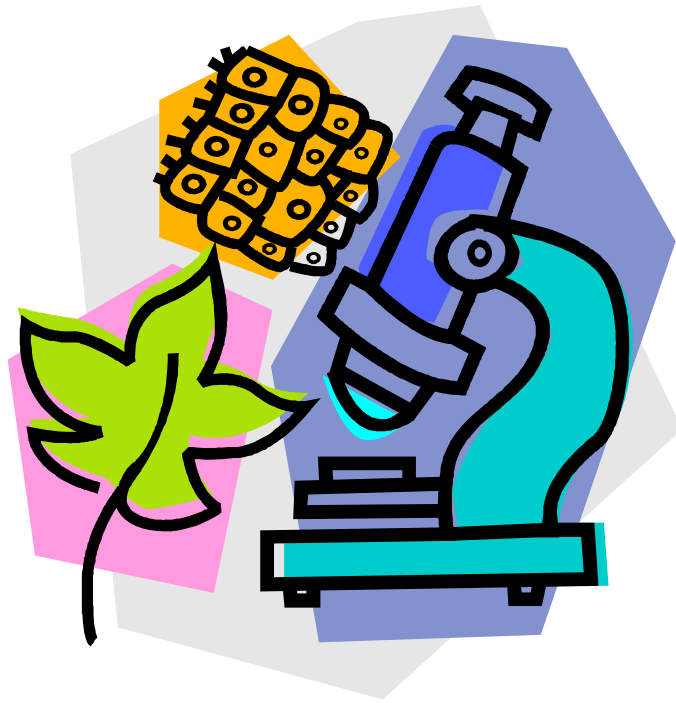


# **The Living Environment**

## **Laboratory & Activity Manual**

**Brighton High School  
Rochester, New York**



**Student:** \_\_\_\_\_

**Grade:** \_\_\_\_\_

**Biology Teacher:**\_\_\_\_\_

**HR#:** \_\_\_\_\_



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## Lab Report Format

**Title:** Use my title or your own. Be sure the title reflects the subject of lab.

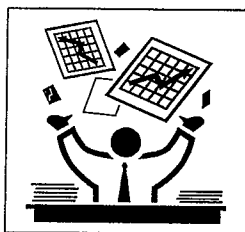
**Objective:** What is the purpose of this lab?  
What question is this lab designed to answer?  
What is your hypothesis? (I think \_\_\_\_ will \_\_\_\_ **because** \_\_\_\_)

**Materials:** List like  
the this  
materials please

**Procedure:**

1. List the steps from beginning to end. Number each step.
2. Use complete sentences and pictures (if necessary).
3. Write between 5 and 10 steps.
4. Write clearly so that anyone can repeat the procedure.
5. Do NOT include "get materials" or "clean up."

**Data and Observations:**



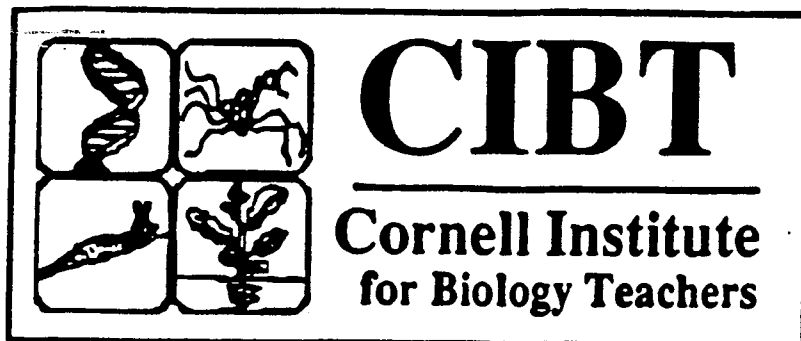
Use tables, charts, and graphs to show your data  
Use a computer, straight edge or ruler to make charts and graphs.  
Draw pictures neatly and in color if possible.  
Show all calculations and formulas  
Record answers with significant figures and with **correct units**.  
Label all pictures, charts, graphs, etc.

**Analysis:**

- Write the following in **complete sentences and paragraphs**-
- a. Restate the objective. ("The purpose of this lab was to...")  
Describe any new **skills or vocabulary** you learned in this lab.  
Identify the **independent** and **dependent variable**.  
Discuss the **controlled variables or control group** in the lab.
  - b. Discuss how your **data** does/does not support your hypothesis.  
Explain **WHY** your data turned out like it did.  
(i.e. discuss the **concept** that explains your results)  
Explain any sources of error or ways to improve the experiment.

