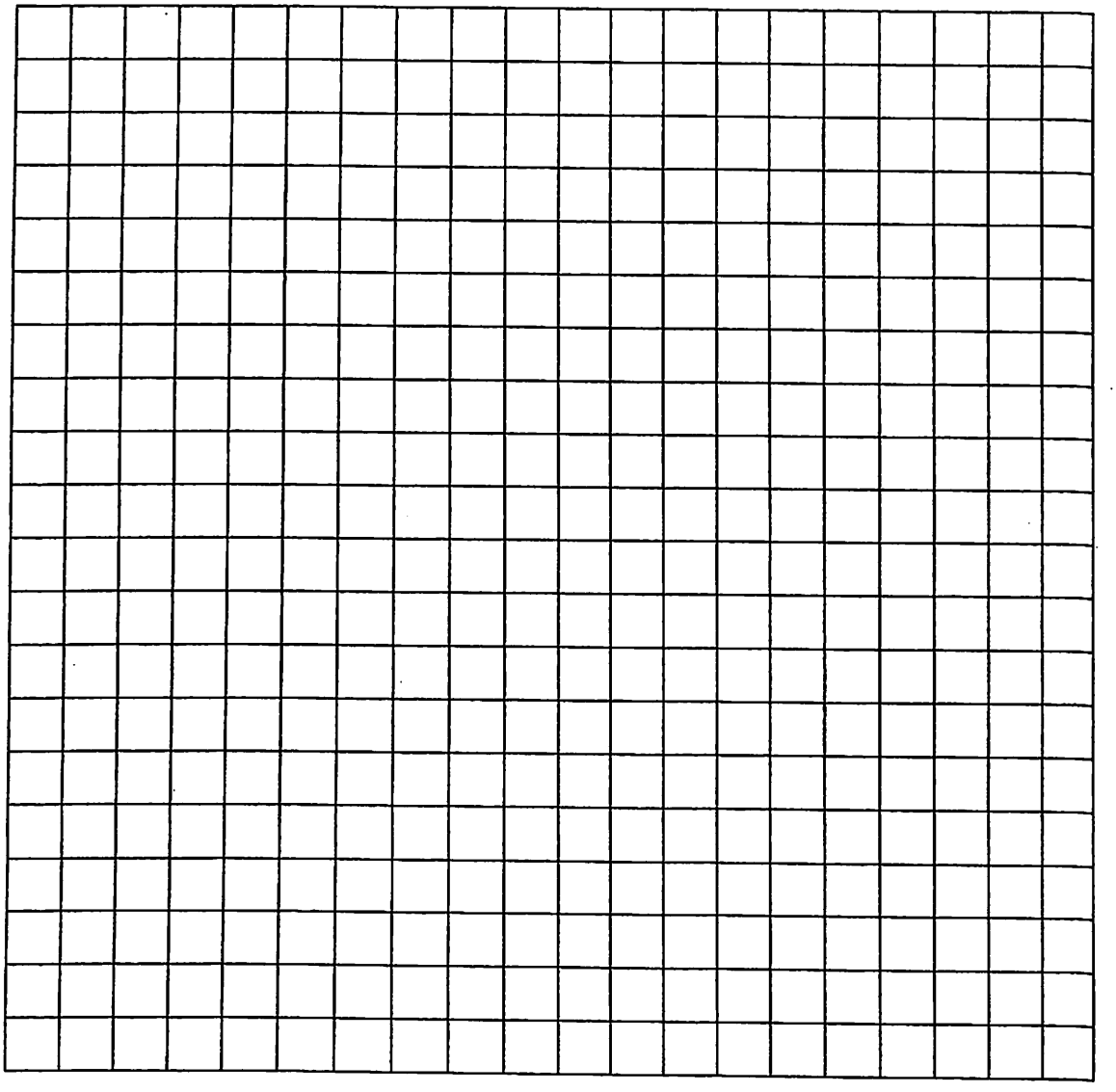


Name _____ Regents Biology

Table 2. Change in Mass of a Developing Baby

Time (weeks)	Mass (grams)		Time (weeks)	Mass (grams)
4 (1 month)	0.5		24 (6 months)	650.0
8 (2 months)	1.0		28 (7 months)	1100.0
12 (3 months)	15.0		32 (8 months)	1700.0
16 (4 months)	100.0		36 (9 months)	2400.0
20 (5 months)	300.0		38 (9.5 months)	3300.0

Title. _____

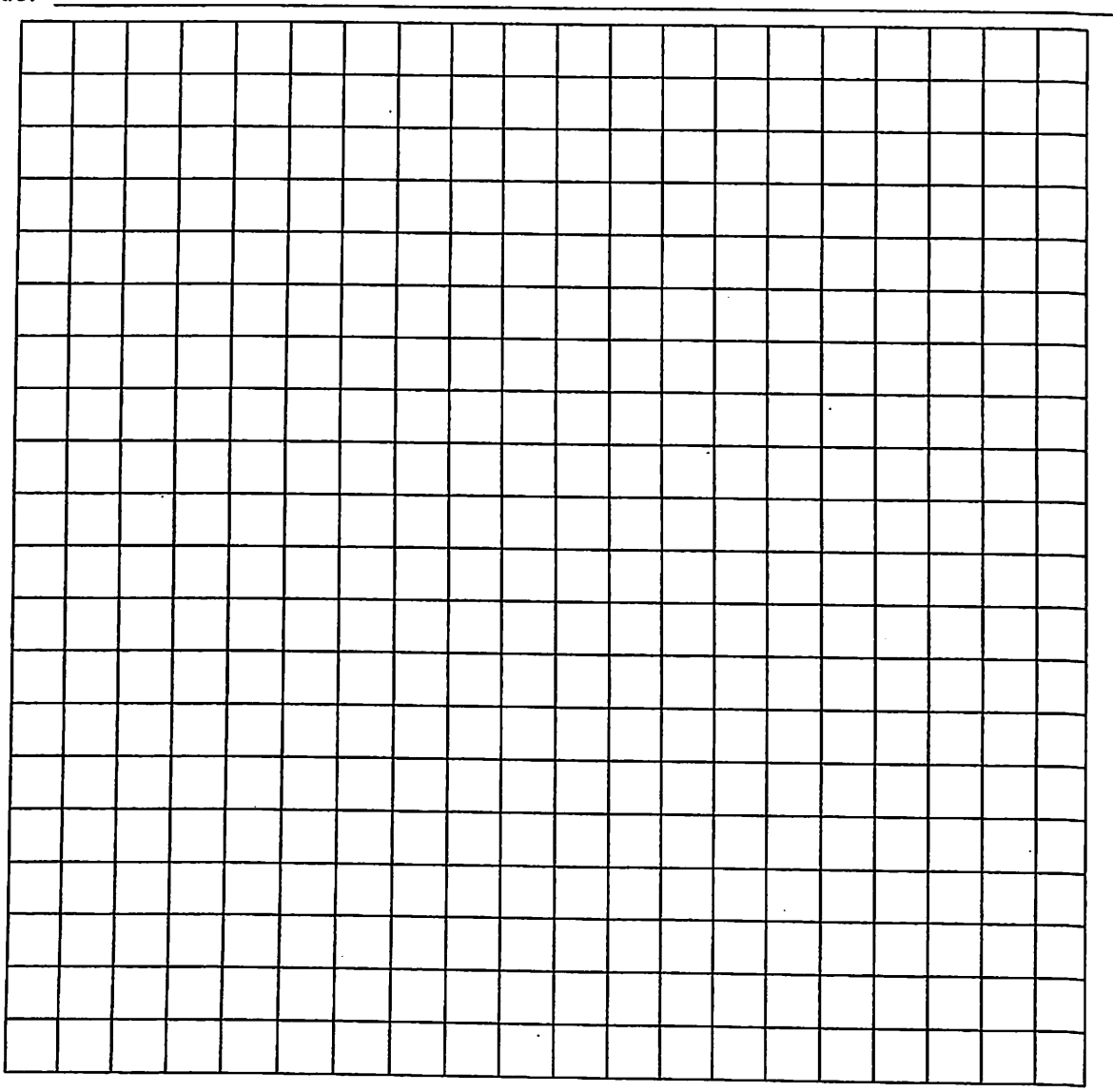


Name _____ Regents Biology

Table 3. Survival Rates of Babies by Developmental Age

Time (weeks)	% Survival		Time (weeks)	% Survival
10	0		25	65 (50–80)
21	0		26	85 (80–90)
22	5 (0–10)		28 (7 months)	95
23	23 (10–35)		30	97
24 (6 months)	55 (40–70)		36 (9 months)	99

Title. _____



Unit 5. Genetics and Biotechnology

Time Frame- About 4 weeks

Overview

A. Structure of DNA
    a. Meaning of Genetics
        i. Heredity
        ii. Chromosomes
            1. Species chromosome number
            2. Karyotype
        iii. Relationship between genes and DNA
        iv. Genetic Recombination (covered here or within Reproduction unit)
        v. Structure of DNA molecule
            1. Nucleotides and their components
            2. Base-pairing method

B. DNA Replication
    a. Concept of template
    b. Enzymes involved

C. RNA
    a. Absence of Thymine and presence of Uracil
    b. messenger RNA
    c. transfer RNA
    d. ribosomal RNA
    e. Protein Synthesis
        i. Transcription
        ii. Translation
        iii. Polypeptide formation
    f. Genetic Code

D. Mutations
    a. Substitutions
    b. Insertion or Addition
    c. Deletion
    d. Inversion

E. Cancer

F. Environment and Gene Expression

G. Genetic Engineering
    a. Restriction Enzymes
    b. Insulin Production
    c. Biotechnology
    d. Selective Breeding
    e. Gene Manipulation
    f. Cloning

NYS Standards

Standard 4: Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 2: Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.

Lesson Objectives:

Students will be able to:

- Define the terms genetics, hereditary traits, gene, chromosome, and karyotype.
- Explore the relationship between chromosomes, genes and DNA
- Describe the structure of DNA
- Define and explain the term base-pairing
- Compare and contrast the roles of DNA and RNA in protein synthesis
- Succinctly describe the role of the 3 types of RNA
- Explain how proteins are synthesized
- Be able to read the genetic code chart
- List some bases of genetic variations
- Explain chromosome and gene mutations
- Explain types and causes of mutations
- Define genetic engineering
- Define biotechnology
- List some ways in which genetic engineering and/or biotechnology are being used to benefit humanity
- Explain the process of cloning
- Identify the techniques of gel electrophoresis and chromatography

Suggested Activities:

- DNA Worksheet
- An Inventory of My Traits
- Strawberry DNA extraction
- Show virtual gel Electrophoresis Lab from http://learn.genetics.utah.edu/content/labs/gel/
- Protein Synthesis (Insulin Lab)
- Mutations and Muscular Dystrophy

Key Vocabulary

Base	Genes	Recombination
Biotechnology	Genetic Engineering	Replicate
Bond	Genetics	Restriction Enzymes
Cancer	Heredity	Selective Breeding
Chromosome	Karyotype	Subunit
Clone	Mutation	Template
Cloning	Nucleotide	Traits
DNA	Polypeptide	Transcription
Expressed	RNA	Translation

DNA

by Drs. Ingrid Waldron and Jennifer Doherty, Department of Biology, University of Pennsylvania, © 2011, version 1

1. What is the function of DNA?

2. Which cells in our bodies contain DNA?

Why do these cells need DNA?

3. Which of the following do you think contains DNA?
   bananas __ concrete __ fossils __ meat __ metal __ spinach __ strawberries __

Explain your reasoning.

DNA Structure

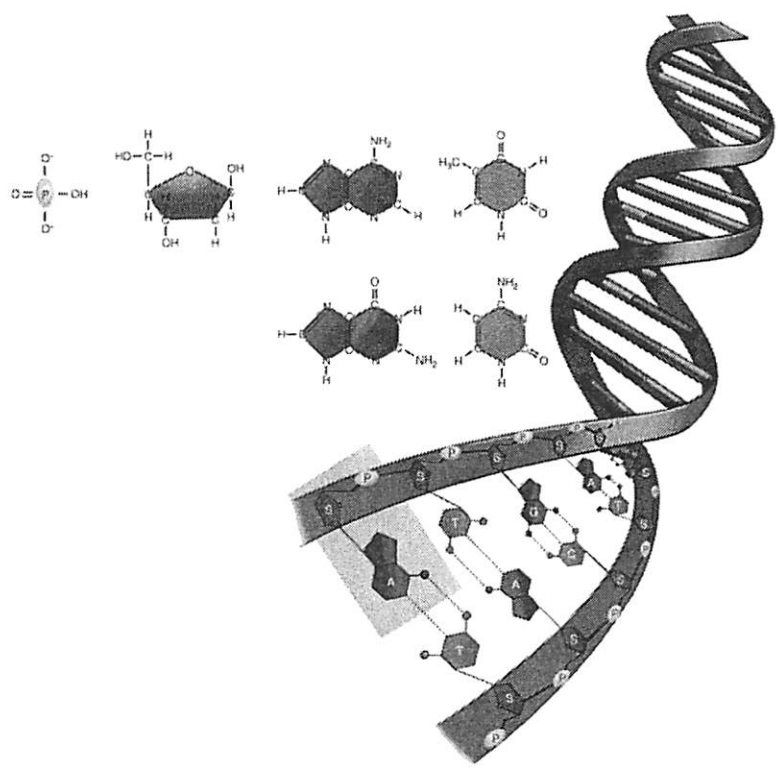
DNA consists of two strands of nucleotides wound together in a **double helix**.

4. Each **nucleotide** contains:
   - a phosphate group
   - a deoxyribose sugar
   - one of four nitrogenous bases.

Connect each part of a nucleotide in the list above to the matching diagram in the figure.

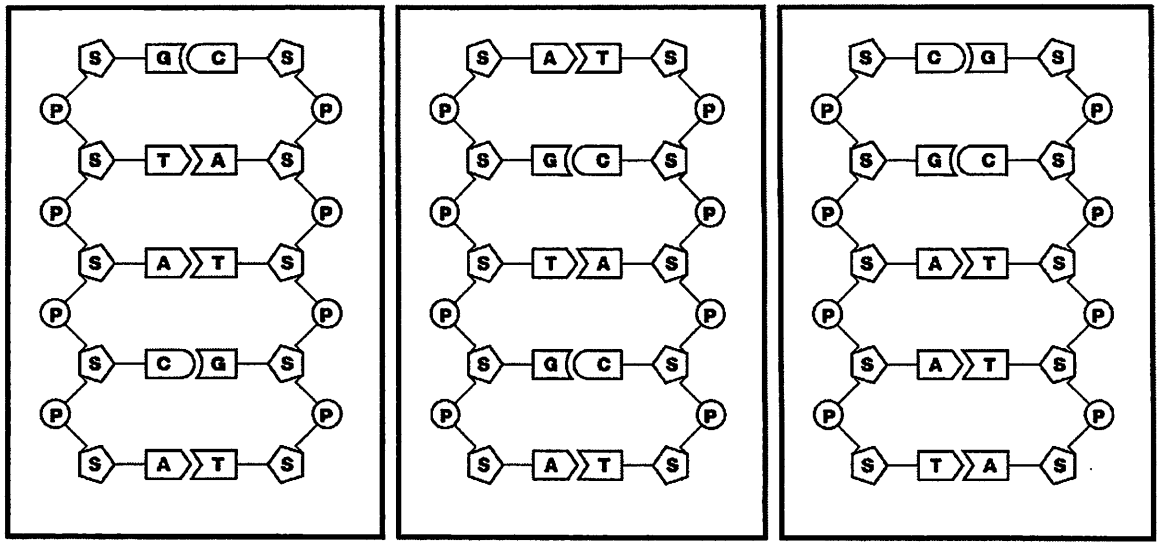
Draw a rectangle around a single nucleotide in the double helix.

5. The complete name for DNA is **deoxyribonucleic acid**. Which component of each nucleotide accounts for the "deoxyribo" part of this name?



The drawings below show a very small section of the DNA double helix from three very different organisms: a plant, a mammal, and a bacterium. Each strand of DNA shown contains five nucleotides. Each nucleotide has:

S = sugar molecule called deoxyribose
P = phosphate group
plus one of the four bases: **A** = adenine, **C** = cytosine, **G** = guanine, or **T** = thymine



Plant **Mammal** **Bacterium**

(From BioRad's "Forensic DNA fingerprinting kit" http://www.bio-rad.com/cmc_upload/Literature/12525/4006096G.pdf)

6. Complete the following sentences to describe the structure of DNA.

In the backbone of each strand in the DNA double helix molecule, the sugar of one nucleotide is bonded to the _____ in the next nucleotide.

The _____ of the nucleotides in each strand of DNA extend toward each other in the center of the DNA double helix molecule.

A in one strand always pairs with _____ in the other strand, and **G** in one strand always pairs with _____ in the other strand. These are the **base-pairing rules**.

7. DNA has the same double helix structure in all living organisms. However, we know that a plant, mammal and bacterium must have different genes in their DNA to result in the very different characteristics of these different organisms. So, the question is: What is different in the DNA of these different organisms? Complete the following table to identify what is different between the DNA of the plant, mammal and bacterium.

	Compare the plant and mammal DNA.	**Compare the mammal and bacterium DNA.**
Is the arrangement of the sugar and phosphate groups the same in each type of DNA?		
Does each type of DNA contain the same four bases (**A, C, G, T**)?		
Is the sequence of bases the same in each type of DNA?		
Are the base-pairing rules the same in each type of DNA?		

What is the only characteristic that differs between these segments of DNA from a plant, a mammal and a bacterium?

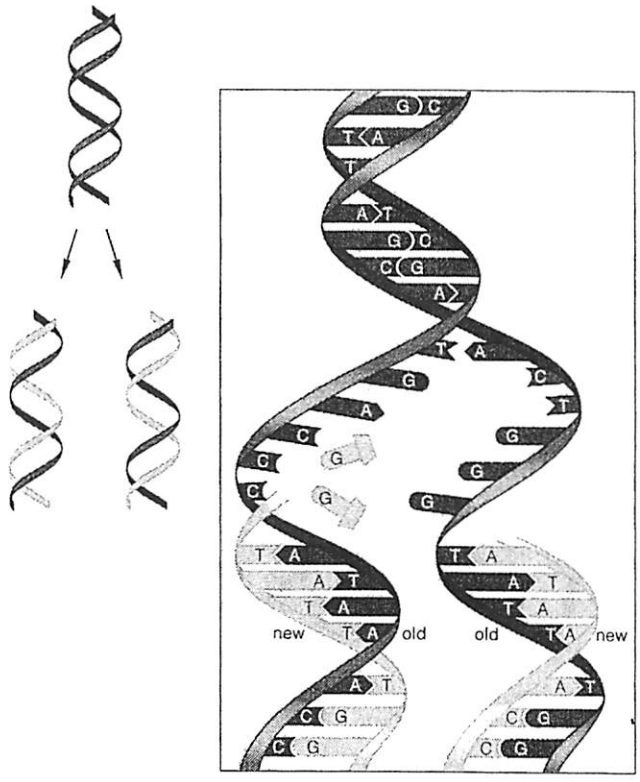
These observations illustrate the similarity of the basic structure of DNA in all living organisms. The genetic differences between plants, mammals and bacteria are due to differences in the sequence of bases in their DNA. The sequence of bases in each gene in the DNA is crucial, since this sequence gives the instructions for how to make each protein and proteins determine the characteristics of the plant, animal or bacterium.

DNA Replication

New cells are formed when a cell divides into two daughter cells. For example, cell division in the lining of your mouth makes the new cells that replace the cells that are rubbed off whenever you chew food. Before a cell can divide, the cell must make a copy of all the DNA in each chromosome; this process is called **DNA replication**.

8. Explain why DNA replication is needed before a cell divides into two daughter cells.

9. The diagrams on the right show DNA replication. Explain in words what happens during DNA replication.

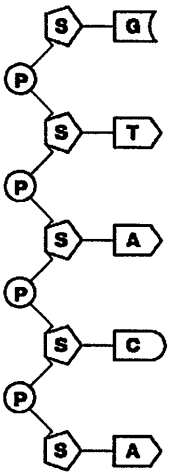


(From Biology -- A Human Emphasis, Sixth Edition by Starr)

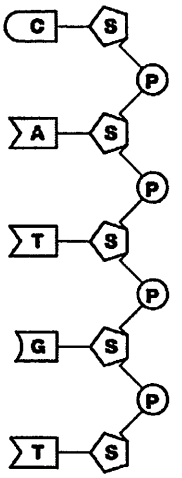
10. What is the function of DNA polymerase?

Based on the function of DNA polymerase, explain why each part of the name DNA polymerase (DNA, polymer, -ase) makes sense.

11. As shown in the diagram on the previous page, during DNA replication the two strands of the double helix separate and each old strand serves as the template for synthesizing a new strand to produce two copies of the original DNA molecule. In the drawing below, the small segment of plant DNA from page 2 is shown after the two strands of the DNA molecule have been separated. Use the base-pairing rules to write in the bases for the nucleotides in both new strands of DNA.



Old Strand New Strand

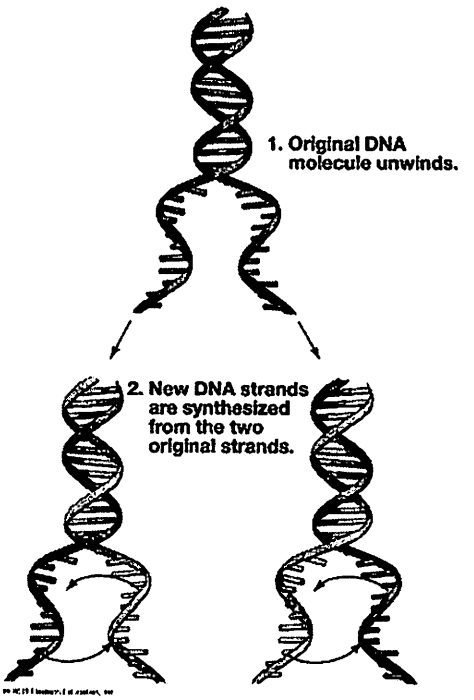


New Strand Old Strand

Look at both of the double-stranded pieces of DNA you have created. Are there any differences between these two pieces of DNA?

Are these new double-stranded pieces of DNA the same as or different from the original piece of plant DNA (shown on page 2)?

12. What is wrong with the figure on the right? Why would the type of DNA replication shown in the bottom part of the figure be biologically impossible?
(Hint: Compare this figure with the figure on page 3 and think about how the new strands are formed when a DNA molecule is replicated.)



DNA -- Teacher Notes

by Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania, 2011[1]

This discussion/worksheet activity can be used to introduce your students to DNA structure and DNA replication or to review these topics. The first version of the Student Handout is designed as a review for students who are already familiar with DNA structure and replication. The second version of the Student Handout includes explanatory material and can be used to introduce students to the double helix structure of DNA and the process of replication.

Teaching Points

- DNA is a nucleic acid made of two strands of nucleotides wound together in a spiral called a double helix.
- Each nucleotide is composed of a sugar molecule known as deoxyribose, a phosphate group, and one of four different nitrogenous bases: adenine (**A**), thymine (**T**), guanine (**G**), or cytosine (**C**).
- The phosphate and sugar parts of the nucleotides form the backbone of each strand in the DNA double helix.
- The bases extend toward the center of the double helix, and each base in one strand is matched with a complementary base in the other strand, in accord with the base-pairing rules: **A** pairs with **T** and **G** pairs with **C**.
- These characteristics are the same for the DNA of all organisms. The DNA of different organisms differs in the sequence of nucleotides, and these differences in nucleotide sequence are responsible for the genetic differences between different organisms.
- DNA replication produces two new DNA molecules that are identical to the original DNA molecule, so each of the new DNA molecules carries the same genetic information as the original DNA molecule.
- During DNA replication, the two strands of the original DNA double helix are separated and each old strand is used as a template to form a new DNA strand. The enzyme DNA polymerase adds nucleotides one-at-a-time, using the base-pairing rules to match each nucleotide in the old DNA strand with a complementary nucleotide in the new DNA strand. Thus, each new DNA double helix contains one strand from the original DNA molecule, together with a newly synthesized matching DNA strand.

Instructional Suggestions, Alternative Versions and Supplementary Biological Information

As background for this activity, students should know that DNA is the genetic material. "Understanding the Functions of Proteins and DNA" (available at http://serendip.brynmawr.edu/exchange/bioactivities/proteins) provides a suggested sequence of activities for introducing students to DNA as the genetic material.

As mentioned above, we have provided two versions of the Student Handout for this DNA activity. The first version is designed for students who are familiar with DNA structure and replication. To maximize student participation and learning you may want to have your students complete the questions individually or in pairs, followed by a whole class discussion.

The second version of the Student Handout includes explanatory material to introduce students to DNA structure and replication. This version also provides a hands-on simulation version of question 11 on page 4. Students use nucleotide diagram pieces and tape to carry out DNA replication (adapted from *Instructor Guide to Biology -- A Guide to the Natural World* by Jennifer Warner). Templates for making enough nucleotide pieces for nine students or pairs of students are provided on the last page of

[1] These Teacher Preparation Notes, the related Student Handout and additional activities are available at http://serendip.brynmawr.edu/exchange/bioactivities/DNA.

these Teacher Notes. Obviously, the Word files for the two different versions of the Student Handout can be used to insert whichever version of question 11 you prefer in whichever version of the Student Handout you prefer.

If you would like to use a hands-on version of this DNA activity that includes extraction of DNA from human cheek cells, we recommend the DNA activity available at http://serendip.brynmawr.edu/sci_edu/waldron/#dna. Another alternative is to use the procedure for extracting DNA from green split peas (available at http://learn.genetics.utah.edu/content/labs/extraction/howto/) in combination with either version of this discussion/worksheet activity. Additional information and suggestions are provided in the Teacher Preparation Notes available at http://serendip.brynmawr.edu/sci_edu/waldron/#dna.