**Conclusion**

Discuss one major concept or theme of biology and how it relates to this lab. Concepts might include: scientific method, unity or diversity of life, interdependence, organization, adaptations, evolution, ecology, the flow of energy, form and function, homeostasis, metabolic processes, cell processes, etc.



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Lab issue/rev. date: 11/94

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## Cornell Institute for Regional Biology Mentors (CIRBM):

Funded by DDE II A Grant, August 1994  
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# Flinn Scientific's Student Safety Contract

## PURPOSE

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35. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.
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37. Take great care when transferring acids and other chemicals from one part of the laboratory to another. Hold them securely and walk carefully.

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53. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine if an object is hot by bringing the back of your hand close to it prior to grasping it.

## QUESTIONS

54. Do you wear contact lenses?  
☐ YES ☐ NO
55. Are you color blind?  
☐ YES ☐ NO
56. Do you have allergies?  
☐ YES ☐ NO

If so, list specific allergies \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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## Introduction

Hissing cockroaches are a tropical rain forest species native to Madagascar. They don't fly, bite or spread diseases. They hide in leaf litter on the forest floor and hiss when disturbed. Hissing cockroaches have sticky pads and tiny hooked claws on their feet. They can climb clean glass and can cling to irregular surfaces.

## Purpose

- To introduce you to the LoggerPro software, probes & sensors
- To provide practice in conducting a **controlled** scientific experiment
- To examine the life function of respiration

## Materials

- |                                |                     |                                 |
|--------------------------------|---------------------|---------------------------------|
| * Madagascar Hissing Cockroach | * laptop computer   | * 2 Go!Links                    |
| * carbon dioxide gas sensor    | * oxygen gas sensor | * oxygen-carbon dioxide chamber |

## Safety

- Be gentle with the cockroaches, taking care when detaching their claws from things.
- The cockroaches CAN'T hurt you, but you can hurt them

## Hypothesis

*Briefly* state the changes you expect in the oxygen and carbon dioxide gases in the chamber as time progresses if respiration is occurring.

---

---

## Procedure      Be attentive and listen to your teacher's directions.

1. With a partner, **sign out** a laptop computer, an oxygen sensor and carbon dioxide sensor. Gather all other necessary equipment and return to your lab station.
2. Carefully connect each sensor to a Go!Link and connect them into the two USB ports in your laptop.
3. Open the LoggerPro software. Under *Experiment* and *Data Collection*, set the program to collect one measurement *every minute* for *30 minutes*.
4. Carefully get one adult cockroach and bring it back to your lab area. **Carefully** place your cockroach into the chamber. Once your cockroach is situated, connect the two sensors into the openings in the chamber.
5. Under *Experiment* press *Start Collection* begin your experiment. Once group in the class will run the experiment without a cockroach in the chamber.

6. Once data collection starts, click *Analyze* and then *Autoscale*. Please keep an eye on your experiment, watching the developing graphs as they appear.
7. At the end of the 30 minutes, save your data to your network folder and print your data table and graphs making sure to include BOTH your names when the printer prompts you for them. Print **2** copies (one for you and one for your lab partner).

### Clean Up

- Disconnect and return all equipment where you found it according to your instructor's directions
- Carefully slide the cockroach **head first** from the chamber and **hand carry** it back to its cage
- Wash your hands with soap and water

### Analysis

1. Explain any evidence of respiration by the cockroach.
2. Go to another pod and view data from two other lab groups that had cockroaches in their chambers. Does their data correspond to your results?
3. What was the purpose of the set up that did NOT have a cockroach in the chamber?

What do we call this set up?

4. How would your results be affected if you used a different sized cockroach than the one you used today? Be sure to include what you would expect with a smaller AND a larger cockroach.
5. How would your results be affected if you used a cockroach that was more active than the one you used today?
6. How would temperature inside the chamber affect your overall results? Be sure to include what you would expect at colder AND at warmer temperatures.
7. According to your graph, extrapolate to determine how long it would take for your cockroach to use half the oxygen that was present at the beginning of the experiment?

### Conclusion

Briefly state what you have learned about respiration in living things, such as cockroaches.



A **classification system** is a way of separating a large group of closely related organisms into smaller subgroups. With such a 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 through a process of elimination.