To help students understand why accurate replication of the sequence of nucleotides in DNA is so important, you may want to use all or part of the following diagram in your discussion of question 11 on the top of page 4 of the Student Handout.

nucleotide sequence in the DNA of a gene

→ nucleotide sequence in messenger RNA (mRNA)
(transcription)

→ amino acid sequence in a protein
(translation)

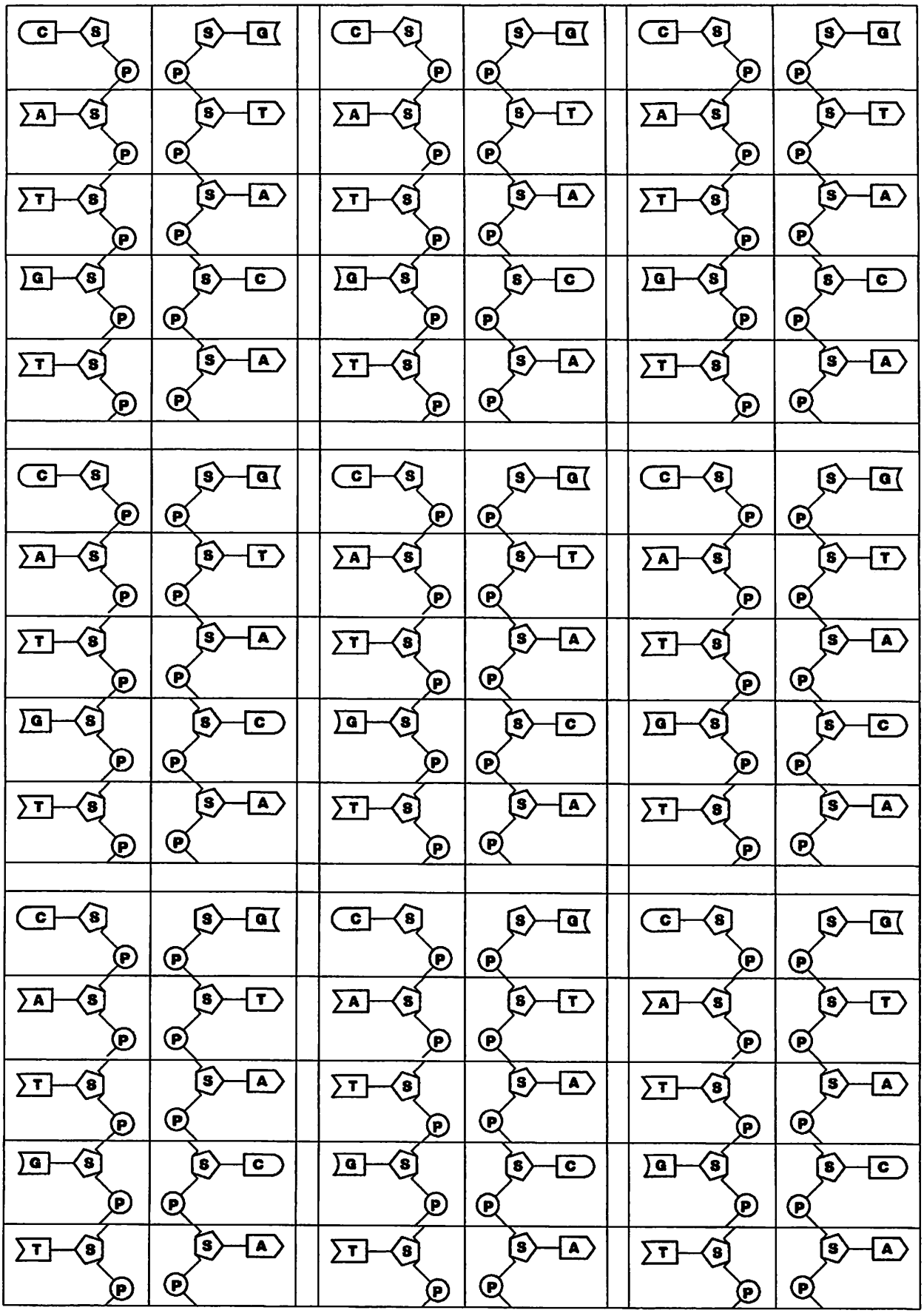
→ structure and function of the protein
(e.g. normal hemoglobin vs. sickle cell hemoglobin)

→ person's characteristics or traits
(e.g. normal health vs. sickle cell anemia)

Our DNA activity teaches students about DNA structure and replication, but includes only minimal discussion of the function of DNA. We recommend that you follow this DNA activity with our activity "From Gene to Protein -- Transcription and Translation" to teach students about the function of DNA. This hands-on simulation activity (available at http://serendip.brynmawr.edu/sci_edu/waldron/#trans) helps students understand how the sequence of nucleotides in a gene specifies the sequence of amino acids in a protein which in turn determines the structure and function of the protein and results in characteristics such as sickle cell anemia.

One important point that is not mentioned in our Student Handout is that, during actual DNA replication, sometimes mistakes are made and the wrong nucleotide is added to the new strand of DNA. DNA polymerase can "proofread" each new double helix DNA strand for mistakes and backtrack to fix any mistakes it finds. To fix a mistake, DNA polymerase removes the incorrectly paired nucleotide and replaces it with the correct one. If a mistake is made and not found, the mistake can become permanent. Then, any daughter cells will have this same change in the DNA molecule. These changes are called point mutations because they change the genetic code at one point, i.e. one nucleotide. Some point mutations result in significant effects, such as the genetic disease, sickle cell anemia.

To ensure student understanding of the basic process of DNA replication, this activity ignores many of the complexities observed in actual DNA replication. Also, although the same basic DNA double helix structure is observed in all living organisms (as emphasized in this activity), the structure of chromosomes differs between eukaryotes and prokaryotes. For more information on these topics, see a college textbook for biology majors such as Campbell, Reece, et al., Biology; Freeman, Biological Science; or Raven et al., Biology.



Nucleotides for Nine Students or Pairs of Students
for the Hands-On Version of Question 11 on Page 4 of the Student Handout, Version 2

An Inventory of My Traits

Abstract

Students take an inventory of their own easily-observable genetic traits. Working in small groups, they observe how their trait inventories differ from those of others. Students record their observations in a data table and make a bar graph to show the most and least common traits in the group.

Logistics

Time Required

- **Class Time:**
  30 minutes
- **Prep Time:**
  20 minutes to review activity and make copies of student pages

Materials

Copies of student pages

Prior Knowledge Needed

How to construct and read bar graphs

Appropriate For:

Ages: 10 - 13
USA grades: 5 - 7

Learning Objectives

- Traits are observable characteristics that are passed down from parent to child.
- An individual will have many traits they share in common with others.
- An individual's overall combination of traits makes them unique.
- Some traits are more common in a population than others.

Special Features You'll Find Inside

- Includes a fun optional activity in which students predict the number of traits it will take to distinguish a student volunteer from everyone else in the class.
- Includes a math extension in which students calculate the frequency of traits in their classroom, then compare their calculations with given frequencies for the general population.

Module
The Basics and Beyond:
An Introduction to Heredity

An Inventory of My Traits

Classroom Implementation

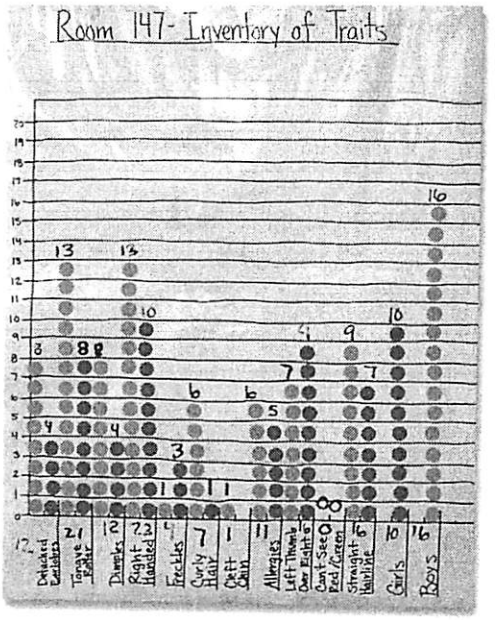
Quantities

Per Student

- One copy of student pages S-1 to S-3

Activity instructions:

- Begin by demonstrating one of the traits listed in *An Inventory of My Traits: Survey* (page S-1). Ask students who possess this trait to stand. Point out the relative numbers of students standing and sitting for the trait. Continue this process with 2-3 more traits.



- Explain that traits are observable characteristics we inherit from our parents. Some traits are common in a population (our class) while others are not. And, every person has a different overall combination of traits that makes them unique.
- Divide students into groups of four or more. Have each student in the group complete An Inventory of My Traits: Survey (page S-1) to determine their unique combination of the traits described.
- After students complete the survey, have them tally their group information on the data table (page S-2) and draw a bar graph (page S-3).
- *Optional*: You may collect the traits data from the whole class by creating a large wall chart (see example on the left). Have a representative from each group fill in their data. Once all the data has been collected, have the students make a bar graph from the class data or make one large graph together.

Optional activity:

- Ask students to predict how many traits they would have to look at on the *Survey* in order to identify any given classmate as unique.
- Select a volunteer who would like to determine his or her uniqueness. Ask all students to stand.
- Have the volunteer call out one of their traits at a time, beginning with question 1 on the *Survey* and continuing in sequence. For each trait, direct all students who do not share that trait to sit down; students who share the trait remain standing. Once a student sits down, they do not get up again.

Common Misconceptions

Students may think that the more common traits are "better", but this is not always the case. Sometimes traits simply show up more frequently in the human population.

More advanced students may think that dominant traits are more common than recessive traits. However, frequency has very little to do with whether a trait is dominant or recessive. That is, a dominant trait is not necessarily more common and a recessive trait is not necessarily rare in a population.

An Inventory of My Traits

- Continue in this way until the volunteer is the only one standing. Count the number of traits it took to distinguish the volunteer from everyone else in the class. Compare this number with the students' predictions.
- Repeat with several additional volunteers.

Math extension:

- Have students practice converting fractions to decimals, then decimals into percentages by calculatig the frequency of the following traits in your classroom: tongue rolling, handedness and hand clasping.
- Students can then compare their calculated frequencies with those for the general population (provided in the table below).

Example: # of students with the trait/# of students in the class x 100 = _____%
15 tongue rollers / 21 students in the class x 100 = 71%

Trait	Frequency in General Population*
Tongue rolling	Can roll tongue – 70% Cannot roll tongue – 30%
Handedness	Right handed – 93% Left handed – 7%
Hand clasping	Left thumb on top – 55% Right thumb on top – 44% No preference – 1%

*Frequencies for traits are from Online Mendelian Inheritance In Man (see http://www.ncbi.nlm.nih.gov/omim/).

Standards

U.S. National Science Education Standards

Grades 5-8:
Content Standard C: Life Science - Reproduction and Heredity

- Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.
- The characteristics of an organism can be described in terms of a combination of traits.

AAAS Benchmarks for Science Literacy

Grades 3-5:
The Living Environment: Heredity - Some likenesses between children and parents, such as eye color in human beings, or fruit or flower color in plants, are inherited. Other likenesses, such as people's table manners or carpentry skills, are learned.

Module
The Basics and Beyond: An Introduction to Heredity

An Inventory of My Traits

For offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next.

Credits

Activity created by:
Molly Malone, Genetic Science Learning Center
April Mitchell, Genetic Science Learning Center
Louisa Stark, Genetic Science Learning Center
Harmony Starr, Genetic Science Learning Center (illustrations)

This activity was adapted from: "Alike But Not The Same" in Human Genetic Variation, NIH Curriculum Supplement Series (1999). Available at http://science-education.nih.gov/customers.nsf/highschool.htm.

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Additional Resources

Visit the Teach.Genetics website to get more great resources like these!

Name _____

Date _____

An Inventory of My Traits – Survey

What combination of these traits do you have? Complete the survey to find out.

1.	I have detached earlobes	☐ Yes	☐ No
2.	I can roll my tongue	☐ Yes	☐ No
3.	I have dimples	☐ Yes	☐ No
4.	I am right-handed	☐ Yes	☐ No
5.	I have freckles	☐ Yes	☐ No
6.	I have naturally curly hair	☐ Yes	☐ No
7.	I have a cleft chin	☐ Yes	☐ No
8.	I have allergies	☐ Yes	☐ No
9.	I cross my left thumb over my right when I clasp my hands together	☐ Yes	☐ No
10.	I can see the colors red and green (I am not color blind)	☐ Yes	☐ No
11.	The hairline on my forehead is straight.	☐ Yes	☐ No
12.	I am a:	☐ Male	☐ Female

Adapted from "Alike But Not The Same" in Human Genetic Variation, NIH Curriculum Supplement Series 1999. http://science-education.nih.gov

Name _____

Date _____

An Inventory of My Traits – Data Table

How many people in your group have each trait?
Fill in the data table below by counting the number of people who marked "yes" and the number of people who marked "no" for each trait.

TRAIT	YES	NO
Detached earlobes		
Tongue rolling		
Dimples		
Right-handed		
Freckles		
Naturally curly hair		
Cleft chin		
Allergies		
Cross left thumb over right		
See the colors red and green		
Have a straight hairline		

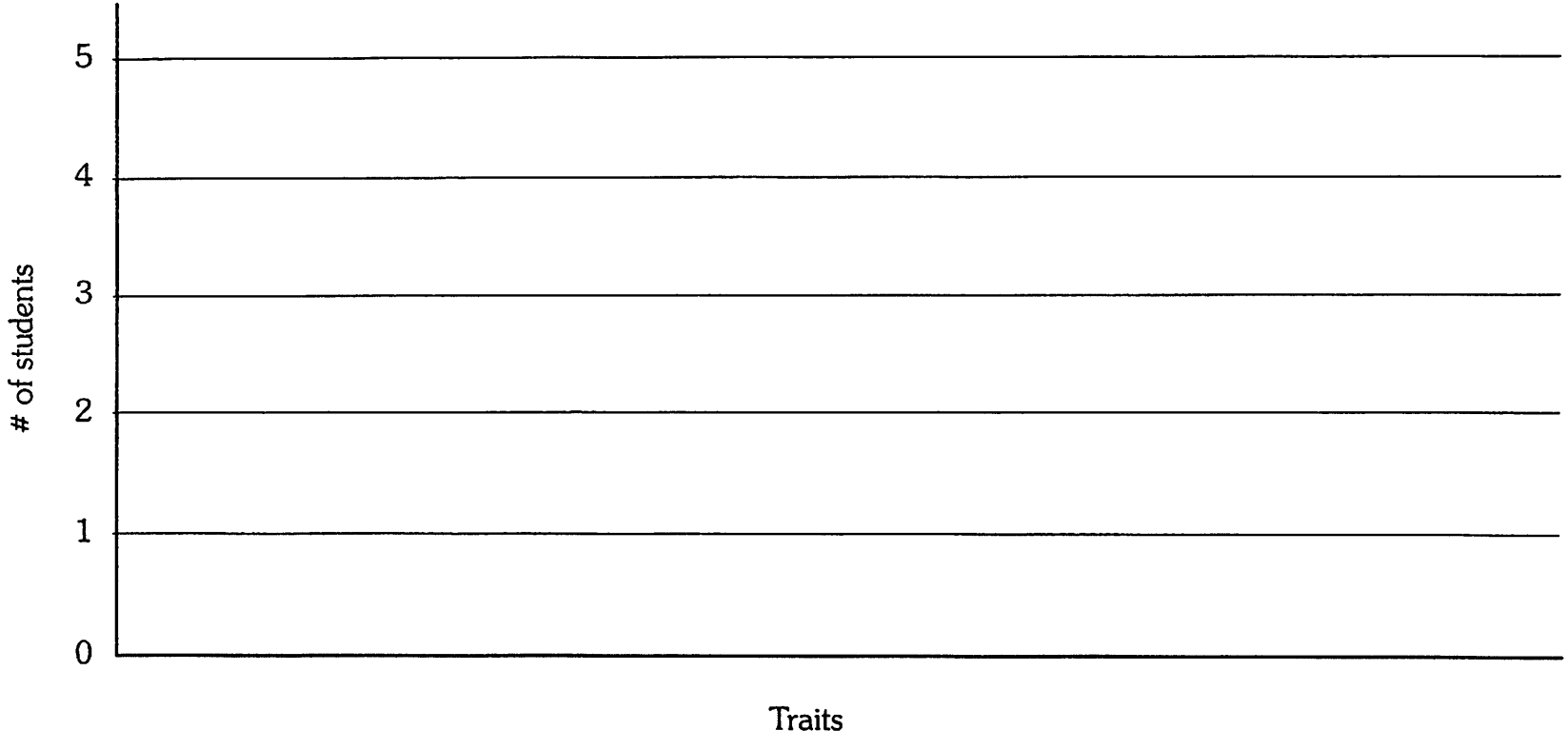
Adapted from "Alike But Not The Same" in Human Genetic Variation, NIH Curriculum Supplement Series 1999. http://science-education.nih.gov

Name _____

Date _____

An Inventory of My Traits – Graph

Make a bar graph showing how many people in your group answered "yes" for each trait. Be sure to label each trait under the bar you draw for it.



Name _____

Date _____

Un Inventario de mis Rasgos – Encuesta

¿Quales son los rasgos que tú tienes que se le hacen singular?
Para averigüar, completa la encuesta que sigue abajo.

1.	Tengo los lóbulos de las orejas separados	☐ Si	☐ No
2.	Puedo hacer rollito mi lengua	☐ Si	☐ No
3.	Tengo hoyuelos	☐ Si	☐ No
4.	Escribo con la mano derecha	☐ Si	☐ No
5.	Tengo pecas	☐ Si	☐ No
6.	Mi cabello es rizado por naturaleza	☐ Si	☐ No
7.	Tengo la barbilla partida	☐ Si	☐ No
8.	Tengo alergias	☐ Si	☐ No
9.	Cuando entrelazo mis dedos pongo mi pulgar izquierdo sobre mi pulgar derecho	☐ Si	☐ No
10.	Puedo ver los colores rojo y verde (No soy daltónico)	☐ Si	☐ No
11.	La rayita en mi frente es recta	☐ Si	☐ No
12.	Yo soy:	☐ Hombre	☐ Mujer

Adapted from "Alike But Not The Same" in Human Genetic Variation, NIH Curriculum Supplement Series 1999. http://science-education.nih.gov

Name _____

Date _____

Un Inventario de mis Rasgos – Tabla de Datos

¿Cuantas personas de tú grupo tienen cada rasgo?
Completa la tabla de datos que aparece a continuación contando el número de personas que marcaron "Si" y el número de personas que marcaron "No" en cada rasgo.

RASGO	SI	NO
Lóbulos de las orejas unidos		
Puede hacer rollito la lengua		
Hoyuelos		
Escribe con la mano derecha		
Pecas		
Cabello rizado natural		
Barba partida		
Alergia		
Cruza el pulgar izquierdo sobre el derecho		
Puede ver los colores rojo y verde		
Tenga una rayita recta		

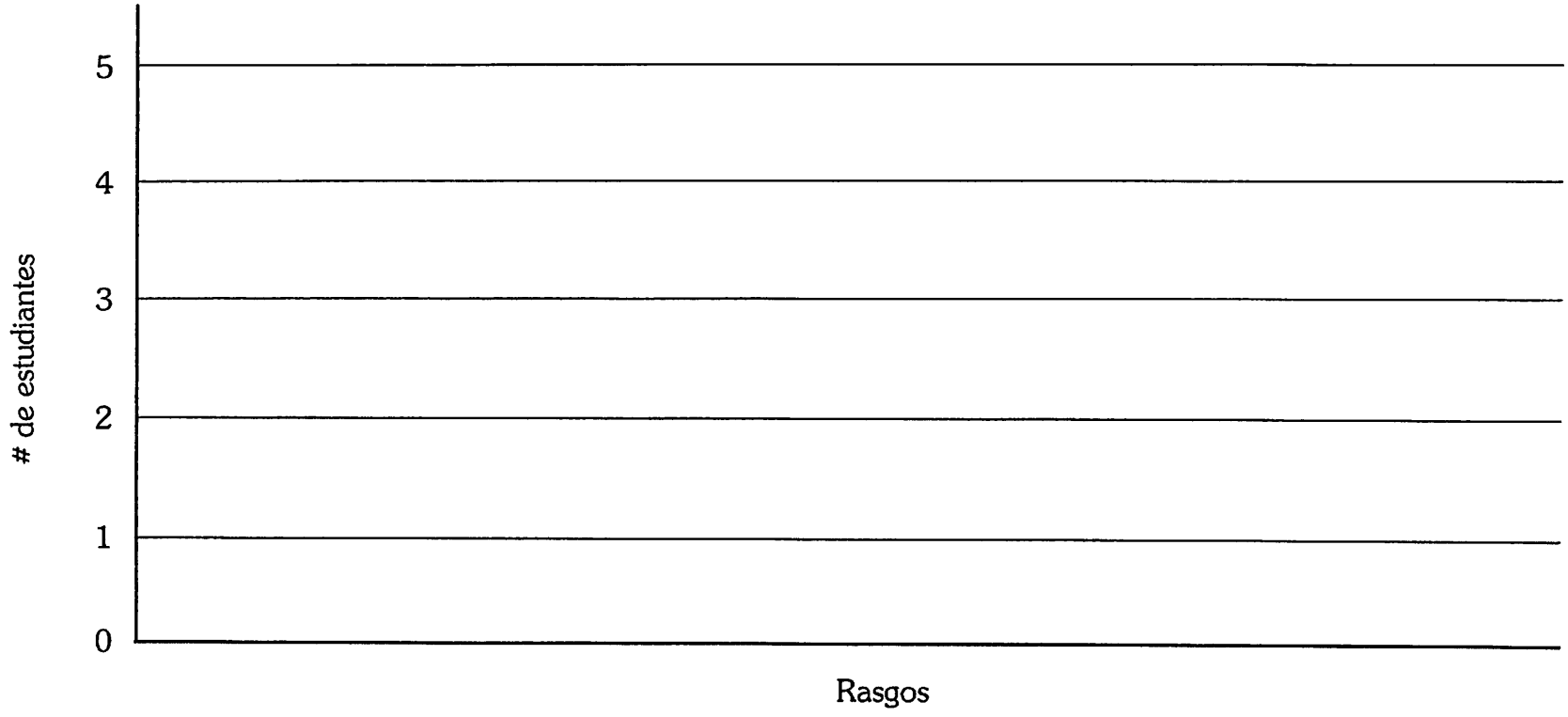
Adapted from "Alike But Not The Same" in Human Genetic Variation, NIH Curriculum Supplement Series 1999. http://science-education.nih.gov

Name _____

Date _____

Un Inventario de mis Rasgos – Gráfica

Haz una gráfica de líneas mostrando cuántas personas en tu grupo contestaron "Si" en cada rasgo. Asegúrate de marcar cada barra con el nombre del rasgo que estás dibujando.



General Biology Lab

Strawberry DNA Extraction

Background

The native wild or wood strawberry, *Fragaria vesca*, has only two sets of chromosomes (diploid), but the grocery store strawberry, *Fragaria ananassa*, has eight sets of chromosomes(octoploidy) and will supply an abundance of DNA. So, commercial strawberries make an excellent subject for collecting DNA.

Another reason strawberries work so well is that they are soft and easy to smash. Also, ripe strawberries produce enzymes (pectinases and cellulases) which help in breaking down the cell walls making it easier to extract the DNA.

First, you are going to break open the cells of a fresh strawberry by crushing it. Second, you will use a lysis buffer to break down the cellular and nuclear membranes to separate the DNA from the other cell parts. Third, you will filter the solid material out with a piece of cheesecloth and collect the liquid containing the DNA. Finally, you precipitate the DNA from the solution using cold ethanol.

After completing this lab, you will have a sample of pure strawberry DNA and you will never again look at a strawberry in the same way.

Objectives

The purpose of this activity is become familiar with lab procedures for extracting DNA, collect a DNA sample and observe the physical characteristics of DNA.

Materials

- Zip seal plastic bag
- 1 strawberry
- 10 ml lysis buffer
- cheesecloth
- small plastic cup
- 95% ethanol (ever clear)
- ice water bath
- test tube
- Plastic stir stick
- Safety goggles

Safety Precautions

- Most of the chemicals are fairly mild but treat all chemicals with respect.
- Wear safety goggles.
- Make sure you wash your hands after the lab.

Procedure

1. Obtain a fresh strawberry. If the green leaves (sepals) on the strawberry have not yet been removed; remove them.
2. Place the strawberry in a zip seal plastic bag. Press the air out and seal it.
3. Gently mash the bagged strawberry with your fingers for 5 minutes. Don't break the bag.
4. Add 10 ml of lysis buffer to the bag. Press the air out carefully and seal the bag.
5. Mash the bagged strawberry with the lysis buffer for 2 minutes.

   CAUTION: Mix carefully, the fewer bubbles created the better your results.
6. Cut one of the bottom corners of your baggie off and squeeze the strawberry pulp along with the liquid into a small cup covered with cheesecloth.
7. Rinse the pulp with water to ensure you obtain as much DNA as possible.
8. Discard the baggie, cheesecloth and the strawberry pulp into the trash can.
9. Place the filtrate into a test tube, but leave room to add the alcohol.
10. **Slowly** drizzle **ice-cold** ethanol **along the side of the test tube** until DNA begins to appear. It will look somewhat like cotton candy fibers.
11. Keep the test tube at eye level so you can see what is happening! Pay attention to the characteristics of the DNA as it precipitates.

Analysis

1. What did the DNA look like?

2. In order to study our genes, scientists must extract the DNA from human tissue. Would you expect the method of DNA extraction we used for the strawberry to be the same for human DNA? Explain?

3. Is the DNA in any cell in the human body the same? Explain your answer.

4. If you wanted to extract DNA from a living person, which cells would you use and why?

5. Please list two reasons why a scientist might want to study the DNA of strawberries.

Name: _____ Lab Activity

General Biology

Strawberry DNA Extraction

1. What is the function of DNA?

_____

_____

2. Where is DNA located?

_____

3. What are the three basic steps for DNA extraction?

_____

_____

_____

4. How do these steps differ for extraction of DNA from bacteria?

_____

5. What is the purpose of the salt solution in this experiment?

_____

6. Why was detergent added to the extraction buffer?

_____

7. Why does the DNA rise to the top after addition of the alcohol?

_____

_____

"The greater the scientist, the more he is impressed with his ignorance of reality, and the more he realizes that his laws and labels, descriptions and definitions, are the products of his own thought.

They help him to use the world for purposes of his own devising rather than understand and explain it."

--Alan W. Watts

Name: _____ Date: _____

Protein Synthesis
(Insulin Lab)

Purpose: Students will translate DNA strands into and protein model, and use the DNA and model to compare the biochemistry of human and cow insulin

Materials:

Pencil	Amino acid cut outs
Red pen, pencil or marker	Scissors
Human and Cow Insulin Code	Glue or Tape
RNA Codon Translation Key	Envelope

Procedure

Your handout shows 2 DNA sequences that code for the manufacture of *insulin*, the protein-based hormone which controls the body's uptake of sugar from the blood. The first sequence codes for human insulin, and the second sequence codes for cow insulin.

Day One

1. Use a pencil to separate the human insulin code into codons by drawing vertical lines after every third base.

2. Copy all the codons from the human insulin sequence into the first row in **table 1** (DNA Codon). Be sure to record the codons in the same order in which they appear in the original DNA strand.

3. In the second row of **table 1**, write the **mRNA codons** that complement the DNA codons in the first row (remember the base pair rules).

4. Use **table 3** to **translate** the mRNA codons into **amino acids.** Write the amino acids in the third row of **table 1**, underneath their corresponding mRNA codons.

5. Double check your answers with the teacher.

6. Repeat steps 1-5 using the Cow Insulin.

7. Compare the two sequences of DNA. In tables 1 and 2, draw a **red circle** around **all** the DNA and mRNA codons and amino acids which are **different** in the human and cow (note: a difference in DNA may NOT result in a different amino acid – only circle the amino acids that are *different* from each other).

Day Two

8. Find a partner to work with.

9. Get a copy of the **Amino Acids** hand out, scotch tape or glue, and scissors.

10. Examine the Amino Acids handout. You should see numerous shapes, which represent different types of amino acids. Cut out those shapes, and arrange them face up on your desk, so that you can read the name for each amino acid.