In this investigation, it is expected that you:

- use a key to identify 14 shark families
- study the method used in phrasing statements of a key

## Procedure:

1. Read sentences 1A and 1B of the key. Then study Shark 1 for the characteristics referred to in 1A and 1B.
2. Follow the directions in these sentences and continue with this process until a family name for Shark 1 is determined.

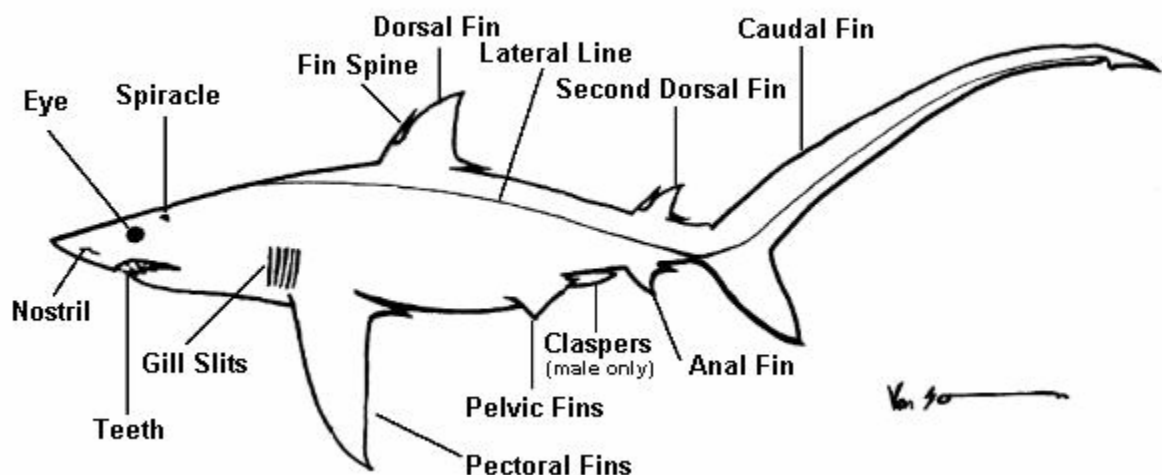
### **Example:**

If the shark has an anal fin and its' body is not kite shaped, follow the directions of 1A and go directly to sentence 2.

-OR-

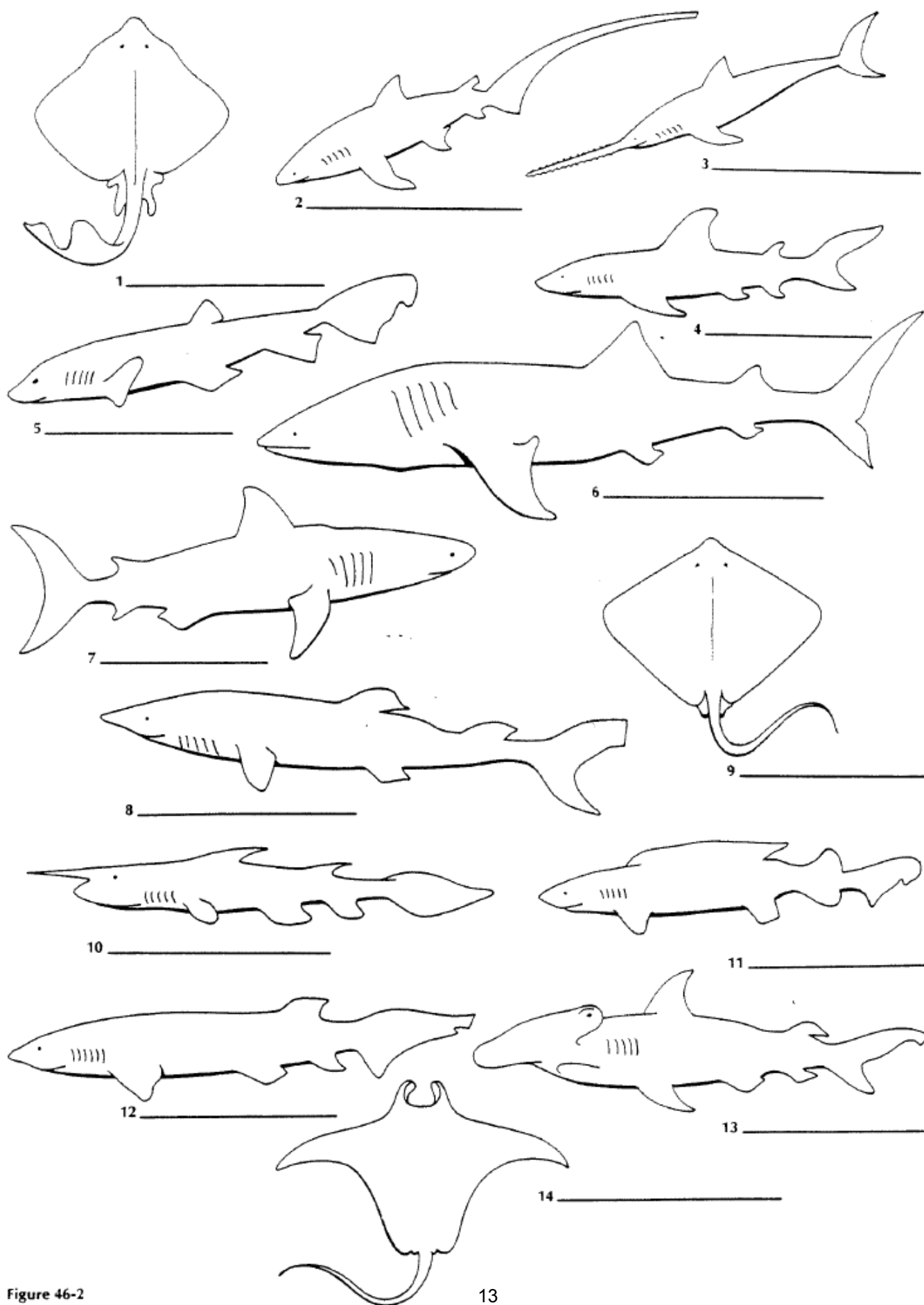
If the shark lacks an anal fin or has a kite shaped body, follow the directions of 1B and go to sentence 10.