11. Your partner and you will assemble the amino acids into a **chain** which is a model of the insulin protein. One of you will make the "human insulin" model, the other the "cow insulin" model. Decide now who will make which molecule.

12. Start with the first amino acid in your molecule (which should be GLY for both the human and cow insulin).

13. Place the second amino acid (ILE) so that it covers the box marked "X" on GLY, and the GLY arrow points to the black line on ILE. Check to make sure you have done it correctly, then tape or glue the two amino acid "molecules" together.

14. Continue adding each amino acid, so that each new molecule covers the "X" of the molecule before it, and the arrows form a continuous (if twisting) line. It is OK if the amino acids overlap.

15. When you are finished, show the molecule to your teacher.

16. When you and your partner are finished, compare your molecules to each other, and note any similarities or differences.

17. At the end of the activity, attach your insulin model to the lab with paper clips, tape, glue or staples (note: that's OR, not AND).

Questions (answer 3-10 in complete sentences)

1. How many differences were there in the DNA codons for human and cow insulin?

2. How many differences were there in the amino acids of human and cow insulin?

3. How are the human and cow sequences for insulin similar? Specifically look at their length, the bases in them, and the order of the bases.

4. Did every difference in the DNA sequence result in a difference in the amino acid sequence? Why, or why not?

5. What is the relationship between DNA and amino acids?

6. What is the relationship between amino acids and proteins?

7. The function of a protein is determined by its shape. What determined the shape of your insulin model?

8. For many years diabetics used injections of cow or sheep insulin to control their disease. Compare the human insulin and cow insulin models. Why was cow insulin an effective substitute for the human insulin?

9. What would happen to the insulin molecule if the amino acids were assembled in a different order?

10. A mutation causes the 18th base in the human DNA sequence to change from A to T. Would this code for a functional protein? Explain your answer.

Table 3: RNA Codon Translation

FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC } PHE	UCU, UCC, UCA, UCG } SER	UAU, UAC } TYR	UGU, UGC } CYS	U
	UUA, UUG } LEU		UAA, UAG } STOP	UGA } STOP	C
				UGG } TRP	A
					G
C	CUU, CUC, CUA, CUG } LEU	CCU, CCC, CCA, CCG } PRO	CAU, CAC } HIS	CGU, CGC, CHA, CGG } ARG	U
			CAA, CAG } GLN		C
					A
					G
A	AUU, AUC, AUA } ILE	ACU, ACC, ACA, ACG } THR	AAU, AAC } ASN	AGU, AGC } SER	U
	AUG } MET or START		AAA, AAG } LYS	AGA, AGG } ARG	C
					A
					G
G	GUU, GUC, GUA, GUG } VAL	GCU, GCC, GCA, GCG } ALA	GAU, GAC } ASP	GGU, GGC, GGA, GGG } GLY	U
			GAA, GAG } GLU		C
					A
					G

DNA Code for Insulin

Sequence 1: Human Insulin

CCATAGCACCTTGTTACAACGTGAAGGTAAACAAGGGACATGGTTGACCTTTTGATGACATTA

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
DNA Codon																					
mRNA Codon																					
Amino Acid																					

Sequence 2: Cow Insulin

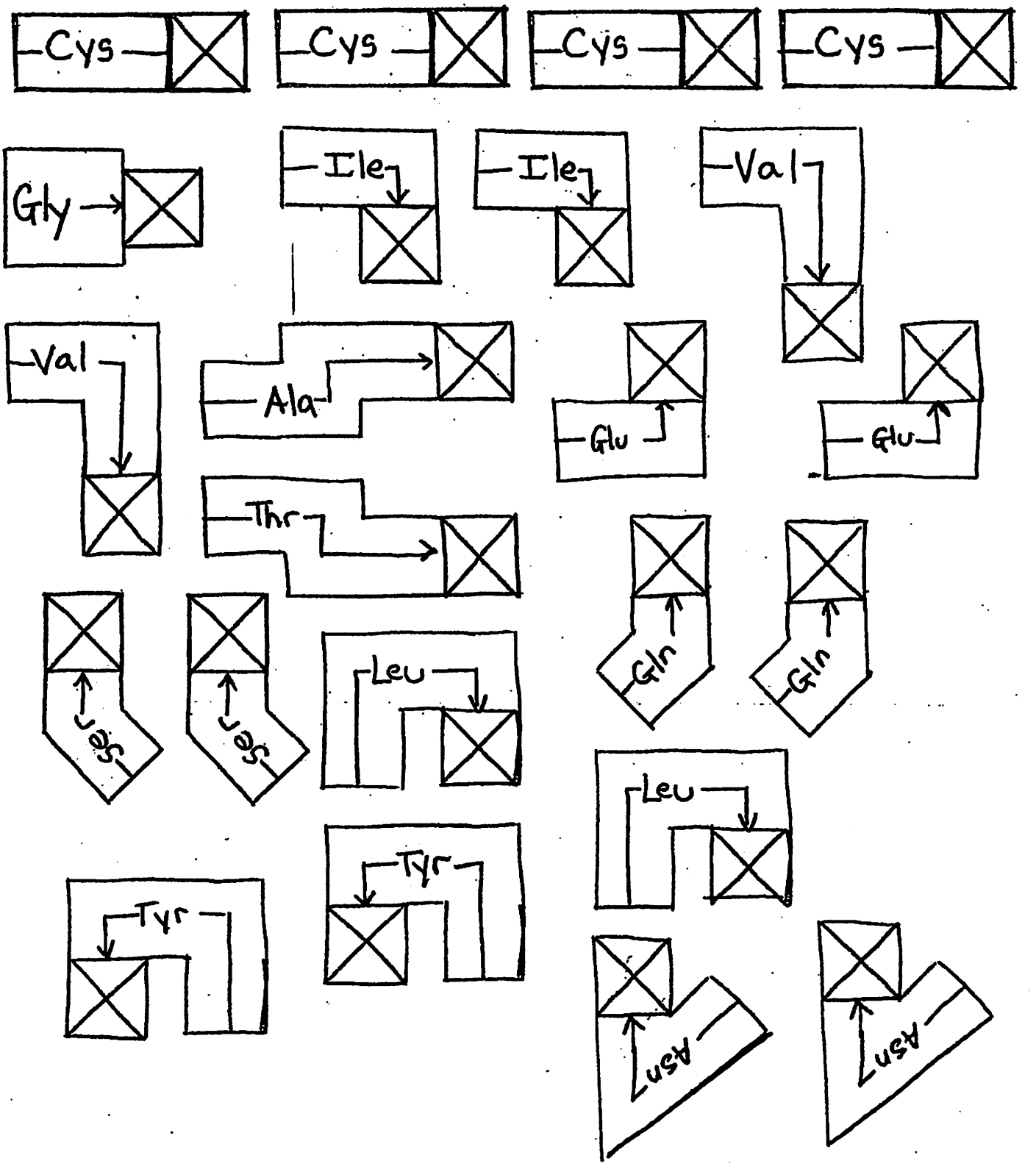
CCGTAGCATCTTGTTACAACGCGAAGGCACACAAGGGAGATGGTTGACCTTTTGATAACATTA

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
DNA Codon																					
mRNA Codon																					
Amino Acid																					

HUMAN INSULIN

Cow Insulin

Amino Acids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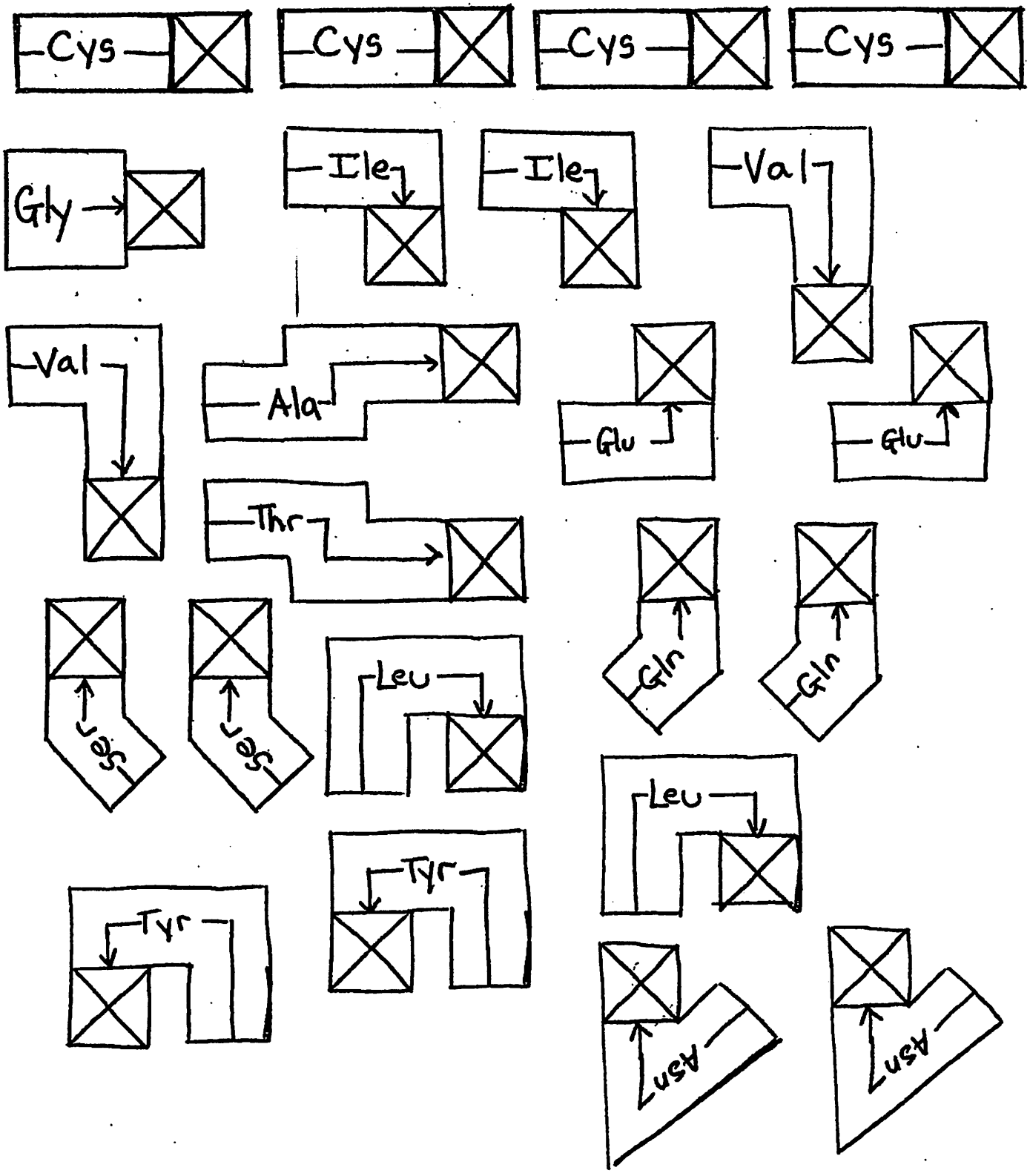
Amino Acids


Cys
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Teacher Notes for
The Molecular Biology of Mutations and Muscular Dystrophy

By Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania, 2011[1]

In this discussion/worksheet activity students explore the effects of different types of point mutations and deletion mutations and analyze the reasons why deletion mutations generally have more severe effects than point mutations. Students use their understanding of the molecular biology of mutations to analyze the genetic basis for the differences in severity of two types of muscular dystrophy. To maximize student participation and learning, you may want to have your students complete the questions individually or in pairs and then have a whole class discussion.

To answer the questions in this activity, students need to understand the genetic code and the processes of transcription and translation. To help your students learn this needed background, I recommend the hands-on simulation activity, "From Gene to Protein - Transcription and Translation" (available at http://serendip.brynmawr.edu/sci_edu/waldron/#trans).

Teaching Points

- A mutation is a permanent change in the DNA of a gene.
- A change in a single nucleotide is a point mutation. Some point mutations result in a change in a single amino acid in the polypeptide produced by transcription and translation of the gene. Other point mutations change a codon to another codon for the same amino acid, resulting in no change in the amino acid sequence of the polypeptide. In other cases, a point mutation results in a stop codon which terminates translation and can result in a drastically shortened, nonfunctional protein.
- If a deletion mutation results in the deletion of one nucleotide from the mRNA molecule or the deletion of any other number of nucleotides that is not a multiple of 3, this causes a frameshift during translation of the mRNA. Every codon after this frameshift is changed, which usually results in the production of a nonfunctional protein. In contrast, a deletion mutation that results in the deletion of three nucleotides or a multiple of three nucleotides from the mRNA molecule will have less severe consequences since there is no frameshift and the subsequent codons will not be affected. This same frameshift rule applies to the effects of insertion mutations.
- Most cases of the more severe Duchenne muscular dystrophy result from frameshift deletion mutations or point mutations that produce a stop codon, while the milder Becker muscular dystrophy results from deletion mutations that do not cause a frameshift.

Suggestions for Discussing Student Handout Questions, with Biology Background

1- 2. The effects of the various mutations should be related to the students' understanding of the process of translation (including the effects of stop codons and the effects of shifts in the reading frame for an mRNA molecule in the ribosome).

The first mutation shown is typically described as a silent mutation since there is no change in the amino acid sequence in the polypeptide. However, recent research has shown that some so-called silent mutations are harmful because they affect RNA folding and thus the rate of breakdown of the RNA transcript or because they serve as a better or worse marker of the end of an exon.

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[1] These teacher notes, the student handout for this activity, and links to additional activities are available at http://serendip.brynmawr.edu/exchange/bioactivities.

The second mutation shown illustrates a missense mutation since there is a change in one of the amino acids in the polypeptide, and the third mutation shown is called a nonsense mutation because it results in an early stop codon. Some missense mutations have little effect, e.g. if an amino acid with similar chemical properties is substituted or the change in amino acid occurs in a region which is not crucial for the function of the polypeptide. Other missense mutations have a substantial effect, e.g. the substitution of a single amino acid which results in the difference between normal hemoglobin and sickle cell hemoglobin (discussed in the hands-on activity "From Gene to Protein - Transcription and Translation", available at http://serendip.brynmawr.edu/sci_edu/waldron/#trans).

The deletion mutations shown are frameshift mutations. (Insertion mutations can also result in a shift in the reading frame in the ribosome.) To help students understand the difference in effects of deletion vs. point mutations you may want to use the following example:

Normal sentence

The big cat ate the fat rat.

Point mutation sentence

i replaced with o

The bog cat ate the fat rat.

Deletion mutation sentence

g deleted

The bic ata tet hef atr at.

The mutations shown in question 1 illustrate the range of effects that can be caused by a change in or deletion of a single nucleotide. Of course there are many other types of mutation, including substitution, deletion or insertion of multiple nucleotides or chromosomal rearrangements.

3. Both Duchenne muscular dystrophy and Becker muscular dystrophy result from mutations of a gene on the X chromosome that codes for the dystrophin protein in muscle cells; this protein helps to stabilize the plasma membrane during the mechanical stresses of muscle contraction. About two-thirds of cases are due to deletion mutations. If the number of nucleotides deleted in the mRNA is not a multiple of three, this type of frameshift mutation results in a severely defective or absent version of the protein, resulting in more rapid breakdown of muscle cells and the more severe Duchenne muscular dystrophy. If the number of nucleotides deleted in the mRNA is a multiple of three, the mutation does not cause a frameshift and this typically results in a less defective version of the protein, less rapid breakdown of muscle cells, and the milder Becker muscular dystrophy. (Notice that the crucial factor is whether the mutation is a frameshift mutation, not the overall length of the deletion which can be quite long for some cases of Becker muscular dystrophy and quite short for some cases of Duchenne muscular dystrophy.) Up to one-fifth of cases of Duchenne muscular dystrophy are caused by a nonsense mutation, i.e. a point mutation that results in a stop codon. (The type of muscular dystrophy can also be influenced by additional factors such as the specific location of the mutation in the dystrophin gene.)

Because the dystrophin gene is on the X chromosome and because the alleles for defective dystrophin are recessive, both of these types of muscular dystrophy are much more common in boys than in girls. Duchenne muscular dystrophy affects one in every 3500 male babies.

For more information on muscular dystrophy see:

- Your Genes, Your Health from the DOLAN DNA LEARNING CENTER, available at http://www.ygyh.org/dmd/whatisit.htm
- Muscular Dystrophy, available at http://www.mayoclinic.com/health/muscular-dystrophy/DS00200

Alternative Activity

"Cookie-ase" (available on the molecular biology page of https://sites.google.com/site/biologypd/home) is a hands-on simulation activity that covers many of the same points, but with a greater emphasis on enzyme function (including phenotypic effects of the tyrosinase gene in albinism) and Mendelian genetics (including the concepts of homozygous, heterozygous, recessive, dominant and X-linked genes) and without using the genetic code chart.

Additional Activities

Additional molecular biology learning activities are suggested in "Molecular Biology: Major Concepts and Learning Activities" (available at http://serendip.brynmawr.edu/exchange/bioactivities/MolBio).

The Molecular Biology of Mutations and Muscular Dystrophy

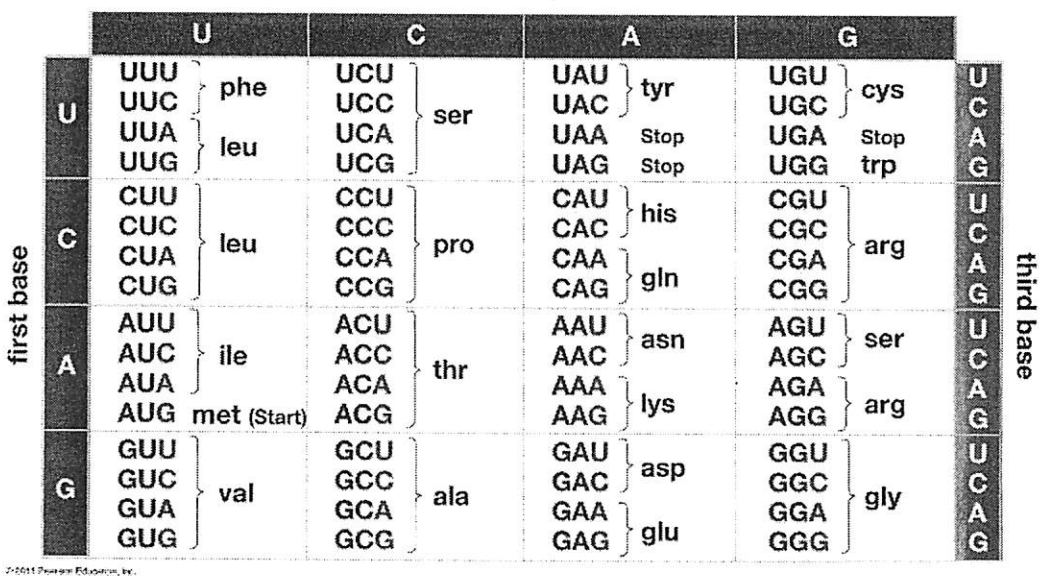
By Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania, 2011[1]

1. The table shows five different mutations of a small section of a gene.

- Use the base-pairing rules to complete the second column. For each mutation, write in any mRNA codons that will be changed as a result of the mutation and use check marks to indicate codons that will not be changed.
- Using the genetic code chart, identify and circle any stop codons in the mRNA molecules.
- For each mutation, write any amino acids that will be changed in the last column. Use dashes to indicate any amino acids that will be missing as a result of stop codons and use check marks to indicate any amino acids that will not be changed.

DNA (Template Strand)	**mRNA** codon	**Polypeptide**
Original DNA = GCAAGTACCTGA	CGU UCA UGG ACU	arg – ser – trp – thr
Mutation = GC**C**AGTACCTGA (nucleotide change underlined)	___ ___ ___ ___	___ ___ ___ ___
Mutation = GCA**C**GTACCTGA (nucleotide change underlined)	___ ___ ___ ___	___ ___ ___ ___
Mutation = GCAAGTAC**T**TGA (nucleotide change underlined)	___ ___ ___ ___	___ ___ ___ ___
Mutation = GAAGTACCTGA (first C deleted)	___ ___ ___ ___	___ ___ ___ ___
Mutation = GCAAGTACTGA (second C deleted)	___ ___ ___ ___	___ ___ ___ ___

Genetic Code Chart for Translating Codons in mRNA to Amino Acids in a Polypeptide



[1] Teachers are encouraged to copy this student handout for classroom use. A Word file (which can be used to prepare a modified version if desired), teacher notes, and links to additional activities are available at http://serendip.brynmawr.edu/exchange/bioactivities.

2. Explain why deletion of a single nucleotide in a gene generally results in more severe defects in the polypeptide than a point mutation that changes a single nucleotide.

3. Muscular dystrophy includes several genetic diseases which cause increasing weakness of a person's muscles. Two different types of muscular dystrophy are caused by different types of mutations in the gene for a protein that helps to prevent muscle cells from dying prematurely.

Duchenne muscular dystrophy is more severe. A child with Duchenne muscular dystrophy begins to show symptoms of loss of muscle function by about age 3 and needs to use a wheelchair by about age 10. A person with Duchenne muscular dystrophy typically dies as a young adult, due to failure of the muscles in the internal organs.

Becker muscular dystrophy is milder. Symptoms do not begin until age 12 or later, and the person can live into their 40s or 50s.

The table shows the main kinds of mutations that are responsible for these two types of muscular dystrophy. Complete the second column to indicate which type of muscular dystrophy you think would be caused by each type of mutation.

Type of Mutation	Type of Muscular Dystrophy
Deletion Mutation → # nucleotides deleted from mRNA is a multiple of 3	
Deletion Mutation → # nucleotides deleted from mRNA is not a multiple of 3	
Point Mutation → stop codon	

Explain your reasoning.

Unit 6: Evolution

Guiding Question: How have organisms on Earth changed over the course of time?

Overview:

A. Formation of Life on Earth
   a. How life started on Earth
   b. The age of Earth
B. Natural Selection and Variation
   a. Darwin and his research
   b. Natural selection
      i. Overproduction
      ii. Survival of the fittest
      iii. Variation
      iv. Environmental influences
   c. Sources of Variation
      i. Mutations
      ii. Meiosis and gene shuffling
C. **NYS state lab:** Beaks of Finches
   a. Common ancestry!
D. Evidence for Evolution
   a. Fossil record
   b. Comparative anatomy
   c. Comparative embryology
   d. Comparative biochemistry
   e. DNA
   f. Antibiotic resistance
E. Rate of Evolution
   a. Depends on the life span of the organism and its genetic traits
   b. Amount of biodiversity
   c. Antibiotic resistance
F. Classification
   a. Genus, species
   b. Dichotomous keys used to identify organisms based on traits
G. Cladograms (evolutionary tree diagrams)
   a. Visual depiction of the change in a species over time
   b. Extinction
      i. Organisms that don't make it to modern day have gone extinct
   c. Evolutionary relationships between species on the diagram

Lesson Objectives

Students will be able to:

- Describe how life on Earth began
- Identify who Darwin is and where he did his research
- Describe Darwin's theory of natural selection

- Explain how each of the mechanisms of natural selection contribute to the way species change over time
- Identify the ways that variation can come about in living things
- Describe why certain "finches" in the state lab "survive" and others do not and how this is related to natural selection
- Describe that it is a combination of a variety of aspects that cause species to change over time
- Identify the similarities in the anatomical structure of organisms of different species as evidence of evolution
- Identify the similarities in the embryos of organisms of different species as evidence of evolution
- Identify the similarities in the biochemistry and DNA of organisms of different species as evidence of evolution
- Describe how antibiotic resistant bacteria are evidence of evolution
- Explain how the rate of evolution varies from species to species
- Describe how dichotomous keys are used to identify unknown organisms
- Describe why we use the genus and species to identify organisms instead of a common name
- Identify the relationships between species on an evolutionary tree diagram
- Identify organisms that have gone extinct on an evolutionary tree diagram
- Explain why a species may go extinct

Suggested Activities:

- NYS lab: Beaks of Finches
- Dichotomous key lab: Sharks
- Constructing a dichotomous key activity
- Phet natural selection simulation online (http://phet.colorado.edu)
    - Search under biology simulations
- Understand Evolution web activity (evidence for evolution)
    - http://evolution.berkeley.edu/evolibrary/article/similarity_hs_01

Key Concepts/ Vocabulary:

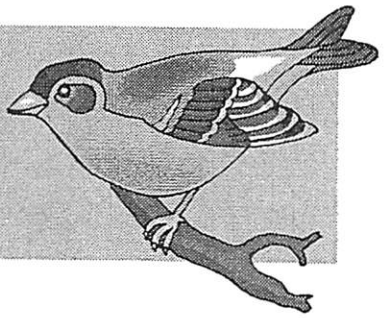
Adaptive value	evolution	extinction
Fossil record	genetic variation	geologic time
Mutation	natural selection	overproduction
Theory	Charles Darwin	Galapagos
Antibiotic resistance	classification	genus
Species	common ancestor	selecting agent
Trait	survival of the fittest	

Name _____ Period _____ Date _____

Laboratory Activity #3 — Student Laboratory Packet

The Beaks of Finches

A Laboratory Activity for the Living Environment



Introduction

Environmental conditions act as selecting agents because they select organisms with the most beneficial traits to become the parents of the next generation. Within a species, individuals with variations that make them better adapted to their environment will survive and reproduce in greater numbers than those without such adaptations. Observations have shown that the offspring of better-adapted individuals inherit many of their parents' favorable variations.

Finches are small birds found in many locations throughout the world. Charles Darwin used the numerous finch species found on the Galapagos Islands as evidence of natural selection. The great variety of beak adaptations present on the Galapagos is thought to be due to the isolation of bird populations on the islands with different kinds and amounts of food. Seed-eating finches exhibit a great number of differences in beak shapes and sizes. During ongoing competition for resources, some finches are successful and become more numerous, while less successful finches decrease in number.

In this laboratory activity, you will work with different tools that will serve to model finch "beaks." The seeds provided represent finch food on a particular island. You will compete with other "finch" species to see which "beak" is best adapted for obtaining a specific food.

Objectives

In this laboratory activity, you will:

- learn how structural differences may affect the survival rate of members within a species
- simulate competition for resources among different species of organisms
- see the role of the environment as a selecting agent

Safety

- You should wear safety goggles for this activity.
- Handle the tools carefully. They may have sharp edges and could cause cuts.
- Be especially careful when two or more of you are reaching for seeds at the same time. The "beak" being used by one student has the potential to strike another student.
- Do not taste or eat any of the seeds.

Important Note: *Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. Later, you will need to transfer your answers to a separate Student Answer Packet. Your teacher will use it in grading your work, and the school will retain it as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.*

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Materials for Each Team

- 1 small plastic dish or cup
- 1 large nonbreakable dish
- 1 tool to serve as a "beak"
- large seeds (such as lima beans)*
- small seeds (such as lentils)
- 2 pairs safety goggles

* may be needed depending on results of Round One

Procedures

1. Examine the different tools ("beaks") and seeds provided. Predict which "beak" will be the *most* successful at picking up small seeds. Give the reasons for your choice.

2. Predict which "beak" will be the *least* successful at picking up small seeds. Give the reasons for your choice.

3. From this point on, you and your partner will model a finch feeding. The tool you were assigned will be your "beak." Describe what characteristics it has that make it good for picking up small seeds. In the remaining space or on a separate sheet of paper, draw an outline of your assigned "beak."

4. Both you and your partner should practice transferring the small seeds quickly from the large dish to the small dish before the competition begins. The large dish of small seeds represents the island environment where you live and feed. The small dish represents a finch stomach. You may move only one seed at a time. You will receive credit only for a seed that falls into and stays in the small dish.

Round One: No Competition, Original Island

5. When given the "Round One" signal, one member of your team should use the "beak" to pick up small seeds one at a time from the large dish and place them in the small dish. Repeat this for a total of four trials, two trials for each partner. A timekeeper will tell you when to start and stop each trial. Record your results in the "Round One: Feeding with No Competition" data table.

Round One: Feeding with No Competition

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

6. Calculate the average number of seeds obtained during the four trials. Round off to the nearest seed. In order to "survive," your species needs to collect an average of 13 seeds per trial. If you achieve that goal, you remain healthy and continue to live on the original island and eat small seeds.

   If your team averaged fewer than 13 small seeds per trial, you and your partner will "migrate" to a new island with a different food supply to avoid starvation. Ask your teacher to give you a new large dish that contains approximately 200 or more large seeds. This will be your island for Round Two. Perhaps your "beak" will be better adapted for feeding success in a new environment.

Round Two: Competition

In this round, instead of feeding alone, you will be competing for food with finches that have different kinds of "beaks." To simulate this competition, your team will feed from the same dish as one other team. If you were successful during Round One, you will be feeding with other finches on small seeds. If you were not successful, you will be competing for large seeds.

7. In the "Round Two: Feeding with Competition" data table, *check the box that indicates whether you are feeding on the original island (small seeds) or on the new island (large seeds).* Complete four trials just as you did the first time and record the results of each trial. Again, wait for the time keeper to tell you when to start feeding and when to stop for each trial.

Round Two: Feeding with Competition

❑ **Original island (small seeds)** ❑ **New island (large seeds)**

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

8. Calculate the average number of seeds obtained during the four trials. Round off to the nearest seed. If your team collected an average of 13 seeds or more per trial, you can go on to Round Three. If your team collected fewer than 13 seeds per trial, you and your partner are now eliminated.

Round Three: Increased Competition

During this round, you will be competing with all of the other finch species left alive on your island. In other words, all of the finch teams that were successful at feeding on small seeds will compete at one dish containing small seeds. At the same time, all of the finches successful at feeding on large seeds during Round Two will compete at one dish of large seeds.

9. In the "Round Three: Feeding with Increased Competition" data table, indicate whether you are feeding on small or large seeds. Complete four trials as before and record the results of each trial and your average.

Round Three: Feeding with Increased Competition

❑ **Original island (small seeds)** ❑ **New island (large seeds)**

		Seeds Collected
Partner #1	Trial #1	
	Trial #2	
Partner #2	Trial #3	
	Trial #4	
	Average	

Analysis Questions

1. What characteristics of your "beak" interfered with feeding success on the original island?

2. Name three traits other than beak characteristics that could contribute to the ability of a finch to compete successfully.

3. It is very unlikely that all of the beaks within a species of finch are exactly alike. Random mutations and new gene combinations resulting from sexual reproduction are the source of beak variations. Describe at least three beak variations that could randomly appear and further improve your species' chances of survival when feeding on small seeds.

4. Why did some "beak" types survive on the new island (with large seeds) when they could not survive on the original island?

5. **Class Activity:** Complete the Class Results data table on the last page of this laboratory activity before going on to the remaining questions.

6. Did those who were successful in Round One survive equally well when others were competing for food at the same dish during Round Two? _____ Support your answer with an explanation.

7. Why were there fewer survivors at the end of Round Three?

8. At the end of Round Three, were the types of "beaks" that were successful on the new island the same as the types of beaks that were successful on the original island? _____ Support your answer with an explanation.

9. Explain how this activity simulates each of the concepts listed below as they are involved in the process of natural selection. Describe a specific example from this laboratory for each concept.

variation: _____

_____

competition: _____

_____

struggle for survival: _____

_____

adaptation: _____

_____

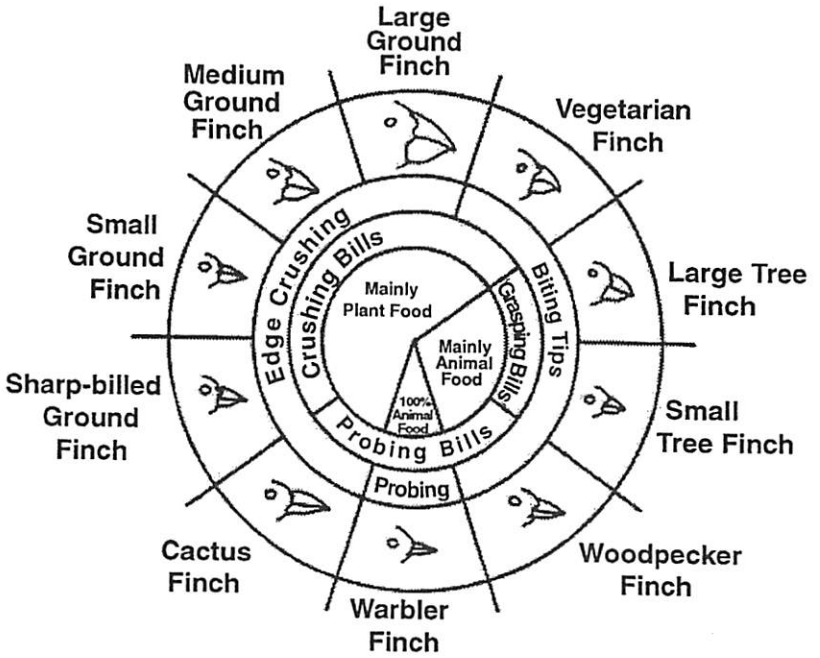
environment: _____

_____

selecting agent: _____

_____

Base your answers to questions 10-12 on Figure 1, which shows various finches found on the Galapagos Islands, and on your knowledge of biology.



— from *Galapagos: A Natural History Guide*

Figure 1. Variations in Beaks of Galapagos Islands Finches

10. Predict which species of finch would be most likely to survive if the weather on the Galapagos Islands gradually changed and the seeds available to the finches became larger with heavier coverings. Support your answer with an explanation.

11. One island is populated by two species—Ground Finches and Small Tree Finches.

    a. What two types of food would you expect to be available on this island? Support your answer with an explanation.

    b. Would you expect the two species to compete for food on this island? Support your answer with an explanation.

    c. How might the two native finch populations be affected if several dozen Sharp-billed Ground Finches were to migrate to the island and survive? Support your answer with an explanation.

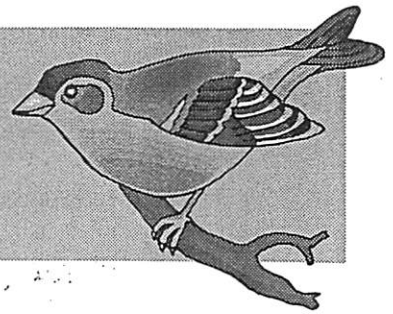
12. a. Explain how an island could support large populations of both Large Ground Finches and Small Ground Finches.

    b. How could you use the materials provided in this lab to test your explanation?

Laboratory Activity #3 — Teacher's Guide

The Beaks of Finches

A Laboratory Activity for the Living Environment



"What a trifling difference must often determine which shall survive, and which perish!"

— *Charles Darwin*

ABSTRACT

Students will simulate natural selection by using different tools to see which are "best adapted" for the task of picking up seeds and transporting them from one container to another. They will use different tools (representing beak variations in finch species) to pick up seeds, which represent food on different islands. Optional enrichment activities are possible.

TEACHER INFORMATION

Instructional Use

One of several different ways to use "The Beaks of Finches" is to schedule it at the beginning of the study of evolution and have students discover concepts of evolution by doing the laboratory. Another option is to assign students background reading and to discuss the concept of evolution prior to the start of the laboratory. Be sure that students are familiar with the concept of natural selection and the terms adaptation and variation. Also, emphasize that Darwin cited the numerous finch species found on the Galapagos Islands as evidence of evolution from a common ancestral finch.

In planning, it is critical to consider the role of students with disabilities. Without careful planning, this type of activity may call attention to a student's disability. In addition to selecting appropriate roles for any students with special needs, make clear to the students that the effectiveness of the tool is what is being rated and not the ability of the student to use it.

Time Requirements

This activity, including Analysis Questions 1-8, requires approximately two 40-minute periods (or a double period) to complete. Analysis Questions 9-12 should be assigned as homework.

Safety

- All participants should wear safety goggles during this activity.
- Instruct students in how to reach for seeds and use the tools safely. The tools selected for this activity may have sharp edges and could cause cuts if not handled carefully. Pliers represent a pinching hazard. When two or more students are reaching for seeds at the same time, the "beak" being used by one student has the potential to strike another student.
- Provide seating arrangements that minimize crowding or collisions.

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Materials

- 1 plastic Petri dish or small container (plastic or paper cup) for each team of two students
- 1 large metal or plastic flat-bottomed dish for each team (approximately 10" round or square)
- seeds in two different sizes: 1 cup of small seeds, such as lentils, and 2 cups of large seeds, such as lima beans, for each team
- grasping tools of various sizes and shapes to simulate beaks, a different tool for each team. These may include but are not limited to different kinds of forceps, clips (hair, bag, binder), tongs, clothespins, chopsticks, or pliers.
- 1 stop watch or clock with second hand
- safety goggles, one pair for each participant
- 1 Student Laboratory Packet and 1 Student Answer Packet for each student. Masters are provided at the end of this guide to duplicate as needed.

Note: Most of the materials are readily available: seeds from the grocery store, tools from a home or school shop or from a local "dollar store."

Preparation

- To make discussion easier and for answering Procedures Question 1, attach a label or tag to indicate the correct name for each of the tools available for this exercise. The named tools must be reasonable and have some chance of being able to transport the seeds from one container to another.
- Place all of the named tools on the front demonstration desk or place an assortment of tools at each lab station.
- Provide adequate time for students to predict the tools' potential to pick up small seeds and place them in the Petri dish, which represents a finch's stomach. Emphasize that this inspection is visual only. Students are not to actually use the tools at this point.
- Randomly assign a tool to each pair of students. Emphasize that evolution is random and therefore the assignment of beaks is random. One way of assigning the beaks randomly is to write the name of each tool on a separate index card and have each team draw a card. The tool named on the card is the tool that team will use as a beak throughout the lab activity.
- Place about a cup of the small seeds into each large dish.
- Give all of the teams a few minutes to practice picking up seeds and moving them from the large container to the Petri dish. Students may use the tools with either one or two hands.

Background Information

To help students make an appropriate correlation between this laboratory exercise and some of the real data collected on finches, give them additional information about finches such as:

- All 14 species of Darwin's finches differ from each other in body size and/or beak size and shape.
- Different beak sizes and shapes differ in their efficiency at performing particular tasks.
- Not only do beaks vary in shape, but so do the muscles used to operate them.

Round One

- Explain to the students that in Round One, *each* of the two students will have two 30-second trials (feeding periods) to use the same tool to pick up seeds from the large dish and place them in the small dish. Each student can pick up only one seed at a time. At the end of each 30-second feeding period, the team should count the number of seeds that have been placed in the Petri dish and record that number on the data table entitled "Round One: Feeding with No Competition." Then the students should return all the seeds to the large dish.
- All students are to "feed" from their own large dish during the same 30-second periods. Announce the start and stop time for each trial or appoint a student to do it. .
- After the students have completed the four trials and recorded their totals for each trial, tell them to calculate the average number of seeds obtained per 30 seconds and record that average on the data table.
- Tell the students that the critical survival value is set at an average of 13 seeds per 30 seconds. Teams with an average of at least 13 seeds per 30 seconds will continue to feed on small seeds (*e.g.*, lentils) in Round Two. They represent finches that have survived successfully in their original environment. Teams with an average of less than 13 seeds per 30 seconds represent finches that have not been successful in obtaining enough food in their original environment. They must seek another food source. These teams will be paired with another unsuccessful team to feed on large seeds (*e.g.*, lima beans) in Round Two.* Successful teams will compete for small seeds in Round Two.

  **Note: Although unsuccessful teams can be encouraged to imagine that they have migrated to a different island to find another food source, the teams do not actually have to move to a new station. They can empty their small seeds into a collecting container and put about two cups of large seeds into their large dish.*

Round Two

- Explain to the students that during Round Two, each team will again have four 30-second feeding periods (two for each student). This time, however, one member from each of two different teams will feed at the same time from the same large dish, simulating competition for the available food. At the end of each 30-second trial, each team should count the number of seeds that have been placed in its Petri dish and record that number on the data table entitled "Round Two: Feeding with Competition." Then the students should return all the seeds to the large dish.
- After the students have completed the four trials in Round Two (two for each team member) and recorded their totals for each trial, tell them to calculate the average number of seeds obtained per 30 seconds and record that average on the data table.
- Tell the students that the critical survival rate remains at an average of 13 seeds per 30 seconds. Teams with an average of at least 13 seeds obtained per 30 seconds will go on to Round Three. Any team that collected fewer than an average of 13 seeds in 30 seconds did not survive the competition. It doesn't matter which type of seed they were feeding on during Round Two. Allow these students to observe Round Three or direct them to start working on the first four Analysis Questions and to be prepared to share answers later with the teams still competing.

Round Three

- Explain to the students that during Round Three, each surviving team will again have four 30-second feeding periods (two for each student). However, all the teams feeding on one kind of seed will feed at the same time from the one large dish, simulating competition for the available food. All surviving groups feeding on small seeds (*e.g.*, lentils) should get together to feed out of a single dish of small seeds. All surviving groups feeding on large seeds (*e.g.*, lima beans) should get together to feed out of a single dish of large seeds.
- After the students have completed the four trials in Round Three and recorded their totals for each trial, tell them to calculate the average number of seeds obtained per 30 seconds and record that average on the data table.
- Tell the students that the critical survival rate remains at an average of 13 seeds per 30 seconds. Teams with an average of at least 13 seeds per 30 seconds have survived. Any team that collected fewer than an average of 13 seeds in 30 seconds is now eliminated from that island.

Correlation of This Investigation to the *Living Environment Core Curriculum* and the *Mathematics, Science, and Technology Learning Standards*

Learning Standard 4

Key Idea Three: Individual organisms and species change over time.

3.1f Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.

3.1g Some characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase.

3.1h The variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions.

Learning Standard 4 Process Skills Addressed

v Makes observations of biological processes
x States an appropriate hypothesis
xiv Organizes data through the use of data tables and graphs
xv Analyzes results from observations/expressed data
xvi Formulates an appropriate conclusion or generalization from the results of an experiment
xvii Recognizes assumptions and limitations of the experiment

Testable Skills and Concepts

- understanding how this activity simulates the process of natural selection
- an understanding of the concepts that this laboratory activity illustrates, including competition, survival, adaptation, and the role of the environment as a selecting agent
- how to construct data tables incorporating quantitative and qualitative data
- recognition of safe laboratory procedures
- how to organize and analyze data through the use of data tables

References

The original idea for the basic procedure used in this activity came from C. Sprague. Her version can be found on the web at http://www.accessexcellence.org/AE/AEC/AEF/1996/sprague_beaks.html.

Enrichment Activities

- If more time is available, repeat the entire procedure using other seed types and/or introducing nonfood influences, such as small pebbles or vermiculite. Compare the results with those of the original procedure.
- Investigate other factors. For example, is the best tool for gathering seeds also able to break them open successfully? If the technology is available to you, you can help students determine quantitatively the force exerted by a particular tool. If not, students may simply test whether a given tool can break a selected seed type using reasonable muscle action.
- One of the landmark pieces of background information on this topic is the October 1991 *Scientific American* article, "Natural Selection and Darwin's Finches," by Peter Grant.
- Finches living in areas with dense vegetation have mating calls that are very different from those living in areas of sparse vegetation. This phenomenon increases the probability of finding a mate, leading to the stabilization of genetic characteristics specific to the environment. More information on this can be found at http://www.horizon.fr/galapagos/evolutionan.html
- Finch reproductive behavior is also of interest to some students. For example, in 13 of the species, reproductive readiness (adulthood) is marked by a change in beak color from yellow to black. Such a feature in common is highly suggestive of common ancestry and common origin for all 13 species. It has persisted in spite of other changes in bill structure and function. For more on finch reproduction, visit: http://www.life.uiuc.edu/wikelski/finches.html
- "Voyage to the Galapagos," a Scientific American Frontiers presentation on PBS, shows a short (11-minute) segment on the Galapagos finches. Contact http://www.PBS.org.saf.

Student Answers

The remaining pages duplicate the Student Answer Packet and include sample data and possible answers. They can be used to score students' papers. However, please note that student data and the wording of answers will vary. Alternative answers may be acceptable. The last six pages are the masters for the Student Answer Packet. Each student must be provided with a copy of the Student Answer Packet.

Procedure Questions: Sample Data and Answers

1. Examine the different tools ("beaks") and seeds provided. Predict which "beak" will be the *most* successful at picking up small seeds. Give the reasons for your choice.

   Student answers will vary depending on the tools provided.

2. Predict which "beak" will be the *least* successful at picking up small seeds. Give the reasons for your choice.

   Student answers will vary depending on the tools provided.

3. From this point on, you and your partner will model a finch feeding. The tool you were assigned will be your "beak." Describe what characteristics it has that make it good for picking up small seeds. In the remaining space or on a separate sheet of paper, draw an outline of your assigned "beak."

   Student answers will vary depending on the tool assigned.

Analysis Questions and Answers

1. What characteristics of your "beak" interfered with feeding success on the original island?

   Answers will vary depending on the tools provided. Generally, large, heavy, slippery, or flat tools are less successful.

2. Name three traits other than beak characteristics that could contribute to the ability of a finch to compete successfully.

   Answers will vary but may include eyesight, coordination, aggressiveness, speed, and motivation.

3. It is very unlikely that all of the beaks within a species of finch are exactly alike. Random mutations and new gene combinations resulting from sexual reproduction are the source of beak variations. Describe at least three beak variations that could randomly appear and further improve your species' chances of survival when feeding on small seeds.

   Answers will vary but typically will include such traits as being small and light and having a nonskid surface.

4. Why did some "beak" types survive on the new island (with large seeds) when they could not survive on the original island?

   They may not have been suited for gripping small seeds but possessed characteristics that made them able to grip larger seeds.

5. **Class Activity:** Complete the Class Results data table on the last page of this laboratory activity before going on to the remaining questions.

6. Did those who were successful in Round One survive equally well when others were competing for food at the same dish during Round Two? _____ Support your answer with an explanation.

   Answers will vary, but usually fewer should survive. Students should be able to state that increased competition has an adverse effect on seed gathering.

7. Why were there fewer survivors at the end of Round Three?

   There were fewer survivors due to increased competition.

8. At the end of Round Three, were the types of "beaks" that were successful on the new island the same as the types of beaks that were successful on the original island? *No* Support your answer with an explanation.

   No, because the size difference in the seeds favored different types of beaks.

9. Explain how this activity simulates each of the concepts listed below as they are involved in the process of natural selection. Describe a specific example from this laboratory for each concept.

   variation: *different beaks, different size seeds*

   competition: *more than one bird feeding at one bowl*

   struggle for survival: *each bird trying to get enough seeds to survive*

   adaptation: *particular characteristics of "beaks"*

   environment: *students, seeds, and the dishes where competition occurs can all represent parts of the environment*

   selecting agent: *type of "beak" available for feeding and/or type of seed available*

10. Predict which species of finch would be most likely to survive if the weather on the Galapagos Islands gradually changed and the seeds available to the finches became larger with heavier coverings. Support your answer with an explanation.

    Large Ground Finches, because they have big, thick beaks.

11. One island is populated by two species — Ground Finches and Small Tree Finches.

    a. What two types of food would you expect to be available on this island? Support your answer with an explanation.

       Animal food (such as insects) and plant food (such as seeds). Information from the chart was used.

    b. Would you expect the two species to compete for food on this island? Support your answer with an explanation.

       No, they would not compete as long as there is enough food for each species. If either food became scarce, they might compete.

    c. How might the two native finch populations be affected if several dozen Sharp-billed Ground Finches were to migrate to the island and survive? Support your answer with an explanation.

       The Small Ground Finches might have to compete with the new Sharp-billed Ground Finches, since they have similar food preferences and beaks.

12. a. Explain how an island could support large populations of both Large Ground Finches and Small Ground Finches.

       The island would need to have both large and small seeds available.

    b. How could you use the materials provided in this lab to test your explanation?

       I would put many large and small seeds in the same large dish. Then I would run trials using tools from the "large-seed survivors" and tools from the "small-seed survivors" to compete for the seeds in the dish.

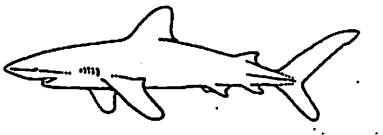
Class Results

Answers will vary based on types of tools used and on actual classroom data. Keep a record of the data for each class. Make a transparency of the chart and help the class compile the information. Solicit general information for the size and shape of the beaks.

Beaks That Were	Number of Beak Types	Characteristics of Beaks (Size and Shape)
Present at the beginning of the activity		
Successful at feeding in Round One on the original island—fed on small seeds, did not need to migrate		
Not successful at feeding in Round One on the original island—fed on small seeds, had to migrate to the new island		
Successful at feeding in Round Two on the original island—fed on small seeds		
Successful at feeding in Round Two on the new island—fed on large seeds		
Not successful at feeding in Round Two on either island—species dies out		
Successful at feeding in Round Three on the original island—fed on small seeds		
Successful at feeding in Round Three on the new island—fed on large seeds		
Not successful at feeding in Round Three on either island—species eliminated		

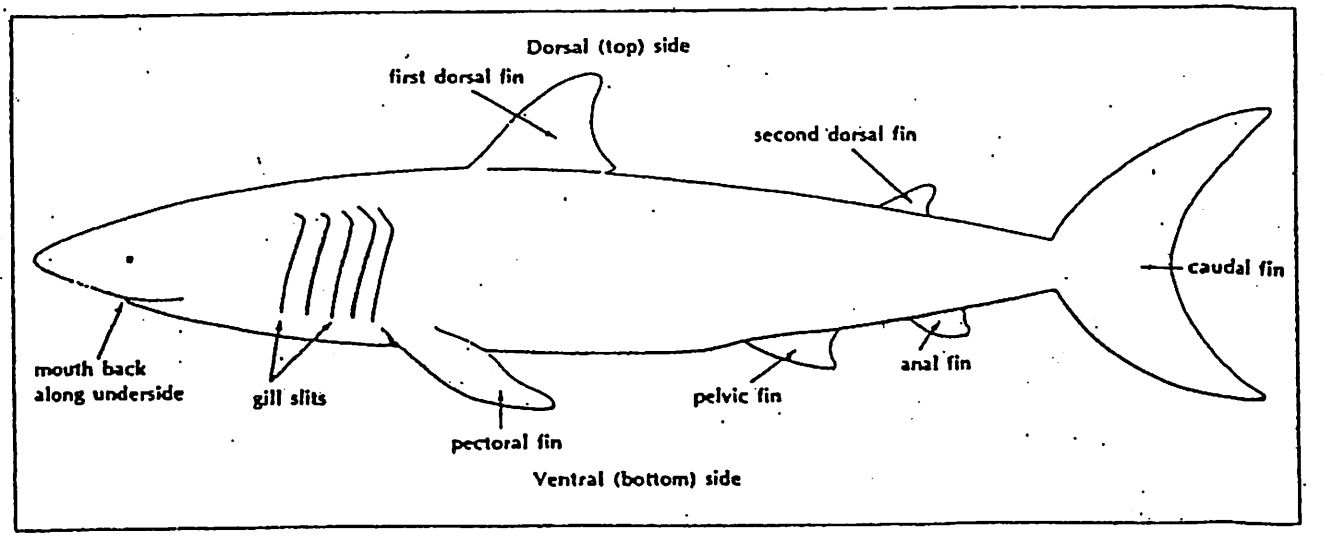
Name: _____ Period: _____

THE SHARK LAB



Classification is a way of separating a large group of closely related organisms into smaller subgroups. With a classification system, identification of an organism is easy. The scientific names of organisms are based on the classification systems of living organisms. To classify an organism, scientists often use a key. A key is a listing of specific characteristics, such as structure and behavior, in such a way that an organism can be identified.

Use the example below as a guide to the shark parts used in the key.



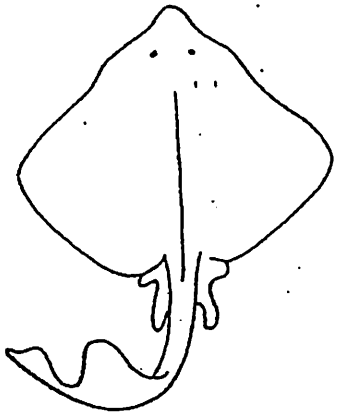
1. Read sentences 1 A and 1B of the key. Then study Shark 1 in for the characteristics referred to in 1 A and 1B. Follow the directions in these sentences and continue until a family name for Shark 1 is determined.

   For example, to key a shark that has an anal fin and a body that is not kite shaped, follow the directions of IA and go directly to statement 2. To key a shark that lacks an anal fin and has a kite shaped body, follow the directions of 1B and go to statement 10.

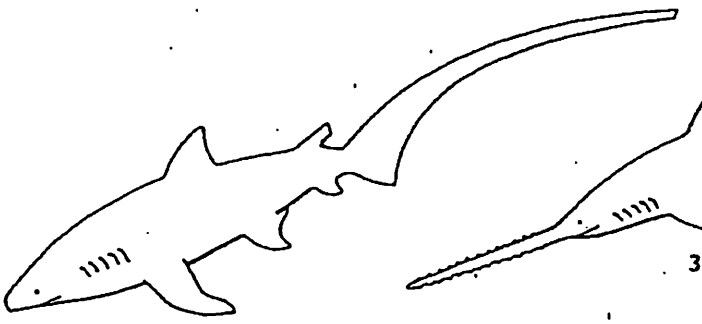
2. Continue this process with each shark until all animals have been identified. Write the family name on the line below each animal.