- Continue this process with each shark until all animals have been identified. Write the family name on the line below each animal.
- Use the figure below as a guide to the anatomical features used in the key.



# **SHARK KEY**

1. A. Anal fin present or body not kitelike in shape.....Go to 2.  
B. Anal fin absent or body is kitelike in shape.....Go to 10.
2. A. Six gill slits present.....*Family Hexanchidae*  
B. Five gill slits present.....Go to 3.
3. A. Only one dorsal fin.....*Family Scyliorhinidae*  
B. Two dorsal fins.....Go to 4.
4. A. Mouth at very front of head rather than on ventral (belly) surface....*Family Rhincodontidae*  
B. Mouth on ventral surface.....Go to 5.
5. A. Head expanded on side with eyes at end of expansion.....*Family Sphyrnidae*  
B. Head not expanded.....Go to 6
6. A. Caudal fin crescent in shape.....*Family Isuridae*  
B. Caudal fin not crescent in shape.....Go to 7
7. A. First dorsal fin almost half total length of body.....*Family Pseudotriakidae*  
B. First dorsal fin normal length.....Go to 8
8. A. Caudal fin is as long as the entire body.....*Family Alopiida*  
B. Caudal fin is much shorter than the length of the body.....Go to 9
9. A. Long pointed snout.....*Family Scapanorhynchidae*  
B. Snout normal.....*Family Carcharhinidae*
10. A. Snout long and lined with sharp saw-like teeth.....*Family Pristiophoridae*  
B. Snout not saw-like.....Go to 11.
11. A. Body normal, not kite-like.....*Family Squalidae*  
B. Body kite-like.....Go to 12.
12. A. Small dorsal fin present near tip of tail.....*Family Rajidae*  
B. No dorsal fin present near tip of tail.....Go to 13
13. A. Front of animal with two hornlike appendages.....*Family Mobulidae*  
B. No hornlike appendages.....*Family Dasyatidae*
14. A. Body normal, not kite-like.....*Family Squalidae*  
B. Body kite-like.....Go to 12.
15. A. Small dorsal fin present near tip of tail.....*Family Rajidae*  
B. No dorsal fin present near tip of tail.....Go to 13
16. A. Front of animal with two hornlike appendages.....*Family Mobulidae*  
B. No hornlike appendages.....*Family Dasyatidae*







## Introduction

**Ecology** is the study of interactions between organisms and their environment. One type of interaction frequently studied by ecologists is the **competition** between two or more species for limited resources. When a resource, such as water or sunlight, is limited, those species that need it will compete for it. A species can successfully compete for resources through changing its characteristics and features over long periods of time (**evolution**). A species can do this by either becoming better adapted for using the resource (thus depriving competitors of the resource) or by directly producing chemicals that interfere with its competition's growth.