SHARK CLASSIFICATION KEY

1.	A. Body kitelike in shape (if viewed from the top)	Go to statement 12
	B. Body not kitelike in shape (if viewed from the top)	Go to statement 2
2.	A. Pelvic fin absent and nose sawlike	Family Pristiophoridae
	B. Pelvic fin present	Go to statement 3
3.	A. Six gill slits present	Family Hexanchidae
	B. Five gill slits present	Go to statement 4
4.	A. Only one dorsal fin	Family Scyliorhinidae
	B. Two dorsal fins	Go to statement 5
5.	A. Mouth at front of head rather than back along underside of head	Family Rhinocodontidae
	B. Mouth back along underside of head	Go to statement 6
6.	A. Head expanded on side with eyes at end of expansion	Family Sphyrnidae
	B. Head not expanded	Go to statement 7
7.	A. Top half of caudal fin exactly same size and shape as bottom half	Family Isuridae
	B. Top half of caudal fin different in size and shape than bottom half	Go to statement 8
8.	A. First dorsal fin very long, almost half total length of body	Family Pseudotriakidae
	B. First dorsal fin regular length	Go to statement 9
9.	A. Caudal fin very long, almost as long as entire body	Family Alopiidae
	B. Caudal fin regular length	Go to statement 10
10.	A. A long needlelike point on end of nose	Family Scapanorhynchidae
	B. Nose without long point	Go to statement 11
11.	A. Anal fin absent	Family Squalidae
	B. Anal fin present	Family Carcharhinidae
12.	A. Small dorsal fin present near tip of tail	Family Rajidae
	B. No dorsal fin present near tip of tail	Go to statement 13
13.	A. Front of animal with two hornlike appendages	Family Mobulidae
	B. No hornlike appendages	Family Dasyatidae



1 _____



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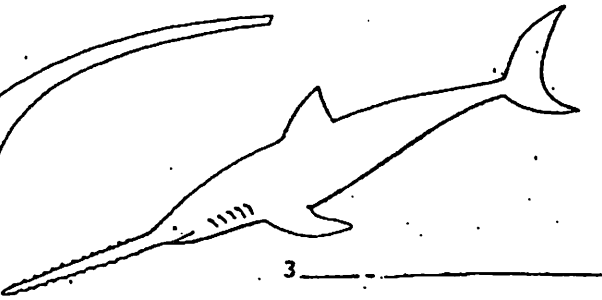

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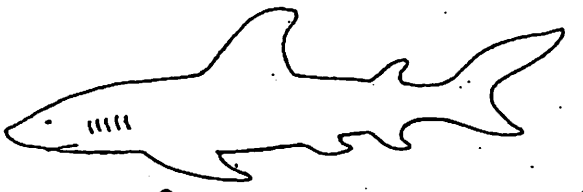

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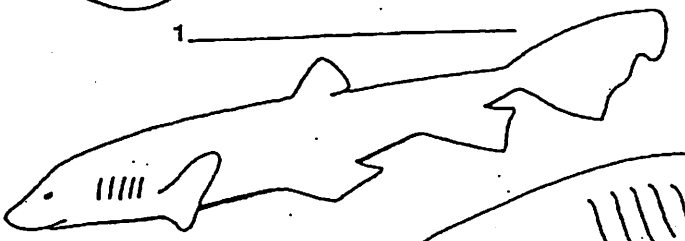

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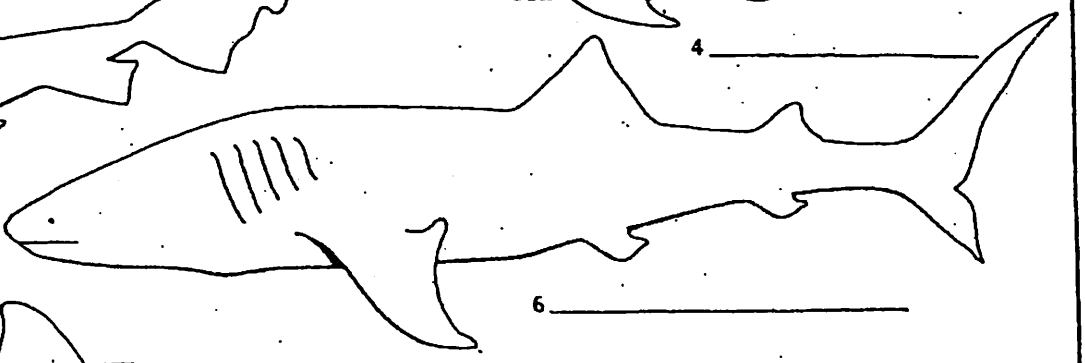

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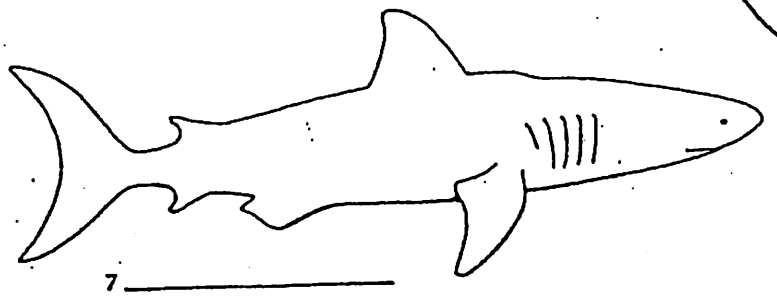

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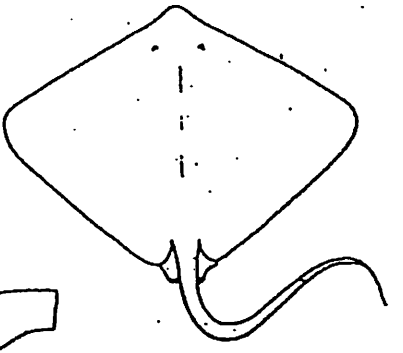

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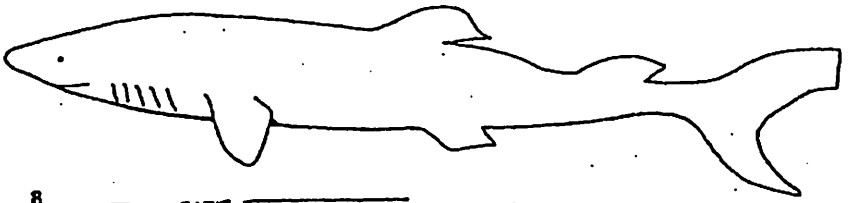

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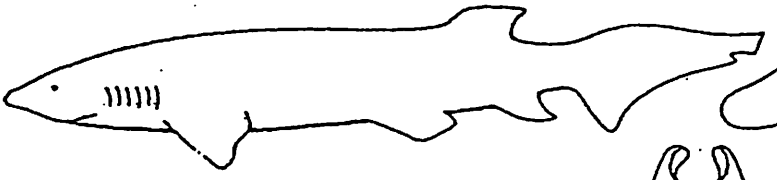

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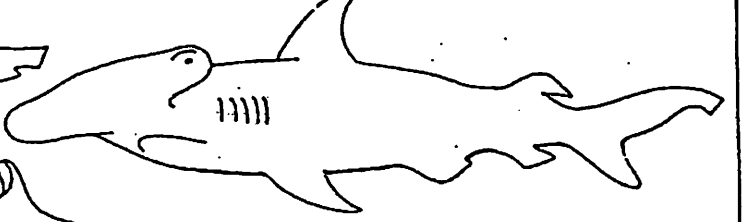

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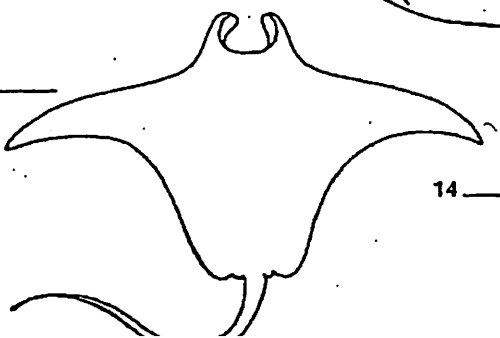


14 _____

1. As you used the classification key to identify the sharks, did you go from general to specific characteristics or from specific to general characteristics?

2. What group does the scientific name of the shark represent?

3. Do you think that there may be some closely related species of organisms that cannot be identified with a classification key? Explain your answer.

4. Why do you think biological classification keys always present two, rather than some other number, of choices at each step?

5. What types of problems would scientists have today if Carolus Linnaeus had not developed his classification and naming system for organisms?

6. Explain what is meant by the statement "Classification systems are the inventions of humans; diversity is the product of evolution."

7. List the family for each shark.

1 _____

2 _____

3 _____

4 _____

5 _____

6 _____

7 _____

8 _____

9 _____

10 _____

11 _____

12 _____

13 _____

14 _____

Name _____ Class _____ Date _____

Open-Ended Inquiry • Design Your Own Lab

Chapter 18 Lab Dichotomous Keys

Problem

Can you construct a dichotomous key that could be used to identify organisms?

Introduction

In May 2007, scientists and other volunteers gathered in Rock Creek Park, Washington, D.C., to participate in a BioBlitz—a quick, 24-hour survey of species living in the park. Teams worked in 4-hour shifts throughout the park. By the time they were done, the teams had identified more than 650 species!

Teams included experts on different types of organisms such as birds, beetles, fungi, and plants. The experts used identification guides, or keys, to help them identify the organisms they found.

In this lab, you will first use a dichotomous key to identify sharks. A dichotomous key is built around pairs of statements that describe a visible trait. The reader must select the statement in each pair that best describes a specimen. By following the steps in the key, the reader narrows down the list of choices and finally names the specimen. After you have learned to use a dichotomous key, you will design your own key for a group of organisms.

Skills Focus

Observe, Classify, Compare and Contrast, Sequence

Materials

- reference materials

Pre-Lab Questions

1. **Observe** Name three different physical traits that are used in the shark dichotomous key.

_____

_____

_____

Name _____ Class _____ Date _____

Dichotomous Key for Sharks		
Step	**Characteristic**	**Species**
1a	Anal fin present . . . *Go to Step 2*	
1b	No anal fin . . . *Go to Step 6*	
2a	One dorsal fin	*Notorynchus cepedianus*, Sevengill shark
2b	Two dorsal fins . . . *Go to Step 3*	
3a	Spines on dorsal fins	*Heterodontus francisci*, Horn shark
3b	No spines on dorsal fins . . . *Go to Step 4*	
4a	Mouth at front of head	*Rhincodon typus*, Whale shark
4b	Mouth at bottom of head . . . *Go to Step 5*	
5a	Eyes on ends of hammerlike projection	*Sphyrna zygaena*, Smooth hammerhead
5b	No hammerlike head	*Carcharodon carcharias*, Great white shark
6a	Flattened body (like ray)	*Squatina squatina*, Angel shark
6b	Body not flattened . . . *Go to Step 7*	
7a	Long sawlike projection from snout	*Pristiophorus schroederi*, Bahamas sawshark
7b	No sawlike projection	*Somniosus microcephalus*, Greenland shark

Data Table		
Shark	**Scientific Name**	**Common Name**
A		
B		
C		
D		
E		
F		

Name _____ Class _____ Date _____

Part B: Construct a Dichotomous Key

You will be working with a group of organisms such as snails, birds, antelopes, rodents, or aquarium fish. You will need to consult reference books or Web sites that include illustrations.

5. Choose a group of organisms. Then make a list of visible physical traits that vary among the species in the group.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

6. Choose 6 or 8 species from the group. On a separate sheet of paper make a simple drawing of each species. Use a letter to label each drawing. Record the scientific name and common name of each species next to the appropriate letter.

A: _____

B: _____

C: _____

D: _____

E: _____

F: _____

G: _____

H: _____

7. Use the space on page 111 to construct a dichotomous key for your group of organisms, using the key for sharks as a model.
8. Check the usefulness of your key by making a copy of your key and asking another student to use it to identify your drawings.

Name _____ Class _____ Date _____

Dichotomous Key

Analyze and Conclude

1. **Predict** How would the dichotomous key for sharks need to change if you wanted to use it to identify 10 different sharks?

_____

_____

_____

_____

2. **Evaluate** What was the most challenging part of making your own dichotomous key?

_____

_____

_____

Name _____ Class _____ Date _____

3. **Infer** Suppose you had real specimens of your organisms instead of drawings. What other traits could you use to build a dichotomous key?

_____

_____

_____

4. **Compare and Contrast** The shark dichotomous key groups three species that lack anal fins together. But a recent cladogram of sharks indicates that one of them (the Greenland shark) is actually most closely related to the Sevengill shark, which has an anal fin. What does this tell you about the difference between a dichotomous key and a cladogram?

_____

_____

_____

_____

_____

5. **Draw Conclusions** In what way are the characters used to design a dichotomous key more limited than the characters that are used to build a cladogram?

_____

_____

_____

_____

6. **Infer** The dichotomous keys in this lab are used to trace organisms to the species level. Could keys be designed which classify unknown organisms to higher levels of the Linnaean system—to a family or order, for example? Why or why not?

_____

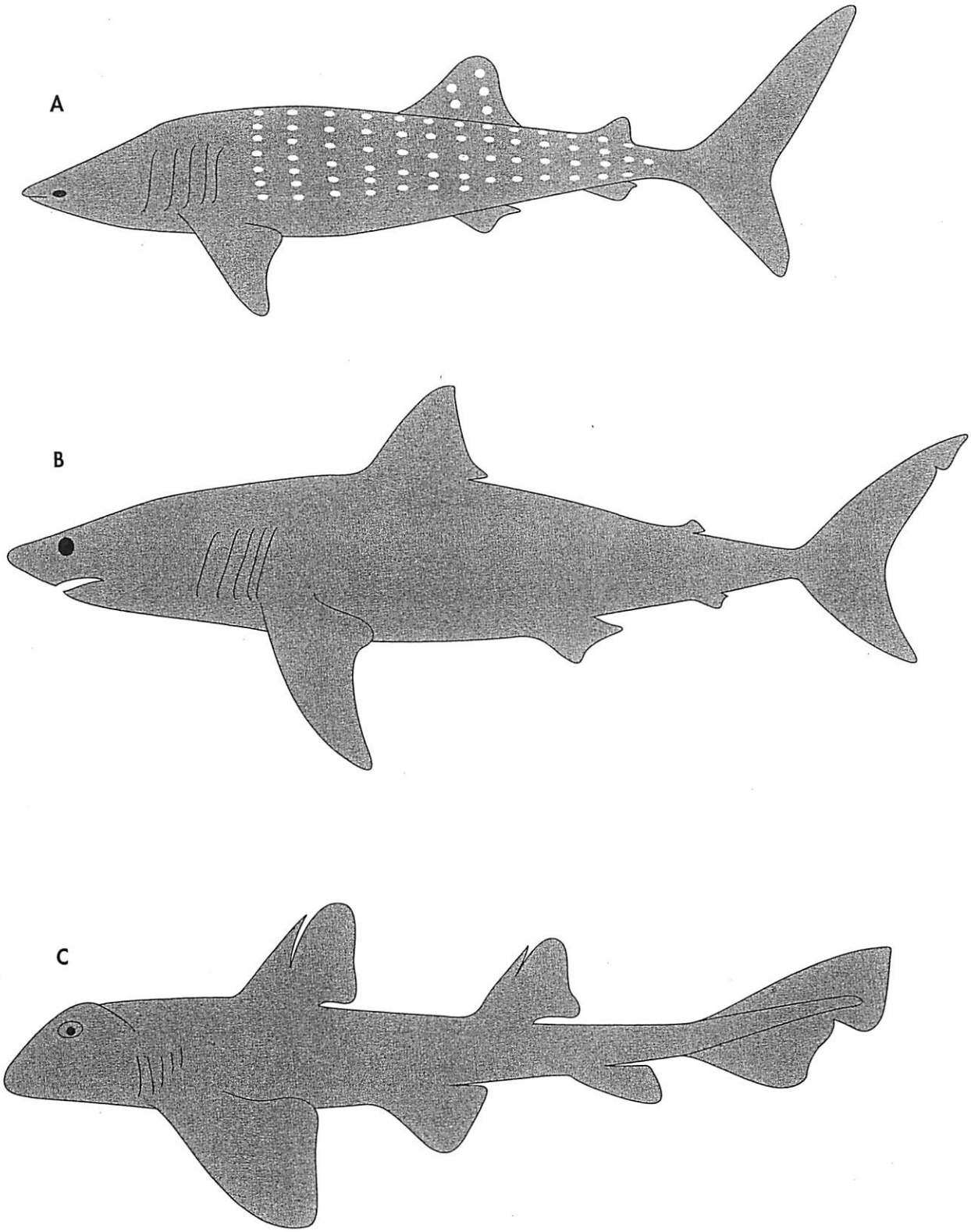
_____

Extend Your Inquiry

Find a cladogram in your textbook or other reference that lists derived characters. Which of the derived characters could be used as traits in a dichotomous key? Which of the traits could not be used, and why?

Name _____ Class _____ Date _____

Figure 2 Shark species



Name _____ Class _____ Date _____

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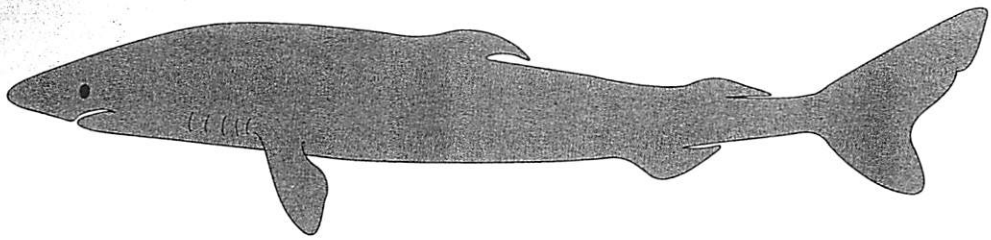

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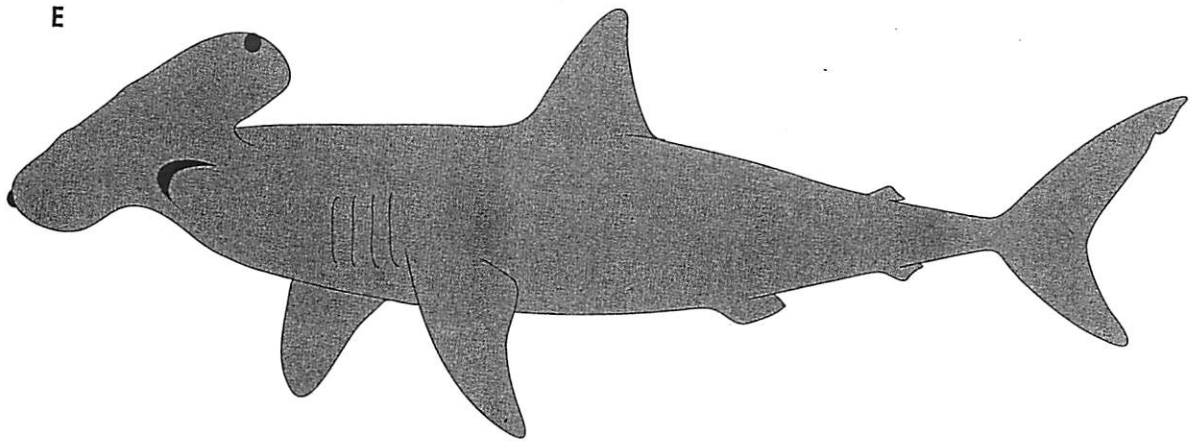

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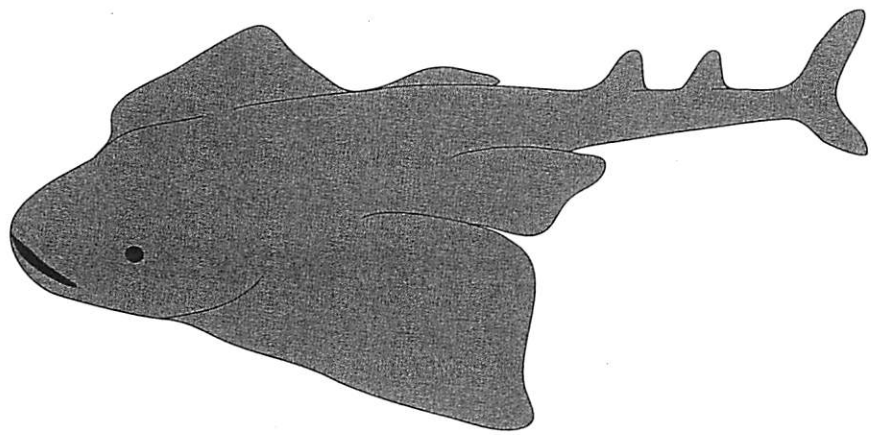

Unit 7: Ecology and Human Impact on the Environment

Overview

A. Properties of Populations
B. Population Growth
C. Community Structure and Population Interactions
    1. Predation
    2. Animal and Plant Defenses
    3. Symbiosis: Mutualism, Commensalism and Parasitism
D. Food Chains, Food Webs, Energy Pyramids and Trophic Levels
E. Ecological Succession
F. Chemical Cycles
G. Human Impact on the Environment
    1. Carbon dioxide emissions and global warming
    2. Depletion of atmospheric ozone
    3. Invasive species
    4. Habitat destruction
    5. Loss of biodiversity

Standards: NYS - Living Environment Standards

Key Idea 1: Living things are both similar to and different from each other and from nonliving things.

Explain how diversity of populations within ecosystems relates to the stability of ecosystems.
Performance Indicator 1.1a Populations can be categorized by the function they serve. Food webs identify the relationships among producers, consumers, and decomposers carrying out either autotropic or heterotropic nutrition.
Performance Indicator 1.1b An ecosystem is shaped by the nonliving environment as well as its interacting species. The world contains a wide diversity of physical conditions, which creates a variety of environments.
Performance Indicator 1.1c In all environments, organisms compete for vital resources. The linked and changing interactions of populations and the environment compose the total ecosystem.
Performance Indicator 1.1d The interdependence of organisms in an established ecosystem often results in approximate stability over hundreds and thousands of years. For example, as one population increases, it is held in check by one or more environmental factors or another species.
Performance Indicator 1.1e Ecosystems, like many other complex systems, tend to show cyclic changes around a state of approximate equilibrium.
Performance Indicator 1.1f Every population is linked, directly or indirectly, with many others in an ecosystem. Disruptions in the numbers and types of species and environmental changes can upset ecosystem stability.

Key Idea 6: Plants and animals depend on each other and their physical environment.

Performance indicator 6.1 Explain factors that limit growth of individuals and populations.

Performance Indicator 6.1a Energy flows through ecosystems in one direction, typically from the Sun, through photosynthetic organisms including green plants and algae, to herbivores to carnivores and decomposers.

Performance Indicator 6.1b The atoms and molecules on the Earth cycle among the living and nonliving components of the biosphere. For example, carbon dioxide and water molecules used in photosynthesis to form energy-rich organic compounds are returned to the environment when the energy in these compounds is eventually released by cells. Continual input of energy from sunlight keeps the process going. This concept may be illustrated with an energy pyramid.

Performance Indicator 6.1c The chemical elements, such as carbon, hydrogen, nitrogen, and oxygen, that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment as heat.

Performance Indicator 6.1d The number of organisms any habitat can support (carrying capacity) is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organisms through the activities of bacteria and fungi.

Performance Indicator 6.1e In any particular environment, the growth and survival of organisms depend on the physical conditions including light intensity, temperature range, mineral availability, soil/rock type, and relative acidity (pH).

Performance Indicator 6.1f Living organisms have the capacity to produce populations of unlimited size, but environments and resources are finite. This has profound effects on the interactions among organisms.

Performance Indicator 6.1g Relationships between organisms may be negative, neutral, or positive. Some organisms may interact with one another in several ways. They may be in a producer/consumer, predator/prey, or parasite/host relationship; or one organism may cause disease in, scavenge, or decompose another.

Performance indicator 6.2 Explain the importance of preserving diversity of species and habitats.

Performance Indicator 6.2a As a result of evolutionary processes, there is a diversity of organisms and roles in ecosystems. This diversity of species increases the chance that at least some will survive in the face of large environmental changes. Biodiversity increases the stability of the ecosystem.

Performance Indicator 6.2b Biodiversity also ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries with significant value to humankind. As diversity is lost, potential sources of these materials may be lost with it.

Performance indicator Explain how the living and nonliving environments change over time and respond to disturbances.

Performance Indicator 6.3a The interrelationships and interdependencies of organisms affect the development of stable ecosystems.

Performance Indicator 6.3b Through ecological succession, all ecosystems progress through a sequence of changes during which one ecological community modifies the environment, making it more suitable for another community. These long-term gradual changes result in the community reaching a point of stability that can last for hundreds or thousands of years.

Performance Indicator 6.3c A stable ecosystem can be altered, either rapidly or slowly, through the activities of organisms (including humans), or through climatic changes or natural disasters.

The altered ecosystem can usually recover through gradual changes back to a point of longterm stability.

Key Idea 7: Human decisions and activities have had a profound impact on the physical and living environment.

Performance indicator 7.1 Describe the range of interrelationships of humans with the living and nonliving environment.

Performance Indicator 7.1a The Earth has finite resources; increasing human consumption of resources places stress on the natural processes that renew some resources and deplete those resources that cannot be renewed.

Performance Indicator 7.1b Natural ecosystems provide an array of basic processes that affect humans. Those processes include but are not limited to: maintenance of the quality of the atmosphere, generation of soils, control of the water cycle, removal of wastes, energy flow, and recycling of nutrients. Humans are changing many of these basic processes and the changes may be detrimental.

Performance Indicator 7.1c Human beings are part of the Earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems. Humans modify ecosystems as a result of population growth, consumption, and technology. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems may be irreversibly affected.

Performance indicator 7.2 Explain the impact of technological development and growth in the human population on the living and nonliving environment.

Performance Indicator 7.2a Human activities that degrade ecosystems result in a loss of diversity of the living and nonliving environment. For example, the influence of humans on other organisms occurs through land use and pollution. Land use decreases the space and resources available to other species, and pollution changes the chemical composition of air, soil, and water.

Performance Indicator 7.2b When humans alter ecosystems either by adding or removing specific organisms, serious consequences may result. For example, planting large expanses of one crop reduces the biodiversity of the area.

Performance Indicator 7.2c Industrialization brings an increased demand for and use of energy and other resources including fossil and nuclear fuels. This usage can have positive and negative effects on humans and ecosystems.

Performance indicator 7.3 Explain how individual choices and societal actions can contribute to improving the environment.

Performance Indicator 7.3a Societies must decide on proposals which involve the introduction of new technologies. Individuals need to make decisions which will assess risks, costs, benefits, and trade-offs.

Performance Indicator 7.3b The decisions of one generation both provide and limit the range of possibilities open to the next generation.

Engage and Motivate:

A. Properties of Populations

Expand Vocabulary: Point out that the prefix bio- means life and the prefix a- means not.

Evaluate Understanding: Have students work in groups of four. Ask one group member to name and individual organism. Then, have a second group member identify a population in which that organism belongs. The next student should then describe a community in which that population belongs. Finally, the fourth group member should then describe an ecosystem in which the community is found.

Guiding Question: How do different organisms get the energy they need to survive?

Build Background: Ask students: From what do you get energy and for what do you use energy? Students' responses should indicate that they get energy from a variety of foods, and that they use energy for all of their activities and life processes. Tell students that all living things must obtain energy and that all living things use energy. Make a giant food web on the board. Start by asking several students what they had for breakfast/lunch. Ask them what organisms those foods cam from and write them on the board. Try and have students trace where all of those organisms get their energy from. Eventually, you should have a large food web with the sun as the ultimate source of energy.

Address Misconceptions: Students may think that energy is created by the process of photosynthesis. Remind students that photosynthesis produces energy-rich compounds but it does not produce energy. Explain that energy cannot be created or destroyed, but it can change form. Reinforce that the sun is the ultimate source of energy for the earth's ecosystems.