**Allelopathy** is how one species can directly inhibit, or prevent, the growth of another species. Chemicals produced by one species are released into the environment, affecting the growth or development of the other species. The chemicals can slow seed germination, limit seedling growth and even poison the seedling outright. Allelopathy is most often seen where a habitat is crowded with plants needing the same resources.

It has been suggested that the **invasive species** purple loosestrife *may* have allelopathic effects on other plants. This claim, however, has not been well documented in the professional literature. You will research purple loosestrife, determine a reasonable hypothesis based on your research and conduct an original experiment on the allelopathic affects of purple loosestrife.

## Purpose

- To determine the allelopathic effects of different plant species on radish seeds (*Raphanus*)
- To determine if purple loosestrife (*Lythrum salicaria*) has an allelopathic effect on other plants

## Materials (per 4 students)

- \* 5 petri dishes
- \* 5 filter papers
- \* scissors
- \* 50 radish seeds (*Raphanus*)
- \* 1 mL graduated pipette
- \* distilled water
- \* marker
- \* metric ruler
- \* 5 mL sample of each plant extract to be tested (goldenrod, lettuce, black walnut and loosestrife)

## Safety

- The plant extracts are not to be consumed!
- Goggles must be worn throughout the **Procedure** portion of this activity.
- Wash your hands after the lab is done.

## Hypothesis

Working with your lab partner, conduct **research** (read and take notes) on the four different plant species below and their effect (if any) on other plants' growth. After you have completed your research, formulate your hypotheses. Use the space on the following page to help gather your information. Mrs. Randell has information on her website to help your research go smoothly (*Resources, Living Environment, Allelopathy Lab*).

## Hypothesis (con't)

	Here's what we found out	Here's our hypothesis
Goldenrod ( <i>Solidago</i> )		
Lettuce ( <i>Lactuca</i> )		
Black Walnut ( <i>Juglans nigra</i> )		
Purple Loosestrife ( <i>Lythrum salicaria</i> )		

\*\*\* We will use \_\_\_\_\_ as our control for this experiment.

You **MUST** show your teacher your hypotheses & receive approval before starting the procedure!! \_\_\_\_\_  
Teacher check

=====

## Procedure (working in groups of 4)

- 1) Label each of your petri dishes with the plant extracts to be tested. Also, label your names on the dish.
- 2) Trace the bottom of the petri dish onto the filter paper with PENCIL! Carefully cut out the filter paper and place the filter paper on the bottom of the petri dish. It should lay complete flat.
- 3) Using your pipette (demonstrated by instructor), place 5 mL of the corresponding plant extract into the petri dish. Make sure all the filter paper is moist. It is OK if there is a little bit of fluid not absorbed by the paper.  
  
\*\* Be sure the extract you are using correctly corresponds to the labeled dish!!  
  
\*\* Be sure to use ONLY the labeled pipette with its corresponding extract to avoid contamination.
- 4) Place 10 radish seeds per dish on the wet filter paper. Space the seeds out evenly.
- 5) Being careful not to disturb the seeds, gently place the petri dishes in a location specified by your instructor.
- 6) Record the number of seeds that have germinated in each dish after 5 days. Also, compare the *relative* lengths of the *hypocotyls* in each petri dish.

## **Clean Up**

- Return all equipment as you found it.
- Return the laptop to the cart, making sure it is plugged in for the next class.
- Wipe down your table area and wash your hands with soap and water.

**Data** *Create a data table below.*

## **Analysis**

- 1) Using a bar graph, graph your data. Be sure to label all axes and to give your graph a title.
- 2) Define allelopathy.
- 3) Describe how allelopathy gives an organism an advantage in its environment.
- 4) What is the only difference between the five petri dishes in your experiment?
- 5) List four factors that must be kept the *same* between all of the petri dishes in this lab.
- 6) Give two ways you could improve this experiment to achieve more accurate results.
- 7) Based on your research, hypothesize one reason *other than allelopathy* why purple loosestrife is so quick to take over an area.

## **Conclusion**

- 1) State whether or not your data support EACH of your four hypotheses.
- 2) How could a farmer benefit by knowing about the allelopathic affects of some plants?