Address Misconceptions: A common misconception is that phytoplankton are too small to be important photosynthesizers. Tell students that oceans cover three quarters of Earth's surface, and that each drop of ocean water down to a depth of one hundred meters is home to thousands of phytoplankton. Then, tell them that phytoplankton produce 70 percent of the Earth's oxygen and are the main consumers of carbon dioxide, a greenhouse gas.

Assess and Remediate: On the board, write the question: How does energy move through an ecosystem? Have each student write a short response. Call on volunteers to share their responses with the class.

B. Population Growth

Guiding Question: What factors limit a population's growth?

Assess Understanding: Have students make a graphic organizer of the factors that impact population growth.

Guiding Question: How do populations grow?

Connect to Math: Have students examine different population growth graphs. Ask students how the shape of the line representing the growth of the bacterial population compares to the shape of line representing the growth of the elephant population. Ask how the graphs differ and why there are different time increments used in the two graphs.

Build Study Skills: Have students use a Venn Diagram to compare and contrast limiting factors. One side should be facts about density-dependent factors and the other side should be density-independent factors. Information apply to both should go in the middle section.

Evaluate Understanding: Name a type of ecosystem, such as a forest, pond or grassland. Have a volunteer identify one population of living things found in that ecosystem. Then, ask volunteers to describe as many specific limiting factors affecting the population as possible. As each liming factor is identified, have students categorize it as density-dependent or density-independent.

C. Community Structure and Population Interactions

Guiding Question: How do organisms interact with one another?

Connection to Math: *Predator –Prey Graphing.* Students can make double line graphs of populations of predators and their prey, such as the rabbit and the lynx. What do they notice about the relationship between the two graphs? Why are their always more prey than predators?

Use Visuals: Show several short video clips of different types of symbiotic interactions. Have students classify the relationship as mutualistic, parasitic or commensalistic. Call on students to identify the two organisms that are involved in the relationship and how they interact. For each example, discuss with the class how a change in numbers of one species in the relationship might affect numbers of the other species.

Evaluate Understanding: On the board, list the six types of community interactions described in the lesson (competition, predation, herbivory, mutualism, parasitism, and commensalisms). For each interaction, call on a student to give a definition and another student to give an example.

D. Food Chains, Food Webs, Energy Pyramids and Trophic Levels

Guiding Question: How does energy move through an ecosystem?

Use Visuals: Show students a picture of a food web and have them examine feeding relationships in an ecosystem and to review the categories of organisms that make up a food web. Review the terms: autotroph, heterotroph, herbivore, carnivore, omnivore, and decomposer.

Make a Model: Make a quick model of a food web using cards with the names of different organisms and a piece of string. As each student gets a different organism they have to connect with fellow classmates until all of the students are connected to at least one other student.

Lab Activity: *Flow of Energy in Ecosystems.* Students will each get a card representing a different species and how much energy they contain. Students act out their roles, eating different organisms and keeping track of how much energy they obtain.

Check for Understanding: Ask students why decomposers are necessary in any ecosystem. Ask them to imagine what would happen to different populations of organisms if the decomposers were removed from an environment.

Check for Understanding: Ask students why a food web is a more accurate representation of the feeding relationships in an ecosystem than a food chain.

Lab Activity: *Weaving a Tangled Web.* Give students the list of organisms from the ecosystem and the description of what each organism eats. Have students construct a food web that includes all of the organisms on the list. They can include pictures if they want.

Build Math Skills: Have students examine a picture of an energy pyramid. Point out that the percentages shown at each level of the energy pyramid are percentages of the original energy entering the food chain. Explain that, at each transfer, about ten percent of the energy from one trophic level is available to move to the organisms at the next trophic level. Give students sample amounts of energy and ask how much would be left after moving through 4 trophic levels.

Lab Activity: *Energy Pyramid.* Provide students with pictures of different organisms and a description of the things they eat. Have students construct an energy pyramid, placing the organisms in the correct spots on the pyramid.

Lab Activity: *Dissecting an Owl Pellet.* Have students dissect an owl pellet and talk about what type of information can be determined about owls and their environment from looking at owl pellets.

Address Misconceptions: Some students may believe that pollutants such as DDT undergo no changes as they move through a food chain. Explain that chemicals may affect different kinds of animals differently, and chemicals may change in form as they move through a food chain.

E. Ecological Succession

Guiding Question: How do ecosystems change over time?

Build Background: Describe or show photographs of a local area, familiar to students, that was recently disturbed by a natural event or human actions. Ask students to predict how the area would look in then years if it were left undisturbed.

Connection to Real Life: Many students will know of an abandoned house lot in their neighborhood. Ask them to describe what is going on with that property in ecological terms.

Use Visuals: Show students pictures of both primary and secondary succession and ask them to compare and contrast the two.

Evaluate Understanding: Ask students to make a series of leveled sketches to show how either primary or secondary succession occurs. Make sure they include both a terrestrial ecosystem and a lake ecosystem.

Lab Activity: *School Ecosystem Survey.* Now that students have a basic understanding of ecological terms, take a mini-field trip around the school grounds. Ask them to look for different types of organisms (autotrophs, heterotrophs, etc.), feeding interactions, signs of predation, signs of succession, and evidence of human influences.

F. Chemical Cycles

Guiding Question: Why is the cycling of matter important to life on Earth?

Visual Analogy: Have students examine pictures of the different chemical cycles and explain how the flow of energy and cycles of matter are different. Students should recognize that energy does not get recycled but simply flows through an ecosystem.

Lead a Discussion: As a class, discuss the different types of processes that cycle matter through the biosphere. Take a minute to talk about why human activity is discussed separately from biological processes.

Address Misconceptions: Explain that atoms cannot be created or destroyed (conservation of matter). They are instead combined and recombined with other atoms to form different compounds. To help, have students refer to the last two paragraphs on page eighty, which describe how a carbon molecule may cycle through the biosphere.

Use Visuals: Show a large picture of the carbon cycle on the board. Have students distinguish between the biological, human, geological, and physical/chemical processes that are involved in the carbon cycle.

Assess and Remediate: Call on volunteers to name a matter cycle that occurs in the biosphere. Then ask additional volunteers to supply details about that cycle.

G. Human Impact on the Environment

Guiding Question: How does human activity affect the environment?

Guiding Question: How is the human population growing?

Guiding Question: How can we use our natural resources wisely?

Guiding Question: How can we change our behaviors to help protect our planet?

Build Background: Write the following questions on the board: What limiting factors affect the human population? How are these limiting factors similar to or different than the liming factors affecting other populations? Ask students to write a brief response to each question. Have volunteers share their responses with the class.

Use visuals: Show students a graph of the human population. Ask them what is different about this graph than other population graphs they have studied? Students should be able to see that the human population has not yet leveled off at some carrying capacity.

Lead a Discussion: How can we determine what the carrying capacity is for humans in the environment? What types of events might happen if the carrying capacity is much lower than the current human population?

Evaluate Understanding: Ask volunteers to describe how the human population growth rate has changed over time.

1. Carbon dioxide emissions and global warming

Guiding Question: What factors affect global climate?

Use Visuals: Have students study the graphs of both carbon dioxide levels and the earth's average temperature. Make sure they understand the source of the data. Then, talk about the many different types of physical evidence of global warming.

Lead a Discussion: Make a list of the different sources of greenhouse gases on the board. Discuss ways that each of these sources could be minimized, and discuss why each of those solutions would be difficult to implement. Introduce students to the concept of a trade-off: that every decision that may have a benefit also has a cost. Ask students to come up with trade-offs they make in their own lives.

2. Depletion of atmospheric ozone

Connect to Chemistry: Explain that ozone is a form of pure oxygen, though different from the form we need for respiration. Further explain that CFC's degrade in the upper atmosphere, releasing chlorine and fluorine which combine with ozone molecules and destroy them. To emphasize how regulation of CFC's had a positive effect on the problem, show students a time lapse photo of the hole in the ozone layer.

3. Invasive species

Lead a Discussion: Watch a clip from the movie, *Cane Toads: An Unnatural History.* Talk about why the cane toads were brought to Australia, what effects they had on the native species, and their overall effect on the ecosystem.

4. Habitat destruction

Activate Prior Knowledge: Describe a well-known natural area, such as a forest preserve or wetlands, in or near the students' community. Have students imagine that a new housing development will be built there. Have them identify positive and negative impacts of such a project.

Lead a Discussion: What are the main causes of habitat destruction? Ask students for examples from their own communities of natural habitats that are being impacted by human activities.

Lab Activity: *Ecological Footprint Assessment.* If computers are available, ask students to take a brief quiz to determine their ecological footprint such as is available on the website: myfootprint.org. Ask students what the website means when it states: "If everyone on earth lived like Americans, we would need almost 7 planets."

Evaluate Understanding: Call on student to explain ecological footprints and describe how they are useful tools for ecologists.

Evaluate Understanding: Have each student write a brief paragraph that describes, in their own words, how sustainable development can help reduce the negative impacts of agriculture, industry, and development.

5. Loss of biodiversity

Guiding Question: Why is it important to protect and conserve biodiversity?

Lead a Discussion: As a class, discuss the value of biodiversity, including the types of biodiversity and biodiversity's benefits to society. Make sure students understand that biodiversity exists on three levels: ecosystem diversity, species diversity, and genetic diversity.

Lead a Discussion: Talk about the two strategies for conserving biodiversity (protecting individual species and preserving habitats and ecosystems). Make sure students know why both are important.

Lab Activity: *NYS Lab Activity – Relationships and Biodiversity.* Students will conduct a series of tests on 4 different species to see which is most closely related to the species of interest. Students should understand that species have medical, aesthetic, commercial, intrinsic, agricultural, cultural benefits.

Lead a Discussion: Read the book or show the movie, "The Lorax." Talk about how the story parallels different aspects of our current biodiversity crisis. Who does the Onceler represent? What is your take on the meaning of the stone's inscription, "Unless?" What are steps we can take in our own lives to help preserve biodiversity?

Evaluate Understanding: Call on students at random to identify specific human activities that result in harm to soil resources, freshwater resources, and atmospheric resources. Ask other students to identify specific human activities that can help preserve resources and habitats.

Evaluate Understanding: Have students fill out a chart that describes the causes, effects, and possible solutions of many of the environmental problems discussed in class.

Objectives - Students will be able to:

A. Properties of Populations

1. **Describe** the study of ecology
2. **Explain** how biotic and abiotic factors influence an ecosystem.
3. **Define** primary producers.
4. **Describe** how consumers obtain energy and nutrients.

B. Population Growth

1. **Identify** factors that affect population growth.
2. **Describe** exponential growth.
3. **Identify** factors that determine carrying capacity.
4. **Identify** limiting factors that depend on population density and those that do not.
5. **Discuss** the trend of human population growth.

C. Community Structure and Population Interactions

1. **Define** niche.
2. **Describe** the role competition plays in shaping communities.
3. **Describe** the role predation and herbivory play in shaping communities.
4. **Identify** the three types of symbiotic relationships in nature.

D. Food Chains, Food Webs, Energy Pyramids and Trophic Levels

1. **Trace** the flow of energy through an ecosystem using food webs and food chains.
2. **Interpret** an energy pyramids.

E. Ecological Succession

1. **Describe** how ecosystems recover from a disturbance.
2. **Compare** succession after a natural disturbance with succession after a human-caused disturbance.

F. Chemical Cycles

1. **Describe** how matter cycles among the living and nonliving parts of an ecosystem.
2. **Describe** how water cycles through the ecosystem.
3. **Explain** why nutrients are important in living things.
4. **Describe** how the availability of nutrients affects the productivity of ecosystems.

G. Human Impact on the Environment

1. **Describe** human activities that can affect the biosphere.
2. **Describe** the relationship between resource use and sustainable development.
3. **Describe** how human activities can affect soil and land, water resources and air resources.

4. **Define** biodiversity and explain its value.
5. **Identify** current threats to biodiversity and explain how biodiversity can be preserved.

Assessments:

Wizard test maker
CastleLearning.com
Regents Style practice questions

Key Vocabulary for Unit 9:

Biotic	Autotroph	Pioneer organism
Abiotic	Heterotroph	Climax community
Population	Food chain	Water cycle
Community	Food web	Nitrogen cycle
Ecosystem	Herbivore	Carbon cycle
Biome	Carnivore	Evaporation
Biosphere	Omnivore	Biodiversity
Exponential growth	Primary consumer	Greenhouse gas
Limiting factor	Secondary consumer	Global warming
Carrying capacity	Decomposer	Ozone layer
Niche	Scavenger	Trade-offs
Predation	Ecological succession	

Build Study Skills for Vocabulary Review:

- Use ***index cards*** to help build and strengthen vocabulary knowledge. You can give extra credit to students for doing this.
- Use vocabulary in ***Do Now*** **and** ***Homework*** assignments.
- Let students construct ***Concept Maps*** using vocabulary terms.
- For the more creative student, have them ***write a story*** on a basic chemical principle using vocabulary terms

Laboratory Activity #1 — Teacher's Guide

Relationships and Biodiversity

A Laboratory Activity for the Living Environment

ABSTRACT

This laboratory activity is a simulation that introduces the use of structural and molecular evidence for developing hypotheses about evolutionary relationships between several hypothetical plant species. Students collect and analyze the data to determine which species is most closely related to a valuable but endangered species. Students also explore the importance of preserving biodiversity.

TEACHER INFORMATION

Instructional Use

This laboratory activity can be used during units on evolution, ecology, genetics, or as a performance assessment of laboratory skills. It requires background knowledge of DNA and protein synthesis.

Time Requirements

This laboratory activity requires 80 minutes to collect data and 40 minutes to answer the questions. Task 7 and the questions for analysis could be completed in class or for homework.

Safety Precautions

Require students to wear safety goggles when handling chemicals in Tests 4 and 5.

Materials

Reusable

- Safety goggles (1 per student)
- Pencil (1 per team)
- Plastic bottles for plant extracts or small plastic condiment cups with lids (4 per team)
- Metric ruler (1 per team)
- Plastic microtip pipettes (4 per team)
- Microscope (1 per team)
- 35-mm film containers or similar-sized containers for testing powder (1 per team)
- Small scoop (1 per team)
- Plastic sandwich bags (13 per team)
- Plastic well tray with 4 depressions, or alternative to conduct Test 5 (1 per team)
- Scissors
- Prepared slides of herbaceous dicot stem cross sections for Test 3 (2 per team)
- Prepared slides of herbaceous monocot stem cross sections for Test 3 (2 per team)
- Genetic code chart (1 per team)
- 32-oz. cup or can to serve as waste container (1 per team)
- 32-oz. cup or bottle for tap water (1 per team)
- Clear plastic packing tape (1 roll per class)
- Hand lens or dissecting microscope

Consumable

- Student Laboratory Packet and Student Answer Packet (1 of each per student) Masters are provided at the end of this guide to duplicate as needed.
- Chromatography paper or filter paper sheets (one 8 cm x 8 cm square per team)
- Food coloring: red, blue, green (1 bottle of each per year)
- White vinegar (1 quart bottle per year)
- Baking soda (1 box per year)
- Plant samples (1 set per team: see teacher instructions for possibilities)
- Seed samples (1 set per team: see teacher instructions for possibilities)
- Tap water
- Pink, green, yellow, and blue paper for copy machine

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Preparation

Keep in mind that this activity is a hands-on simulation designed to use materials that should be readily available to teachers at any time of the year. An illustration of one laboratory kit and sample cut-out labels are provided on pages 12 and 13 of this guide.

This activity can be done by individual students or in teams of two, three, or four students, depending on the classroom situation. It will take approximately four hours to set up materials for 10 student teams. These materials can then be used for many classes and stored for use in future years. Refilling kits as needed requires less than an hour.

Collect specimens of four different types of plants and four different kinds of seeds. The examples given below were selected because they are available at any time of year. Other plant and seed samples, depending on the time of year or the particular specimens that are readily accessible, may be used, such as common weeds, dried or fresh flowers from a florist, or cuttings from common houseplants instead of evergreens. Use any small seeds (spice, garden, lawn, or bird seed).

Label the smallest plant sample and the smallest seed sample as *Botana curus*. It is worth the time to press and dry the plant materials and use clear packing tape to attach them to 5" x 8" file cards, creating simulated herbarium specimens that can be used for many years. The plant samples should be similar enough for students to believe that they might be related, for example, pine, spruce, yew, or juniper branches.

For Test 1, put the plant samples into plastic sandwich bags or tape them to cards. Label them as follows:

Label	Possible Specimen
Botana curus	Juniper
Species X	Spruce
Species Y	Pine
Species Z	Yew

For Test 2, put the seeds into plastic sandwich bags or tape them to file cards. Label them as follows:

Label	Possible Specimen
Botana curus	Celery seed
Species X	Whole black pepper
Species Y	Mustard seed
Species Z	Sesame seed

For Test 3, provide microscopes and prepared slides of monocot and dicot stems. Cover the original labels on slides with the following labels. Make sure that *Botana curus* and Species Z are the most similar.

Label	Possible Specimen
Botana curus stem cross section	Herbaceous monocot stem
Species X stem cross section	Herbaceous dicot stem
Species Y stem cross section	Herbaceous dicot stem
Species Z stem cross section	Herbaceous monocot stem

For Test 4, use the chart below as a reference to make simulated plant extracts. Put 10 mL of each type of extract into labeled screw-cap bottles (15 or 30 mL plastic) or in small plastic condiment cups with lids. Provide four microtip droppers for dispensing the plant extracts.

Label	Amounts To Make Approximately 200 mL of Plant Extract
Botana curus	200 mL white vinegar 4 mL green food coloring 4 mL red food coloring 4 mL blue food coloring
Species X	200 mL tap water 4 mL green food coloring 4 mL red food coloring 4 mL blue food coloring
Species Y	200 mL white vinegar 4 mL green food coloring 4 mL blue food coloring
Species Z	200 mL white vinegar 4 mL green food coloring 4 mL red food coloring 4 mL blue food coloring

Cut 8 cm x 8 cm squares of chromatography or filter paper—at least one per team. Put these in plastic bags labeled "Chromatography Paper."

For Test 5, prepare 35-mm film containers labeled "Indicator Powder." Add enough baking soda (not baking powder) to half fill the film can. Provide a small scoop for dispensing the indicator powder.

For Test 6, prepare labeled plastic bags containing copies of the simulated DNA molecules. Make copies of the simulated DNA strips at the end of the teacher information. Use different colors of paper for each type of DNA to help students keep the fragments from the different species separated.

For all tests, provide each group with the following materials:

- Safety goggles for each student
- 4 microtip pipettes
- Clear plastic cup - low form
- Cup of tap water or easy access to a sink
- Metric ruler
- Well plate with at least 4 wells or four small plastic condiment cups
- Scissors
- Small scoop (could be made from a small soda straw)
- Waste container (*e.g.*, large coffee can)
- Microscope
- Hand lens or dissecting microscope
- Copy of a genetic code chart (photocopied from this guide or may be found in the student textbook)

Correlation of This Investigation to the *Living Environment Core Curriculum* and the *Mathematics, Science, and Technology Learning Standards*

Learning Standard 1

S1.3 a accept scientific explanations only when they
- are consistent with experimental and observational evidence
- can be used to make accurate predictions

S1.3b understand that scientific explanations are tentative and subject to change or improvement, *i.e.*, each new bit of evidence can create more questions than it answers, leading to increasingly better understanding of how things work in the living world

S1.4a recognize that well-accepted theories are ones that are supported by different kinds of scientific investigations and often involve the contributions of individuals from different disciplines

S2.3a develop hypotheses based upon both research and observation

S3.1a interpret data and use it to develop additional hypotheses

Learning Standard 4

3.1e Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as for the molecular and structural similarities observed among the diverse species.

6.2a As a result of evolutionary processes, there is a diversity of organisms and roles in ecosystems. This diversity of species increases the chance that at least some will survive in the face of large environmental changes. Biodiversity increases the stability of the ecosystem.

6.2b Biodiversity also ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries with significant value to humankind. As diversity is lost, potential sources of these materials may be lost with it.

7.2a Human activities that degrade ecosystems result in a loss of diversity of the living and nonliving environment. For example, the influence of humans on other organisms occurs through land use and pollution. Land use decreases the space and resources available to other species, and pollution changes the chemical composition of air, soil, and water.

7.2b When humans alter ecosystems either by adding or removing specific organisms, serious consequences may result. For example, planting large expanses of one crop reduces the biodiversity of the area.

Learning Standard 6

- Search for multiple trends when analyzing data for patterns, and identify data that do not fit the trends.

Learning Standard 7

- Work effectively, gather and process information, generate and analyze ideas, observe common themes, realize ideas, and present results.

Learning Standard 4 Process Skills Addressed

i Follows safety rules in the laboratory
iii Uses a microscope to observe cells
vii Follows directions to correctly use and interpret chemical indicators
viii Uses chromatography and/or electrophoresis to separate molecules
xiii Collects, organizes, and analyzes data, using a computer or other laboratory equipment
xv Analyzes results from observations/expressed data
xvi Formulates an appropriate conclusion or generalization from the results of an experiment

Testable Skills and Concepts

- Use of structural (*e.g.*, flowers, stems, seeds, etc.) and molecular (*e.g.*, DNA, proteins, etc.) similarities to determine evolutionary relationships
- Understanding of evolutionary trees and similarities due to common ancestry
- The importance and maintenance of biodiversity
- Construction of data tables incorporating qualitative and quantitative data
- Use of a universal genetic code table
- Use of a microscope to observe tissue organization
- Use of chemical indicators
- Use of chromatography to separate molecules
- Use of gel electrophoresis for DNA fragment analysis
- Use of safe laboratory practices when using chemicals

References

- "Evolutionary Relationships" from *Laboratory Performance Assessment*—California Golden State Examination
- "How Many CATS" by Anthony Bertino for Cornell Institute for Biology Teachers

Enrichment Activities (optional)

- Have students cooperate to do research and report on a real-world example related to this simulation using the following terms for an Internet search--Taxol, *Taxus brevifolia*, Pacific Yew, ethnobotany, tamoxifen. Reports should reveal additional connections to cancer, chemotherapy, ecological issues, genetic engineering, and medical risk/benefits.
- Consider using the movie *Medicine Man* as an introduction to this laboratory. Use four *Tillandsia* (air plants that can be dried for long-term use) or Bromelid species as the plant samples for the laboratory to strengthen the connection to the movie.
- Consider having students write up their work as if they were going to submit it for publication in a newspaper or scientific magazine such as *Science News*, *Discover*, or *National Geographic*. Provide sample articles as models.
- Help students understand that the study of evolution is important for their future and not just a study of the past. Have them use the information in "Evolution, Science, and Society" (available in html or pdf format at http://www.amnat.org/meagher.html) to make a list of 10 reasons why understanding evolutionary biology is important for their future.
- To make a connection between evolution and ecology, have students do research on the Internet on an actual endangered species and then create a "3 x 3 poster." This type of poster uses nine sheets of 8 1/2 x 11 paper taped together. It is inexpensive, can be done using a computer, and can be folded if it needs to be portable. Students could include the following information about the endangered species on individual sheets of their poster:
  - Picture with common name and scientific name
  - Description
  - Habitat and niche
  - Map showing where it is found
  - Reasons why efforts should be made to save it
  - List of other species that are closely related to it along with their similarities and differences
  - List of human activities that have put it at risk
  - List of things people could do to preserve it
  - Other interesting information about the species

Student Work

Check to be sure that students have completed both the Student Laboratory Packet and the Student Answer Packet. Collect the Student Answer Packet and data table for grading and to keep as evidence of the successful completion of laboratory work for fulfilling the laboratory requirement. To review for Part D of the Living Environment Regents Examination, students must have access to their completed Student Laboratory Packet and a copy of their data table.

Sample Answers for Student Answer Packet

Hypothesize: Tests 1-3

a. Based on your data for structural relationships, which species (X,Y, or Z) would you hypothesize is most likely to produce Curol? _Z_

b. Explain how the evidence from your data table supports your hypothesis. You will test your hypothesis by completing additional tests in the second part of this laboratory activity.
Answers will vary based on the actual plant material used.

Molecular Evidence for Relationships: Test 7

b. Under each DNA sequence, write the complementary messenger RNA base sequences that each of these gene fragments would produce. *Note:* Unlike during DNA replication, in the production of messinger RNA, the DNA base "A" specifies the RNA base "U."

c. Use the universal genetic code table your teacher provides to translate the messenger RNA base sequences into sequences of amino acids in the protein produced by each species. Write the sequences of amino acids under the messenger RNA sequences.

Botana curus	CAC	GTG	GAC	TGA	GGA	CTC	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*ACU*	*CCU*	*GAG*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*THR*	*PRO*	*GLU*	*GLU*

Species X	CAC	GTG	GAC	AGA	GGA	CAC	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*UCU*	*CCU*	*GUG*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*SER*	*PRO*	*VAL*	*GLU*

Species Y	CAC	GTG	GAC	AGA	GGA	CAC	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*UCU*	*CCU*	*GUG*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*SER*	*PRO*	*VAL*	*GLU*

Species Z	CAC	GTA	GAC	TGA	GGA	CTT	CTC
Sequence of bases in mRNA produced	*GUG*	*CAC*	*CUG*	*ACU*	*CCU*	*GAA*	*GAG*
Sequence of amino acids in the protein	*VAL*	*HIS*	*LEU*	*THR*	*PRO*	*GLU*	*GLU*

- State how the amino acid sequence you obtained from the gene fragment for *Botana curus* compares with the sequences for the other three species.
  It is the same as Species Z and different from Species X and Y.

- Summarize your observations of the number of differences in Table 1.
  Sample student answers are given in the Table on page 10 of this guide.

Analysis of Results

1. Using the information in Table 1, identify which plant is most closely related to *Botana curus* and therefore most likely to produce Curol. _*Species Z*_ Explain your choice by citing specific evidence from your research.

   Botana curus *is most closely related to Species Z because both species have the following similarities:*
   - *enzyme for making Curol or reaction in enzyme test*
   - *blue, yellow, pink pigments*
   - *scattered arrangement of vascular bundles*
   - *no difference in the amino-acid sequence of the protein*
   - *4 similar-sized DNA fragments when cut with DNA-cutting enzyme*

2. Did the addition of molecular evidence support or refute the hypothesis that you made earlier based on structural evidence only? _____ Explain why or why not.
   Answers may vary depending on the student's original hypothesis.

3. Which kind of evidence—structural or molecular—is most helpful in making decisions about relationships between species? _*molecular*_ Explain why.
   Molecular evidence is more helpful than structural evidence. Organisms can look alike on the surface (have similar size, shape, and color) but have many hidden molecular differences.

4. Based on your observations, list three characteristics (structural or molecular) that all four species have in common.
   Characteristics could include having needles (or leaves or flowers if different specimens were used), seeds, green pigment that separates to blue and yellow, some common aspects of their DNA code, common amino-acid sequences, or others.

5. Provide a biological explanation for the common characteristics that these species share.
   These common characteristics are most likely due to common ancestry. Other possibilities could be similar genes or evolution.

6. Scientists frequently use branching tree diagrams to represent graphically the relationships between species. Which branching tree, shown below, best represents the relationships among the four species? _2_ Explain how you used the information in the data table to select this tree.
   I chose this tree because it shows Z and Botana curus *closer together.*

7. State two additional kinds of evidence you might use to further support your hypothesis about the relationship between *Botana curus* and Species X, Y, and Z.

   Additional evidence might include:
   - *results of using indicators for other enzymes*
   - *comparisons of amino-acid sequences of other proteins*
   - *comparisons of DNA fragments using other DNA-cutting enzymes or other genes*
   - *comparisons of the internal or microscopic structure of plants and seeds*
   - *comparisons of fossil records*

Reading Passage: *The Biodiversity Crisis*

8. State three examples of human activities that could endanger *Botana curus.*

   Examples of human activities that could endanger Botana curus *might include:*
   - *destruction of natural habitats, which could mean that the species has no place to live*
   - *pollution, which could poison the species*
   - *overharvesting or overgrazing by herbivores, which could reduce the population to dangerously low levels*
   - *introduction of foreign species, which could cause competition with the native species*
   - *removal of herbivores, which could allow other competing species to increase*
   - *removal of predators, which could allow herbivore populations to increase*

9. State three reasons why it might be important to preserve *Botana curus.*

   Reasons for preserving Botana curus *might include:*
   - *It makes Curol.*
   - *Other plants may not be a good source of Curol.*
   - *It could be useful for agricultural purposes that we haven't discovered yet.*
   - *It could have other medical purposes that we haven't discovered yet.*
   - *It might contain useful genes for future genetic engineering.*
   - *Removing it could upset the ecosystem balance.*
   - *Other species may depend on it.*
   - *Actions to preserve this species might also preserve other similar species.*

10. State two arguments people might make for NOT preserving *Botana curus.*

    Arguments for NOT preserving Botana curus *might include:*
    - *It will be expensive to save it.*
    - *We may not succeed in saving it even if we try.*
    - *It is small and grows slowly.*
    - *Other plants could be a source for Curol.*

Sample Completed Table 1: Comparison of *Botana curus* with Species X, Y, and Z

	Structural Evidence			Molecular Evidence			
Species	**Structural Characteristics of Plants**	**Structural Characteristics of Seeds**	**Microscopic Stem Structure**	**Paper Chromatography**	**Test for Enzyme M**	**Differences in Amino Acid Sequences**	**Gel Electrophoresis DNA Banding Pattern**
Botana curus	*Answers will vary.*	*Answers will vary.*	*Scattered bundles*	*Blue Yellow Pink*	*Present*		*4 bands 5, 9, 11, 12*
Species X	*Answers will vary.*	*Answers will vary.*	*Circular bundles*	*Blue Yellow Pink*	*Absent*	*Two differences: SER not THR VAL not GLU*	*3 bands 7, 8, 22*
Species Y	*Answers will vary.*	*Answers will vary.*	*Circular bundles*	*Blue Yellow (see below*)*	*Present*	*Two differences: SER not THR VAL not GLU*	*4 bands 3, 5, 12, 17*
Species Z	*Answers will vary.*	*Answers will vary.*	*Scattered bundles*	*Blue Yellow Pink*	*Present*	*No difference*	*4 bands 5, 9, 11, 12*

* Some brands of green food coloring contain small amounts of red pigment. Either test the Species Y food coloring mix to be certain that it does not contain red or have students compare the relative amounts of pink color on their chromatography.

Table 2: Simulated Electrophoresis Gel (Expected Answers)

- Negative Pole -

Wells →	*Botana curus*	Species X	Species Y	Species Z
# of DNA bases				
24				
23				
22				
21				
20				
19				
18				
17				
16				
15				
14				
13				
12				
11				
10				
9				
8				
7				
6				
5				
4				
3				
2				
1				

+ Positive Pole +

ILLUSTRATION OF SAMPLE MATERIALS FOR ONE STUDENT GROUP

Not to Scale! Microscope is also needed!

Plant *Botana curus*

Plant Species X

Plant Species Y

Plant Species Z

Seeds *Botana curus*

Seeds Species X

Seeds Species Y

Seeds Species Z

DNA Molecules *Botana curus*

DNA Molecules Species X

DNA Molecules Species Y

DNA Molecules Species Z

Genetic Code Chart or Textbook

Scoop

Metric Ruler

4 Droppers

Well Tray

Plant Extract *Botana curus*

Plant Extract Species X

Plant Extract Species Y

Plant Extract Species Z

Stem Slide *Botana curus*

Stem Slide Species X

Stem Slide Species Y

Stem Slide Species Z

Large Waste Container

Indicator Powder

Cup of Water

Hand Lens

Chromatography Cup

Labels for Materials

Photocopy these labels and cut them apart. Use clear packing tape to apply them.

Botana curus Plant Extract	Species X Plant Extract	Species Y Plant Extract	Species Z Plant Extract
Botana curus Plant Sample	Species X Plant Sample	Species Y Plant Sample	Species Z Plant Sample
Botana curus Seeds	Species X Seeds	Species Y Seeds	Species Z Seeds
Botana curus Stem Cross Section	Species X Stem Cross Section	Species Y Stem Cross Section	Species Z Stem Cross Section
Botana curus DNA Molecule	Species X DNA Molecule	Species Y DNA Molecule	Species Z DNA Molecule
Indicator Powder For Enzyme M	Chromatography Paper	Cup for Chromatography	Tap Water
	Waste Container	Well Plate	

Copy this page on green paper and cut into strips

Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC
Botana curus	ATTCCGGATCGATCGCCGGATATACTCCGGTAATATC

Copy this page on pink paper and cut into strips

Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA
Species X	ATTGTACCGGGATCCGGACGTCGCGACTAATATAGCA

Copy this page on yellow paper and cut into strips

Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC
Species Y	ACCGGTCCGGGATCGCACCCGGTACTCCTGTAATATC

Copy this page on blue paper and cut into strips

Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC
Species Z	ATTCCGGATCGATCGCCGGATATTCTCCGGTAATATC

Universal Genetic Code Chart

Messenger RNA codons and the amino acids they code for.

FIRST BASE	SECOND BASE: U	SECOND BASE: C	SECOND BASE: A	SECOND BASE: G	THIRD BASE
U	UUU, UUC: PHE UUA, UUG: LEU	UCU, UCC, UCA, UCG: SER	UAU, UAC: TYR UAA, UAG: STOP	UGU, UGC: CYS UGA: STOP UGG: TRP	U C A G
C	CUU, CUC, CUA, CUG: LEU	CCU, CCC, CCA, CCG: PRO	CAU, CAC: HIS CAA, CAG: GLN	CGU, CGC, CGA, CGG: ARG	U C A G
A	AUU, AUC, AUA: ILE AUG: MET or START	ACU, ACC, ACA, ACG: THR	AAU, AAC: ASN AAA, AAG: LYS	AGU, AGC: SER AGA, AGG: ARG	U C A G
G	GUU, GUC, GUA, GUG: VAL	GCU, GCC, GCA, GCG: ALA	GAU, GAC: ASP GAA, GAG: GLU	GGU, GGC, GGA, GGG: GLY	U C A G

Note: Amino acid abbreviations are in bold type (*e.g.*, PHE, LEU, SER, etc.)

RIVERVENTURE

Classroom Activity: Food Webs

Subject: Biology/Ecology

Grades: 6-12

Standards: See end of lesson plan.

Time: 10 minutes (can last as long as you want depending on how much you develop the activity)

Materials: Yarn, index cards, hole puncher, marker

Lesson objective: The student will understand the interrelatedness of food webs and see how populations affect other populations.

Content:

1. Write the names of various plants and animals (a variety of types) on index cards. You can use the list below, construct your own, or have participants select their own organism. Be sure to include the sun, plants, plant eaters, and flesh eaters in the array.

   sun, grasshopper, robin, grass, berry brush, hawk, quail, dandelion, mouse, worm, rabbit, cow, flea, meadowlark, owl, wheat, tick, fox, weeds, coyote, mushrooms, microscopic bacteria

2. Punch holes in each card and give each participant a card and a piece of string to hang the card around his/her neck.

3. Have individuals identify energy (or food) sources. As each one is identified, pass a ball of yarn between the two people. For example: One student is a cow, and one is the grass. The cow will take the ball of yarn, hold onto one end of the string and pass the rest of the ball to the grass. The grass will hold onto the yarn and pass the rest of the ball to "what it eats," in this case, the sun. Be sure that the sun is connected to all the plants. Once the string gets to the sun, cut it off, and start again in another place.

4. Continue building the web, making the relationships as complex as time and numbers of participants allow. Define terms such as herbivore, carnivore, insectivore, decomposer, etc and include them in your web. [Note that insectivores are specialized carnivores.] Students can be in as many chains as you have time for; they do not have to be in all of the chains.

5. Discuss the nature and complexity of the food web that is formed. Note that it is not as complete or complex as most natural food webs, but that it illustrates how living things are dependent upon one another. Biologists feel that more complex food webs are more stable than simple ones.

6. After discussing the food web, the leader could ask what would happen if a species were removed from the web. Have a student pull on the strings they hold; anyone who feels a tug is directly affected by that organism. Those "organisms" affected directly could then pull on their strings and more organisms are affected. Have different students pull on their strings. When the "sun" pulls on its string, everyone should be affected. Have some organisms drop their string (become extinct) and see who is affected. Have students tell you if certain populations will grow or decline. The teacher can represent nature and cause any type of problem to occur; for example, a wildfire could occur, but some birds were able to fly

away and some types of trees reseed well after a fire. The teacher defines what happens and who is affected; the students then reveal what would happen. New species could also move into the area at any time disrupting the web.

7. Discuss what would happen if all of the predators were removed. Some species might exhaust their food supply and starve, but others will continue to reproduce only until the food supply becomes limiting or their interactions limit population size.

8. If desired, discuss the simplified food webs that produce most foods used by people. Remind the participants that such food webs are inherently unstable and require large amounts of management (raising/slaughtering cows, chickens, etc) to avoid problems.

Closure: Review everything with students telling them that this is the way a food web works. They can throw away their yarn pieces. Students could complete the Food Web Worksheet from the teacher resource page.

Assessment: The activity could be assessed by participation, or students could complete a worksheet like the Food Web Worksheet from the teacher resources page.

This activity was adapted from the 4-H Shooting Sports Program.

Standards:

7.II. Life Science

B. Regulation and Behavior

1. All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
    a. Analyze the basic characteristics and needs of living things.
    b. Compare and contrast how organisms use resources, grow, reproduce, and maintain stable internal conditions (homeostasis).

D. Populations and Ecosystems

2. Populations of organisms can be categorized by the function they serve in an ecosystem. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
    a. Analyze the role of producers, consumers and decomposers in an ecosystem.
    b. Identify kinds of relationships organisms have with each other (predator/prey, competition).
    c. Analyze energy flow in a food chain and its relationship to a food web.

3. The number of organisms an ecosystem can support depends on the biotic resources available. Given adequate biotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.
    a. Compare and contrast how cooperation, competition and predation affect population growth.
    b. Analyze the effects of overpopulation within an ecosystem on the amount of resources available.
    c. Analyze how natural hazards (earthquakes, landslides, wildfires, volcanic eruptions, floods, and storms) affect populations.

7.III. Earth Science

A. Structure of the Earth System

6. For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.
   b. Trace the path of solar energy through a simple food chain and through food webs that include humans.
   c. Examine how energy is transferred through an ecosystem.
   d. Examine how energy is distributed in an energy pyrimad.

8. II. Life Science

A. Diversity and Adaptations of Organisms

2. Biological change accounts for the diversity of species developed through gradual processes over many generations. Biological adaptations, which involve the selection of naturally occurring variations in populations, enhance survival and reproductive success in a particular environment. How a species moves, obtains food, reproduces, and responds to danger is based in the species' evolutionary history.
   b. Analyze how an adaptation can increase an organism's chances to survive and reproduce in a particular habitat (e.g., cacti needles/leaves, fur/scales).
   *[This concept has been taught at a previous grade level]

3. Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.
   a. Determine the factors that contribute to an organism becoming extinct.
   b. Explain some of the natural and human-made pressures that can cause extinction.
   c. Examine ways to prevent the extinction of an organism.

Name: _____ Date: _____
Living Envrionment

OWL PELLET DISSECTION

INTRODUCTION:

Most birds cannot chew their food and owls are no exception. Owls usually swallow their prey whole or in large pieces. However, owls differ from other species of birds because they do not have a **crop**, the baglike organ used to store food after it has been swallowed so that it can be digested later. In owls, food passes directly from the mouth to the gizzard. The **gizzard** is an organ that uses digestive fluids and bits of sand and gravel to grind and dissolve all of the usable tissue from the prey.

The types of tissue that can be dissolved by an owl's digestive system include muscle, fat, skin, and internal organs. These tissues are broken down into a variety of nutritional substances by the owl's gizzard and intestines. Some of these tissues (e.g., fur and bones) cannot by digested. This material, along with other waste collected throughout the body, is ejected from the *vent*, which is the combination reproductive and excretory opening in birds. The pasty white excrement is known as urea. It is very rich in nitrogen and similar to urine in mammals, only thicker.

But what happens to the indigestible material? Indigestible material left in the gizzard such as teeth, bones, skulls, claws, hair and feathers are too dangerous to pass through the rest of the owl's digestive tract. To safely excrete this material, the owl's gizzard compacts it into a tight pellet that the owl regurgitates. The regurgitated pellets are known as **owl pellets**. Owls feed early in the evening and regurgitate a single pellet approximately 20 hours after eating. Unlike snakes, the protein enzymes and strong acids which occur in the digestive tract of raptors do not digest the entire meal.

- What does it mean to <u>regurgitate</u> something? _____
- What can examining an owl pellet tell us about an owl? _____

The owl pellets that you will be examining in this lab have been collected and fumigated from common barn owls. Owl pellets themselves are **ecosystems**, providing food and shelter for **communities** which may include clothes moths, carpet beetles and fungi. Clothes moth larvae are frequently abundant in pellets, feeding on fur and feathers. The black spheres about the size of periods (.) that are found in the pellets are the droppings of the caterpillars. The larvae metamorphose near the surface of a pellet in cocoons made of fur.

- What is a barn owl's niche in the environment? _____

MATERIALS:

Owl Pellets	Paper plate
Dissecting needle	Gloves

PROCEDURE:

1. Obtain an owl pellet from your instructor and unwrap it on the paper plate.

2. Measure the length, width and mass of your owl pellet. Do not forget to write the units.

   Length of pellet: _____
   Width of pellet: _____
   Mass of pellet: _____

3. Write down your observations of what the pellet looks like. _____

_____

_____

4. Place the pellet on the paper plate and gently break it into two pieces. Use the dissecting needles to pull the pellet apart. Carefully separate the bones, skulls, fur and feathers.

5. Use the Owl Pellet Bone Chart to identify where the bones in your pellet came from. **List the type of bone and organism it is from is the space below.**

6. Note if there are any other remains in the pellet. Check all that you find.

Insect _____ Beetle wings_____ Feathers_____ Seeds _____
Plant fibers _____ Other _____

7. Try to construct a full skeleton of an organism using the bones that you found.

Conclusion Questions:

1. How many mammals were present in your pellet? _____

2. Assuming the barn owl produces one pellet each day, estimate how many animals the owl eats per week? _____

   per month? _____

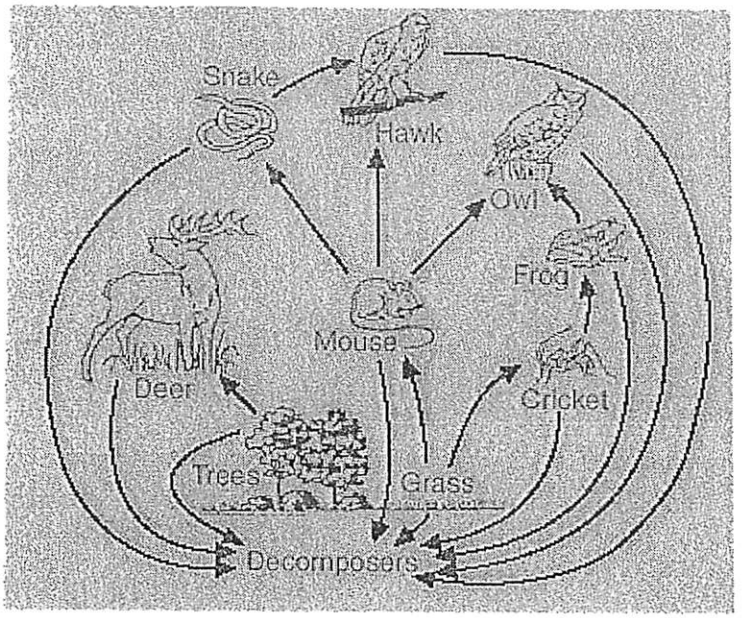
   per year? _____

3. Why do you think farmers like having barn owls on their farms?

4. What can you infer about the mammal population in the area where your pellet was found? Is your answer a good guess, or would you need more pellets to be sure? Why?

5. Other birds beside owls regurgitate pellets. Among these are crows, pelicans, and even some songbirds (songbird pellets contain hard indigestible seeds). What kind of things would you expect to find in the pellet of a sea gull?

REVIEW QUESTIONS:
Base your answers to the questions on the food web below.



1. Trace a path of energy starting with the sun and ending with the hawk.

_____

_____

2. List the primary consumers.

_____

_____

3. Which organisms are part of the food chain which are not represented in the diagram?

_____

_____

4. What would be the effect on the food web if the number of owls decreased?

_____

_____

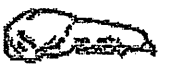
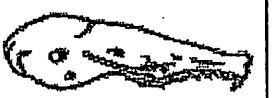
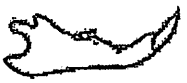
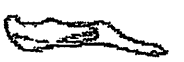
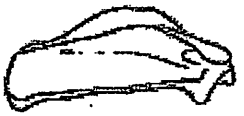
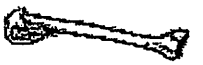
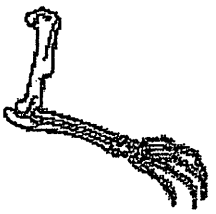
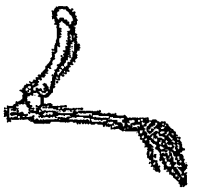
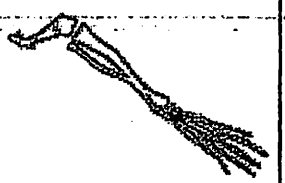
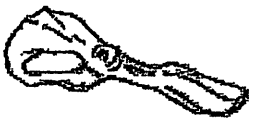
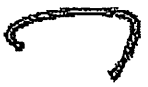
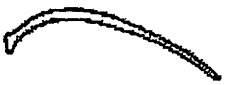
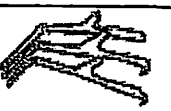
5. State what would happen to the plant population if the number of decomposers decreased and explain why this would happen.

_____

_____

6. Construct a food pyramid (of at least 3 organisms in each level) with owls at the uppermost trophic level.

Owl Pellet Bone Chart

	Rodent	Shrew	Mole	Bird
Skull				
Jaw				
Scapula				
Forelimb				
Hindlimb				
Pelvic Bone				
Rib				
Vertebrae	      			

Name Date
Living Environment Period

Rabbit and Lynx- Predator~Prey Lab

A study was conducted that lasted more than 90 years and counted the populations of lynx and rabbits in a specific area. The scientists noticed a pattern to the population changes within each organism. During this lab activity, you are to determine the pattern and offer an explanation as to why this happens.

1. Using the graph on the following page, determine the population for each the rabbit and lynx for each specific year listed in the table below.

2. For each animal, calculate the ***total population*** for the 90 years by adding the numbers in each column.

3. For each animal, calculate the ***average population*** for the 90 years by dividing the total population by 10.

Year	Rabbit population	Lynx population
1845		
1855		
1865		
1875		
1885		
1895		
1905		
1915		
1925		
1935		
Total		
Average population (Total/10)		

4. Use a **pencil** to draw a horizontal line on the graph showing the average rabbit population and a **pen** to draw the average lynx population.

Graph Analysis

1. Rabbit average population = ...
   Lynx average population = ...

2. Which species has the larger average population? .....

2. Which species is the predator? ..... prey? .....

3. How many "peaks" are there above the average line for the rabbit? .....
lynx?.....

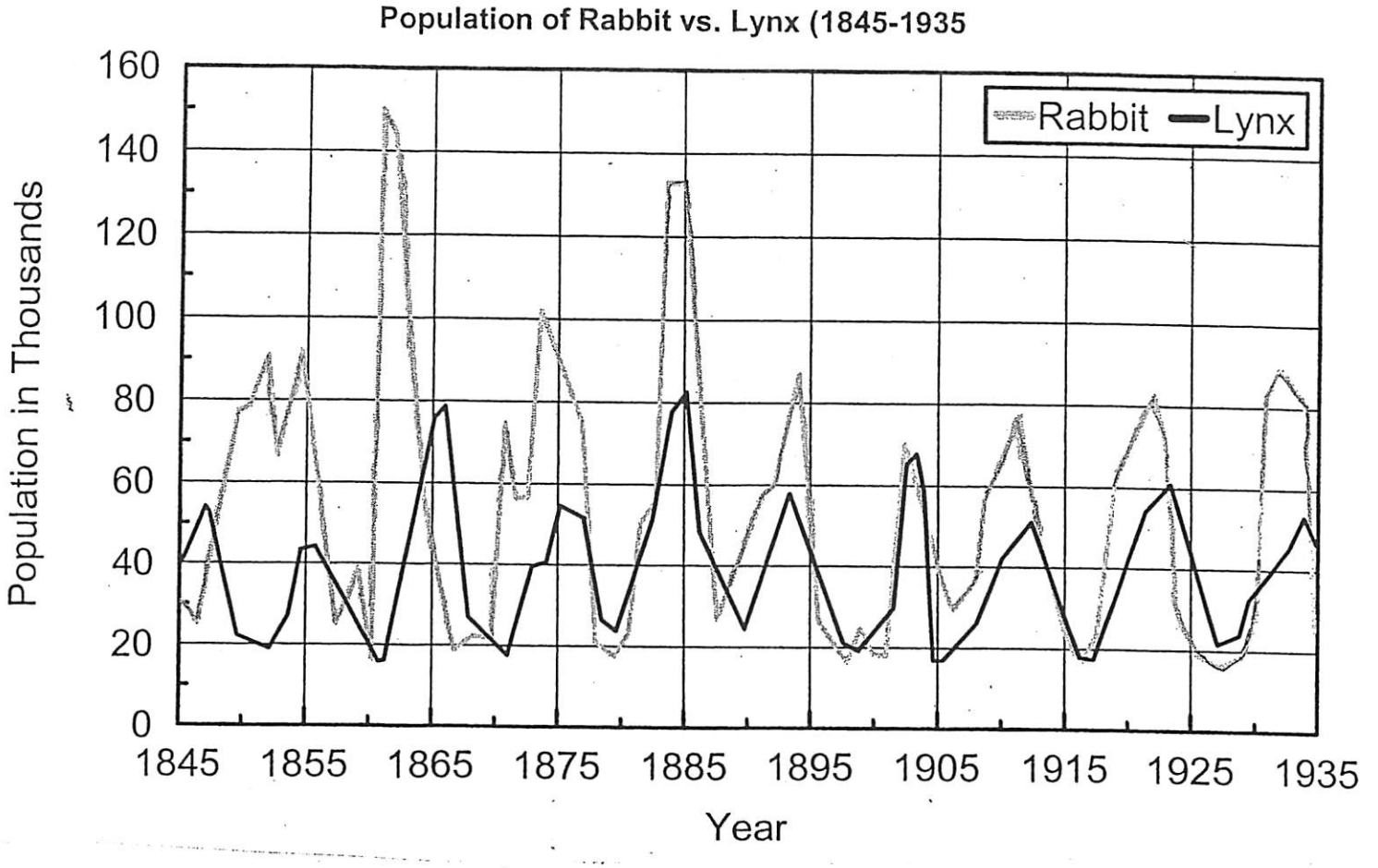
4. On average, when the lynx population is at its maximum, is the rabbit population increasing or decreasing? .....
Why does this happen? .....
.....
.....

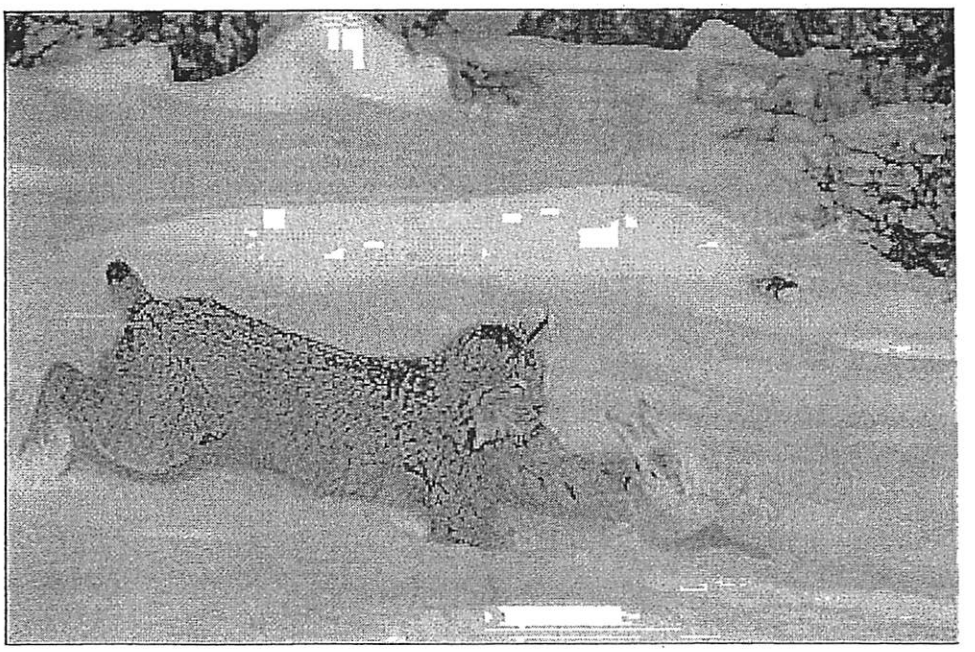
5. What keeps the number of lynx controlled? .....
.....

6. What keeps the number of rabbits controlled? .....
.....

7. What would happen to the rabbits if the lynxes were eliminated from this environment? .....
.....
.....

8. What would happen to the lynxes if the rabbits were eliminated from this environment? .....
.....
.....


Population of Rabbit vs. Lynx (1845-1935
Rabbit
Lynx
Population in Thousands
160
140
120
100
80
60
40
20
0
1845
1855
1865
1875
1885
1895
1905
1915
1925
1935
Year



Name Date
Living Environment Period

The Energy Pyramid

Objective: To show energy flow through a community.

Procedure:

- Use scissors to cut the pictures apart.
- Sort the pictures into groups according to energy sources (Trophic levels).
- Mark each **group** a different color by highlighting the edge of the picture.

Trophic Level	Name of Group	Color Used
I		
II		
III		
IV		

- On the construction paper provided, construct an energy pyramid. Sketch a triangle on the paper and then divide it into your 4 horizontal levels. Paste the pictures on the construction paper.
- Draw an arrow in the direction of ***decreasing*** energy.