## **Bonus**

Describe how the concept of allelopathy could possibly lead to eradication of an invasive species, such as purple loosestrife, from an area.





Name \_\_\_\_\_

### **The Radish-Duckweed Eco-Column**

You have read and heard about **ecosystems, food webs, decomposers, producers, consumers, nutrients, cycles, and water quality**, but it's time to put this knowledge to work! You and your partner will be constructing a **Radish-Duckweed Eco-Column** in order to experiment with growing things under different environmental conditions. As part of this experiment, you will need to keep careful track of your experimental conditions. In addition, we will be measuring temperature, pH, conductivity, total dissolved solids, and nitrate – a nutrient.

Every team will start with roughly the same number of radish seeds and the same number of duckweed plants. Fabulous prizes will be awarded at the end of the experiment in various categories: the biggest radish plants, the most duckweed plants, the greatest ecological disaster. **You must have at least one radish and one duckweed alive at the end of the experiment to be eligible for any prize. Killing everything is pointless and too easy besides.**

This exercise is about more than just growing radishes and duckweed. Eco-Columns are miniature, model ecosystems, complete with land and water. The most important features of this exercise will be to learn how Eco-Column land and water environments are affected by temperature, rainfall, soil type, and pH; and to learn about pH, soil type, dissolved solids, and fertilizer; and how they are measured.

### **Constructing Your Radish-Duckweed Eco-Column**

A. First, you need to be aware of some Safety Rules:

- Cut away from yourself. Take your time.
- Be careful with sharp items (in general).
- Poke drain holes from the inside, out. It is very difficult and much more dangerous to poke holes from the outside.
- Be a little careful of the cut edges of the bottles – they are sharp enough to cut your skin.

B. Working with your partner, follow the steps on the attached sheet to convert a 2-liter bottle into an Eco-Column. Please follow all instructions carefully. The basic sequence is: **measure; mark where to cut; cut (carefully); poke holes (carefully); test assemble (empty).**

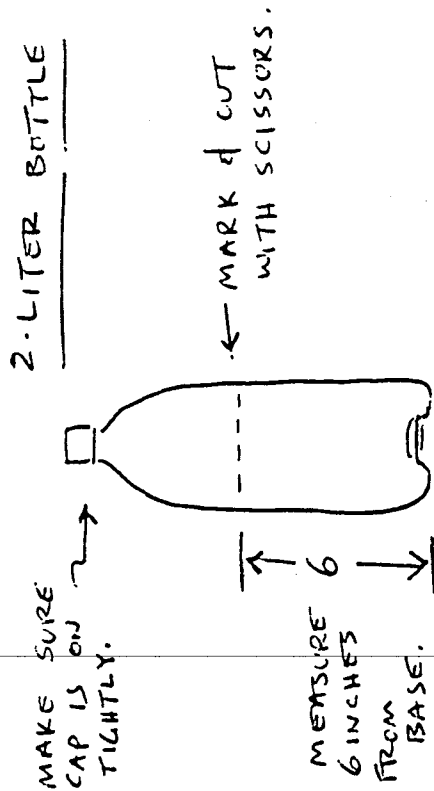
C. **Pick a soil type** for your Eco-Column. (Return “soil type” card.)

D. **Assemble** Eco-Column: soil, water, duckweed plants, and radish seeds.

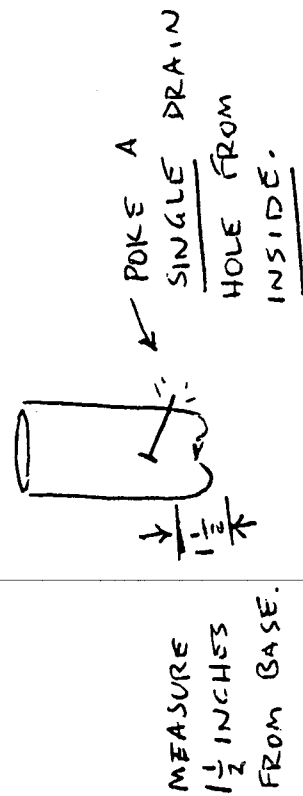
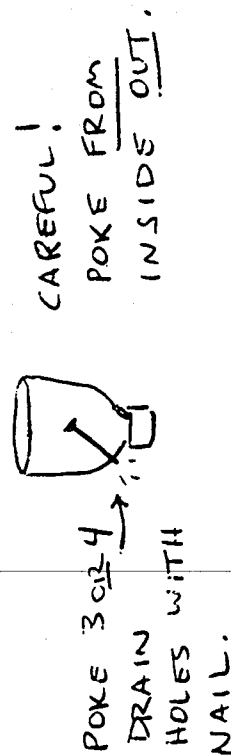
E. **Label** with your names and class period, and place near the window in room 374.

# CONSTRUCTING YOUR ECO-COLUMN

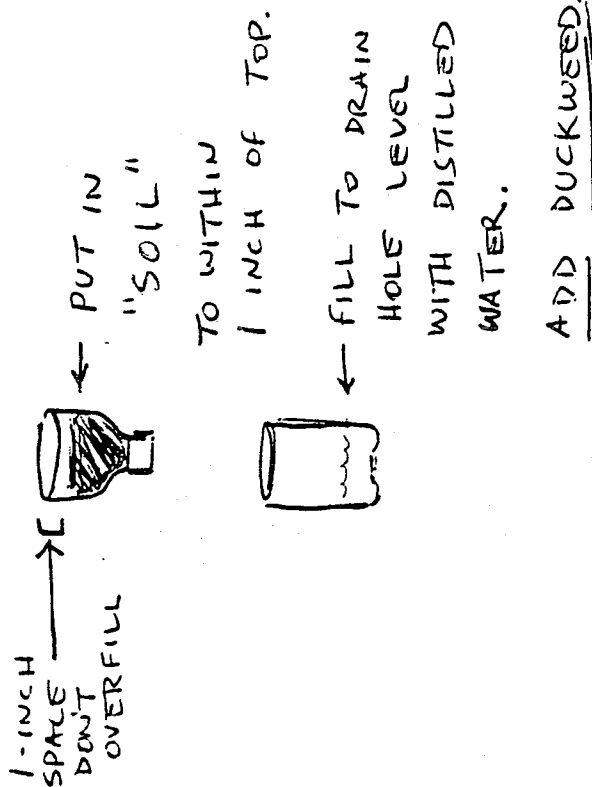
## STEP 1



## STEP 2



## STEP 3



## STEP 4

ASSEMBLE TOP & BOTTOM  
HALVES.

PLANT RADISH SEEDS.  
WATER CAREFULLY.

## STEP 5

CLEAN UP AFTER YOURSELF.  
RECORD YOUR STARTING  
CONDITIONS ON THE  
RECORD SHEET.

Name \_\_\_\_\_

## Radish Report

We have used five soil types to grow our radishes: vermiculite, sand, peat, Brighton clay, and potting soil. The radishes have grown for almost two months – long enough for various nutrient deficiencies to reveal themselves! Watering and sunlight have been essentially the same for all radishes, so we have a controlled experiment comparing soil type and radish growth.

Because the different nutrient deficiencies cause different types of problems, we also have a good visual reference for which nutrients are lacking in each soil type. This is not the quickest type of soil test available, but it is a very specific way of determining which nutrients are the limiting in each soil type.

Examine the radishes, grouped by soil type, carefully sketch and describe the characteristics of the plants, and interpret the nutrient deficiencies for each set of radishes. Please explain and justify your interpretations.

Please include in your report:

- PURPOSE — WHAT WAS THE PURPOSE OF OUR STUDY?
- HYPOTHESIS — WHICH SOIL TYPES DID YOU THINK WOULD BE BEST & WORST, & WHY?
- MATERIALS — LIST EVERYTHING USED.
- PROCEDURE — HOW DID WE SET THIS UP AS A CONTROLLED, SCIENTIFIC EXPERIMENT? (EXPLAIN OUR EXPERIMENTAL DESIGN.)
- DATA / RESULTS — DESCRIBE EACH GROUP OF RADISHES, & MAKE COLORED SKETCHES OF LEAVES, DESCRIBE FEATURES — COLOR, LEAF CURL, SPOTS, "BURNED" EDGES, ETC.
- ANALYSIS — WHICH WERE THE LIMITING NUTRIENTS FOR EACH GROUP OF RADISHES, & WHY?
- CONCLUSION — SUMMARIZE THE EXPERIMENT & RANK THE SOILS FROM BEST TO WORST, WITH BRIEF EXPLANATIONS.