Post-Lab Questions

1. Where does all energy come from?

2. Which trophic level has the most energy?

3. Which trophic level has the least energy?

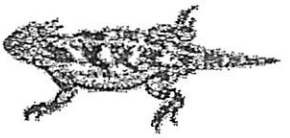
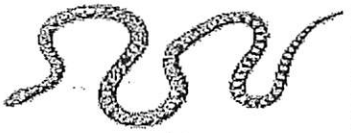
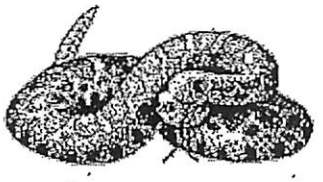
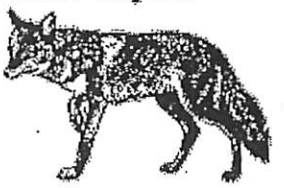
4. What is ***biomass***?

5. Which trophic level has the most biomass?

6. Which level has the least biomass?

7. Would there be more predators or prey in a given community? Why?

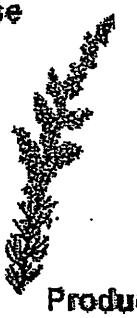
8. Describe how humans might change the energy flow/ food web.

Coast Horned Toad  **Consumer** Small Insects	**Western Fence Lizard**  **Consumer** Insects - Spiders	**Ground Squirrel**  **Consumer** Green Vegetation - seeds - bulbs - acorns
Gopher Snake  **Consumer** Rats - Mice - Rodents - Rabbits Birds - Quail - Lizards	**Grey Fox**  **Consumer** Berries of Various Plants Gophers - Mice - Rodents - Rabbits Birds - Quail	**Spotted Skunk**  **Consumer/Scavenger** Insects - small rodents - Birds Carrion - eggs - some plant material
Western Rattlesnake  **Consumer** Rodents - Squirrels - Rabbits Birds - Lizards - Reptiles	**Scrub (California) Jay**  **Consumer** Insects - Eggs - Small Birds Acorns	**Mountain Coyote**  **Consumer/Scavenger** Squirrels - Mice - Rabbits - Grasshoppers Birds - Berries of various plants
California Quail  **Consumer** Seeds - Leaves - Berries Insects	**Brush Rabbit**  **Consumer** Plant Material Grasses - Herbs - Shrubs - Leaves	**Red-Tailed Hawk**  **Consumer** Rodents - Squirrels - Rabbits - Insects
Rodent (Pocket Mouse)  **Consumer** Seeds of various plants		

Toyon

Producer

Chamise



Producer

Manzanita

Producer

Bitter Cherry

Producer

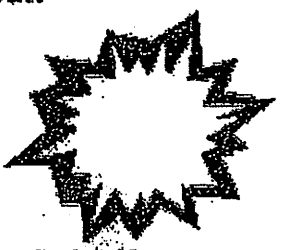
Scrub Oak

Producer

Bacteria-Fungi-Molds

Decomposers
Break down dead or decaying Materials
Recycling Nutrients

Sun



Solar Energy
Ultimate source of energy for most of life on Earth

Grasshopper (Insect)

Consumer
Green Vegetation - Leaves

Spiders

Consumer
Insects

Beetles (Insects)

Consumer
Plant Material - Bark - Leaves

Butterflies (Insects)

Consumer
Flower Nectar

Grubs & Insect Larvae

Consumer
Leaves and plant Material

Name _____

Interpreting Events and Meaning in *The LORAX*

The LORAX is a fictional story about a man who abused the environment and about what he learned. The story begins in the most run-down part of a dull, gray town. A small boy asks the Once-ler to share the secret of the Lorax and how he was "taken away." Thus, the story is told as a "flashback" as the Once-ler talks about the Lorax and past events.

1. Who did the Once-ler represent? _____

2. Who did the Lorax represent? _____

3. The Once-ler moved across the land in his wagon. He came upon a new region with an important natural resource. (A natural resource is a plant, animal, or mineral that can be used by people.) What was this natural resource the Once-ler found?_____

4. Humans often appreciate the beauty of the natural world. Experiences such as finding sea shells on a beach or seeing a rare bird often cause strong feelings. Did the Once-ler have feelings about the region and natural resource that he found?_____

5. The Once-ler used the land's natural resource to start a business which made and sold a product. What was the product? How was it used by buyers?_____
_____

6. Pollution not only affects plant and animal species, but it also affects another living species, human beings. Explain whether the Once-ler's factory and town was a safe and healthy place to live._____
_____
_____

7. The Once-ler's business failed. What happened to cause the failure of this business? _____
_____

8. The Once-ler learned that he had made a serious mistake. What, in your opinion, was his mistake? _____

_____

9. Explain what, in the Once-ler's opinion, must happen for the Lorax and his animals to return. _____

_____

_____

_____

_____

_____

10. Can you think of a real-life example of how man-made pollution affected a real ecosystem, its abiotics (e.g. temperature, water quality, etc.) its biotics (e.g., species extinction), or its habitat? Please briefly describe the incident below. _____

_____

_____

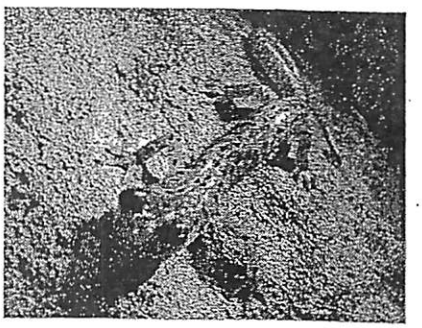
_____

_____

_____

Name _____ Date _____

Living Environment Period _____



Dichotomous Key to Salamanders

Introduction:

A dichotomous key is constructed of a series of couplets, each consisting of two separate statements. For example:

couplet 1. Seeds round soybeans
1. Seeds oblong 2 (this statement indicates that you go to couplet "2")

couplet 2. Seeds white northern beans
2. Seeds black black beans

By reading the two statements of each couplet, you progress through the key from typically broad characteristics to narrower characteristics until only a single choice remains. As long as the correct statement of each couplet is chosen, and the unknown organism is included in the key, a confident identification is usually achieved. Many types of organisms can be identified using a dichotomous key. In this lab, you will identify salamanders.

Materials:

pictures of various salamanders, dichotomous key, metric ruler, pencil

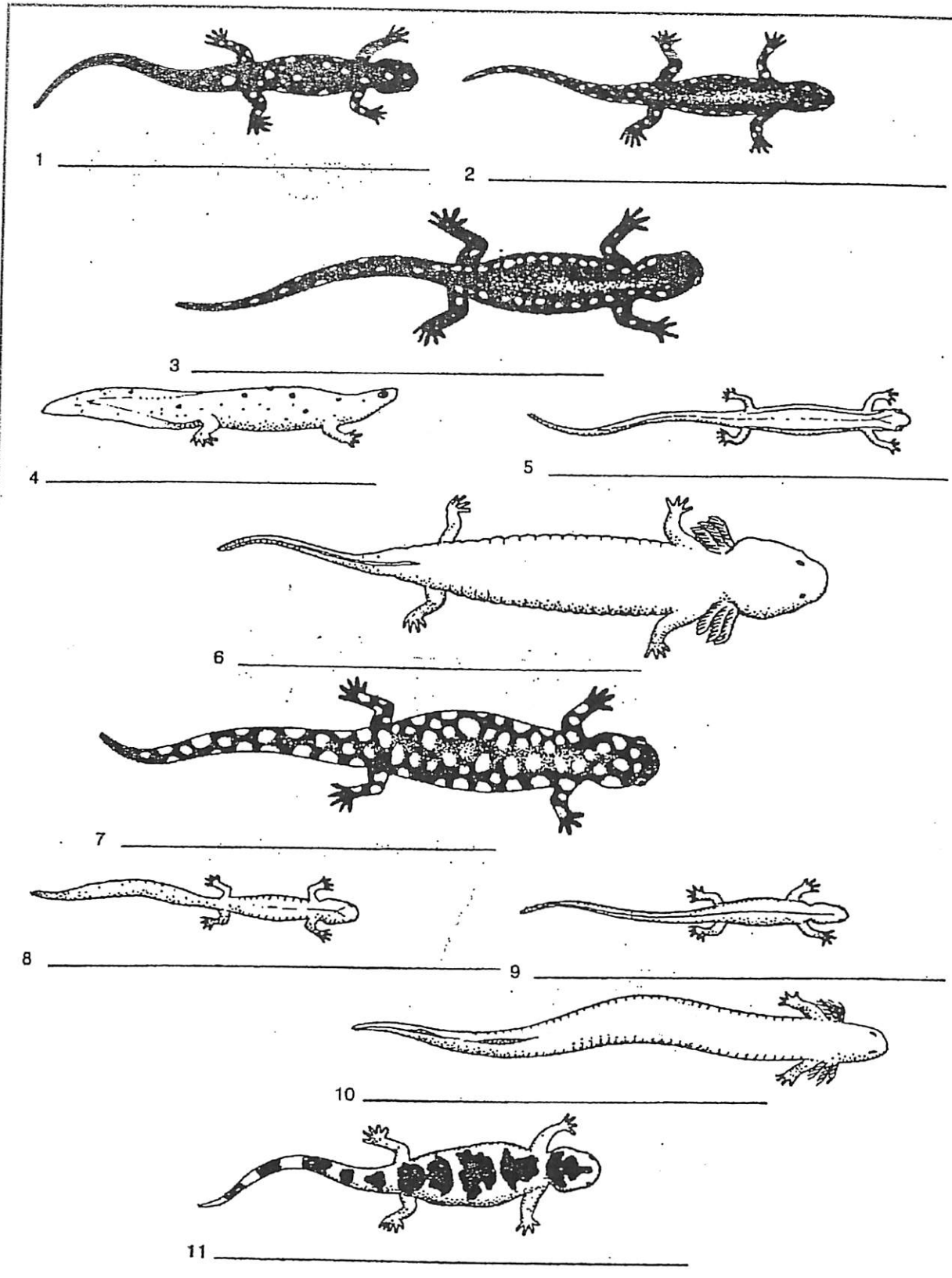
Key to the Salamanders:

1	a	Hind limbs absent	*Siren*
	b	Hind limbs present	Go to 2
2	a	External gills present in adults	*Mud puppy*
	b	External gills absent in adults	Go to 3
3	a	Large size (over 7 cm long)	Go to 4
	b	Small size (under 7 cm long)	Go to 5
4	a	Body background black, large white spots irregular in shape and size completely covering body & tail	*Tiger salamander*
	b	Body background black, small, round, white spots in a row along each side fro eye to tip of tail	*Spotted Salamander*
5	a	Body background black with white spots	Go to 6
	b	Body background light color with dark spots and or lines on body	Go to 7
6	a	Small white spots on a black background in a row along each side from head to tip of tail	*Jefferson salamander*
	b	Small white spots on a scattered throughout a black background from head to tip of tail	*Slimy salamander*
7	a	Large irregular black spots on a light background extending from head to tip of tail	*Marbled salamander*
	b	No large irregular black spots on a light background	Go to 8
8	a	Round spots scattered along back and sides of body, tail flattened like a tadpole	*Newt*
	b	Without round spots and tail not flattened like a tadpole	Go to 9
9	a	Two dark lines bordering a broad, light mid-dorsal stripe with a narrow median dark line extending from the head onto the tail	*Two-lined salamander*
	b	Without two dark lines running the length of the body	Go to 10
10	a	A light stripe running the length of the body and bordered by dark pigment extending downward on the sides	*Red-backed salamander*
	b	A light stripe extending the length of the body, a marked constriction at the base of the tail	*Four-toed salamander*

Procedure:

1. Use the dichotomous key provided to identify the salamanders in Figure 1.
2. Write the correct name for the salamander on the line below each picture.

Types of salamanders



1 _____ 2 _____

3 _____

4 _____ 5 _____

6 _____

7 _____

8 _____ 9 _____

10 _____

11 _____

Supplementary Earth Science Unit

Insertion Point: Before Evolution

Time Frame- 4-6 weeks

Overview

1. Layers of the Earth
    a. Lithosphere, Atmosphere, Hydrosphere
2. Structure of the Earth
    a. Core, Mantle, Crust
3. Rock Cycle
    a. Igneous
    b. Sedimentary
    c. Metamorphic
4. Theory of Plate Tectonics
    a. Continental Drift
    b. Pangaea
    c. Seafloor Spreading
    d. Plate boundaries and formations
        i. Earthquakes
        ii. Ring of Fire
        iii. Volcano
        iv. Islands
        v. Mountains
5. Topography
6. Weather
7. Astronomy

Standard 4: The Physical Setting
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.
Key Idea 1:
The Earth and celestial phenomena can be described by principles of relative motion and perspective.
PERFORMANCE INDICATOR 1.1: Explain daily, monthly, and seasonal changes on Earth.
Major Understandings:
1.1c The Sun and the planets that revolve around it are the major bodies in the solar system. Other members include comets, moons, and asteroids. Earth's orbit is nearly circular.
1.1d Gravity is the force that keeps planets in orbit around the Sun and the Moon in orbit around the Earth.
1.1e Most objects in the solar system have a regular and predictable motion. These motions explain such phenomena as a day, a year, phases of the Moon, eclipses, tides, meteor showers, and comets.
1.1f The latitude/longitude coordinate system and our system of time are based on celestial observations.
1.1g Moons are seen by reflected light. Our Moon orbits Earth, while Earth orbits the Sun. The Moon's phases as observed from Earth are the result of seeing different portions of the lighted area of the Moon's surface. The phases repeat in a cyclic pattern in about one month.
1.1h The apparent motions of the Sun, Moon, planets, and stars across the sky can be explained by Earth's rotation and revolution. Earth's rotation causes the length of one day to be approximately 24 hours. This rotation also causes the Sun and Moon to appear to rise along the eastern horizon and to set along the western horizon. Earth's revolution around the Sun defines the length of the year as 365 1/4 days.
1.1i The tilt of Earth's axis of rotation and the revolution of Earth around the Sun cause seasons on Earth. The length of daylight varies depending on latitude and season.

Key Idea 2: Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.
PERFORMANCE INDICATOR 2.1: Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.
Major Understandings:
2.1a Nearly all the atmosphere is confined to a thin shell surrounding Earth. The atmosphere is a mixture of gases, including nitrogen and oxygen with small amounts of water vapor, carbon dioxide, and other trace gases. The atmosphere is stratified into layers, each having distinct properties. Nearly all weather occurs in the lowest layer of the atmosphere.
2.1b As altitude increases, air pressure decreases.
2.1c The rock at Earth's surface forms a nearly continuous shell around Earth called the lithosphere.
2.1d The majority of the lithosphere is covered by a relatively thin layer of water called the hydrosphere.

2.1e Rocks are composed of minerals. Only a few rock-forming minerals make up most of the rocks of Earth. Minerals are identified on the basis of physical properties such as streak, hardness, and reaction to acid.
2.1f Fossils are usually found in sedimentary rocks. Fossils can be used to study past climates and environments.
2.1g The dynamic processes that wear away Earth's surface include weathering and erosion.
2.1h The process of weathering breaks down rocks to form sediment. Soil consists of sediment, organic material, water, and air.
2.1i Erosion is the transport of sediment. Gravity is the driving force behind erosion. Gravity can act directly or through agents such as moving water, wind, and glaciers.
PERFORMANCE INDICATOR 2.2 : Describe volcano and earthquake patterns, the rock cycle, and weather and climate changes.
Major Understandings:
2.2a The interior of Earth is hot. Heat flow and movement of material within Earth cause sections of Earth's crust to move. This may result in earthquakes, volcanic eruption, and the creation of mountains and ocean basins.
2.2b Analysis of earthquake wave data (vibrational disturbances) leads to the conclusion that there are layers within Earth. These layers - the crust, mantle, outer core, and inner core - have distinct properties.
2.2c Folded, tilted, faulted, and displaced rock layers suggest past crustal movement.
2.2d Continents fitting together like puzzle parts and fossil correlations provided initial evidence that continents were once together.
2.2e The Theory of Plate Tectonics explains how the "solid" lithosphere consists of a series of plates that "float" on the partially molten section of the mantle. Convection cells within the mantle may be the driving force for the movement of the plates.
2.2f Plates may collide, move apart, or slide past one another. Most volcanic activity and mountain building occur at the boundaries of these plates, often resulting in earthquakes.
2.2g Rocks are classified according to their method of formation. The three classes of rocks are sedimentary, metamorphic, and igneous. Most rocks show characteristics that give clues to their formation conditions.
2.2h The rock cycle model shows how types of rock or rock material may be transformed from one type of rock to another.
2.2i Weather describes the conditions of the atmosphere at a given location for a short period of time.
2.2j Climate is the characteristic weather that prevails from season to season and year to year.
2.2k The uneven heating of Earth's surface is the cause of weather.
2.2l Air masses form when air remains nearly stationary over a large section of Earth's surface and takes on the conditions of temperature and humidity from that location. Weather conditions at a location are determined primarily by temperature, humidity, and pressure of air masses over that location.
2.2m Most local weather condition changes are caused by movement of air masses.
2.2n The movement of air masses is determined by prevailing winds and upper air currents.
2.2o Fronts are boundaries between air masses. Precipitation is likely to occur at these boundaries.

2.2p High-pressure systems generally bring fair weather. Low-pressure systems usually bring cloudy, unstable conditions. The general movement of highs and lows is from west to east across the United States.

Objectives - Students will be able to:

1. Structure of the Earth
   a. **Describe** the layers of the Lithosphere: Crust, Mantle, Outer Core, and Inner Core.
   b. **Describe** the characteristics of each layer of the Atmosphere: troposphere, stratosphere, mesosphere, and thermosphere
2. Rock Cycle
   a. **Identify** minerals based on their physical and chemical properties.
   b. **Distinguish** between the 3 main types of rocks: Igneous, Sedimentary, and Metamorphic.
   c. **Explain** how rocks can change from one type to another.
   d. **Analyze** the rock cycle.
   e. **Classify** rocks according to their characteristics.
   f. **Explain** how the Law of Superposition can be used to determine the age of fossils.
3. Theory of Plate Tectonics
   a. Continental Drift
   b. Pangaea
   c. Seafloor Spreading
   d. Plate boundaries and formations
      i. Earthquakes
      ii. Ring of Fire
      iii. Volcano
      iv. Islands
      v. Mountains

a. **Explain** the Theory of Continental Drift and the evidence that supports it.
b. **Construct** a model of Pangaea.
c. **Explain** the process of Seafloor Spreading.
d. **Differentiate** between the Oceanic and Continental crust.
e. **Describe** the three different kinds of plate boundaries.
f. **Explain** the formation of islands.

g. **Discuss** how the Ring of Fire correlates to the occurrences of earthquakes and volcanoes.
h. **Describe** the landforms that result from Plate Tectonics.

4. Topography
    a. **Construct and Interpret** a topographic map.
5. Weather
    a. **Distinguish** between climate and weather.
    b. **Describe** the different air masses that affect the United States.
    c. **Compare and contrast** the four different types of fronts.
    d. **Interpret** a weather map.
6. Astronomy
    a. **Compare and contrast** the motions of rotation and revolution of the Earth and the Moon.
    b. **Describe** the phases of the Moon.
    c. **Discuss** how the gravitational pull of the Moon and the Sun affect the tides.

Engage and Motivate:

1. Structure of the Earth

Guiding Question: How is the Earth divided into layers?

Evidence of Understanding: After the lesson, have pairs of students create a labeled diagram of the layers of the Lithosphere: Crust, Mantle, Outer Core, and Inner Core.

Check for Understanding: Ask students to create a Concept Map that relates the concepts: Crust, Mantle, Outer Core and Inner Core.

Use Models: Challenge students to use arts and crafts materials of their choice to create a 3-D model of the Earth's interior. Materials may include clay, Styrofoam balls, and toothpicks. Tell students to make a key for their model showing what each part represents. Have students display their models in the classroom.

Activate Prior Knowledge: Ask students who have ever traveled in an airplane during a storm what the pilot did to limit the bumpiness of the flight. Elicit from students that the pilot flies above the clouds to avoid the storm. Use their responses to start a discussion on how the atmosphere is structured in layers.

Activate Prior Knowledge: Ask students what they notice about air conditioner placement in a wall. Are they typically installed high up or along the floor level? Discuss with students what they think the reasoning for this placement might be. Use this as a *segue w*ay into convection as a method of heat transfer.

Check for Understanding: Ask students to classify various items (for example, space shuttle, ozone layers, airplanes, clouds, and meteors) according to where they would be found in the atmosphere.

Suggested Labs:
Milky Way Lab Activity
The Layers of the Lithosphere diagram activity

Assessments:

Chapter Assessments in Review Book
Wizard TM
Study Workbook
Exam View software
NYS Intermediate Level Science Exam test questions

Key Vocabulary: Lithosphere Hydrosphere Atmosphere Inner Core Outer Core Crust Mantle Convection Currents Troposphere Stratosphere Ozone Layer Mesosphere Thermosphere

2. Rock Cycle

Guiding Question: How many different types of rocks does the Earth have?

Evidence of Understanding: After the lesson, have pairs of students classify rock samples into Igneous, Metamorphic, and Sedimentary based on their characteristics.

Check for Understanding: Ask students to create a flipbook that lists the type of rock, method of formation, and has a diagram of a rock sample of the type.

Use Models: Challenge students to bring in a cookie sample of each type of rock explaining the reason for their choice.

Activate Prior Knowledge: Have students complete a KWL graphic organizer on rocks.

Activate Prior Knowledge: Ask students what they notice about air conditioner placement in a wall. Are they typically installed high up or along the floor level? Discuss with students what they think the reasoning for this placement might be. Use this as a *segue* way into convection as a method of heat transfer.

Check for Understanding: Have students play a teacher created rock cycle game.

Suggested Labs:
Mineral Identification Lab
Rock Cycle Lab

Igneous Rock Classification Lab
Sedimentary Rock Classification Lab
Metamorphic Rock Classification Lab
Fossil Lab

Assessments:

Chapter Assessments in Review Book
Wizard TM
Study Workbook
Exam View software
NYS Intermediate Level Science Exam test questions

Key Vocabulary: Rock Igneous Rock Sedimentary Rock Metamorphic Rock

Sediment Molten Magma Lava Sediment Weathering Erosion Texture

Deposition Fossil Cycle Compacted Cemented Law of Superposition Streak

Hardness Density Luster Acid Test Cleavage Fracture Mineral

3. Theory of Plate Tectonics
    a. Continental Drift
    b. Pangaea
    c. Seafloor Spreading
    d. Plate boundaries and formations
        i. Earthquakes
        ii. Ring of Fire
        iii. Volcano
        iv. Islands
        v. Mountains

Guiding Question: What causes the continents to be in their current location?

Evidence of Understanding: Class volunteers will act out the process of seafloor spreading. The other class members will identify which student volunteer represents the oldest and youngest crust location.

Check for Understanding: Have students complete a graphic organizer detailing each plate boundary type and occurrences or formations that might result there.

Use Models: Students will construct an earthquake resistant structure using spaghetti and gumdrops. Their structures will be checked for strength using an earthquake simulator.

Activate Prior Knowledge: Distribute a puzzle piece to each student as they enter the room. Ask students to place their piece in the correct location one at a time. When done have students look at a map of the world and ask students what they notice about the edges of certain continents. Elicit from students that certain continents look like they fit together like pieces of a jigsaw puzzle.

Check for Understanding: Have students complete a teacher-created graphic organizer detailing the evidence to support continental drift.

Suggested Labs:
Plot the Ring of Fire
Plot Earthquake lab
Construct Pangaea
Seafloor Spreading Activity

Assessments:

Chapter Assessments in Review Book
Wizard TM
Study Workbook
Exam View software
NYS Intermediate Level Science Exam test questions

Key Vocabulary: Continental Plate Oceanic Plate Plate boundary Fault Fold Mountain Earthquake Volcano Seismic Wave Subduction Plate Tectonic Continental Drift Pangaea Seafloor Spreading Mid-Ocean Ridge Trench Hot Spot Convection Current Mantle Crust

4. Topography

Guiding Question: What information can be gleaned from a topographic map?

Evidence of Understanding: Students will interpret a topographic map.

Check for Understanding: Students will determine steep and gentle slopes from various topographic maps.

Use Models: Students will create a topographic map using the topographic kit.

Activate Prior Knowledge: Guide students through general map skills, such as cardinal directions, landforms, using a scale, and using a map key.

Suggested Labs:
Create a Topographic Map

Assessments:

Chapter Assessments in Review Book
Wizard TM
Study Workbook
Exam View software
NYS Intermediate Level Science Exam test questions

Key Vocabulary: Topography Topographic Map Contour Line Contour Interval Elevation Sea Level Gentle Slope Steep Slope Latitude Longitude Prime Meridian Equator Depression Scale Globe

5. Weather

Guiding Question: How can weather maps be used to predict the weather?

Evidence of Understanding: Students will interpret a weather map.

Check for Understanding: Students will predict weather patterns from weather maps.

Activate Prior Knowledge: Guide students to define the key vocabulary using the roots of each air mass.

Guiding Question: What role do air masses play in creating severe weather?

Suggested Labs:
Plot Hurricane track.
Coloring Air Mass Map
Interpret Weather Map
Weather Forecast

Assessments:

Chapter Assessments in Review Book
Wizard TM
Study Workbook

Exam View software
NYS Intermediate Level Science Exam test questions

Key Vocabulary: Air Mass Maritime Continental Polar Tropical

Weather Climate Weather Map Cold Front Warm Front Occluded Front

Stationary Front Hurricane Tornado Thunderstorm Cloud Water Cycle

Coriolis Effect

6. Astronomy

Address Misconceptions: Students often equate summer with the Earth being closest to the Sun. Reinforce that when the Earth is closest to the sun is actually winter not summer. The Moon doesn't produce its own light. The Moon reflects sunlight.

Guiding Question: What are the two motions of the Earth and the Moon? What phenomena are associated with each?

Evidence of Understanding: After completing the lesson, give students the following assessment to show they understand the difference between rotation and revolution. *Divide the class into groups, and ask each group to complete a rotation and revolution chart.*

Check for Understanding: Teacher will represent the Moon and slowly rotate and revolve around the room at the same rate showing students that only one side of the Moon is every visible from Earth.

Evidence of Understanding: After the lesson, have pairs of students create Draw and label the phases of the Moon.

Activate Prior Knowledge: Fact or Fiction activity.

Use Models: Challenge students to use arts and crafts materials of their choice to create 3-D models of Phases of the Moon, Scale representation of Earth and Moon, and eclipses. Materials may include clay, toothpicks, and beads. Tell students to make a key for their

model showing what each part represents. Have students display their models in the classroom.

Use Visuals: Teacher will use the illuminator to represent the motion of the Earth, Sun, and Moon.

Suggested Labs:
Phases of the Moon
Phases of the Moon Laptop activity

Assessments:

Chapter Assessments in Review Book
Wizard TM
Study Workbook
Exam View software
NYS Intermediate Level Science Exam test questions

Key Vocabulary: Rotation Revolution Axis Orbit Season Solstice

Equinox Moon Sun Earth Phases of the Moon Waxing
Waning

Full Moon New Moon Crescent Gibbous Lunar Eclipse Solar Eclipse Tides