Table 1: Role of Elements in Plant Function

Element	Function	Deficiency Symptoms
<b>MACROELEMENTS</b>		
Nitrogen (N)	Synthesis of organic compounds, including amino acids, proteins, coenzymes, nucleic acids and chlorophyll.	General yellowing (chlorosis) especially of older leaves, lower leaves yellow and die, growth is stunted, younger leaves remain green longer as the mobile nitrogen is retranslocated from older leaves to younger ones; first symptoms on older leaves.
Phosphorus (P)	Component of sugar phosphates (energy carrier), nucleic acids, phospholipids and coenzymes.	Stunted growth, dark green in color, purplish leaves and stems. As it is easily redistributed from older to younger tissues, first symptoms occur in mature older leaves.
Potassium (K)	Protein synthesis, acts as a coenzyme (activator) for many enzymes, sugar and starch formation, needed in plant growth.	Like N and P it can be easily retranslocated from mature leaves to younger plant parts; first symptoms on older leaves. Spindly plants, yellowing of older leaves followed by scattered dead areas. Tips and margins of older leaves often die first.
Calcium (Ca)	Component of cell walls, cell growth and division.	As it is immobile (cannot be retranslocated), symptoms first appear in younger leaves, especially the growing tip. Deformed terminal leaves, growing tip dies, root growth is inhibited.
Magnesium (Mg)	Part of chlorophyll, photosynthesis.	Mobile element—first symptoms as interveinal and marginal chlorosis of lower leaves. Dark, dead (necrotic) spots later appear in the chlorotic areas; finally older leaves die, fruit production is reduced.
Sulfur (S)	Present in some amino acids, vitamins.	General yellowing of plant, reduced growth similar to nitrogen deficiency; relatively immobile—first symptoms on younger leaves.

Table 1: Role of Elements in Plant Function (continued)

Element	Function	Deficiency Symptoms
<b>MINOR OR TRACE ELEMENTS</b>		
Iron (Fe)	Activator (catalyst) in chlorophyll synthesis, electron transport in photosynthesis and respiration.	Immobile—first symptoms in tip—chlorosis of young leaves. Initially small veins remain green, leaves eventually turn completely pale yellow, no necrosis; stunting of growth, flower abortion.
Manganese (Mn)	Activates enzymes (coenzyme), chlorophyll synthesis.	Immobile—veins of young leaves remain green while interveinal tissue yellows, giving a reticular green pattern on a yellow background. Stunted growth, necrotic spots later develop in chlorotic areas.
Boron (B)	Transport of photosynthates, affects flowering, fruiting.	Immobile—growing point dies, side shoots begin to grow, then die. Leaves thicken, curl inward, deform, and become brittle, stunting.
Zinc (Zn)	Part of certain enzymes, formation of chlorophyll, growth regulators.	Mobile—first symptoms in older leaves, interveinal chlorosis. Leaves coil up, stunting—short internodes, leads to closely spaced upper leaves.
Copper (Cu)	Part of certain enzymes, synthesis of chlorophyll.	Immobile—middle and younger leaves. Margins curl into a tube, terminal leaves small, stunted growth, leaf petioles bend downward.
Molybdenum (Mo)	Present in certain enzymes needed for nitrate reduction	All leaves pale green to yellowish; interveinal mottling, leaf margins curl upward, necrosis develops in chlorotic areas, younger leaves remain green.
Chlorine (Cl)	Stimulation of photosynthesis, needed in root and shoot growth.	Wilting of leaves—become chlorotic and necrotic, bronzing of leaves, stunting of roots.

**Introduction**

The Lynx and the Hare One case often cited as an example of the balance of nature is the relationship between the Canada lynx (a predator) and the snowshoe hare (its prey). For over 300 years, the Hudson Bay Company has been involved in the fur trade in Canada. Company records show that the number of snowshoe hare pelts bought tends to fluctuate in a ten-year **cycle**, as does the number of lynx. Your task is to simulate this relationship and predict the future numbers of lynx and hares in an ecosystem.

**Materials:**

- one 7.5 cm cardboard square (the lynx); about 250 2.5 cm construction paper squares (the rabbits); a 50 cm square section of table top (the meadow); masking tape (to mark off the meadow); data table; graph paper.

**Procedure:**

1. Distribute 3 rabbits in the meadow. A lynx needs to eat **3** rabbits in order to survive and reproduce.
2. Toss the lynx square **once** in an effort to catch a rabbit. The lynx is not allowed to skid and the rabbits should be distributed in the field.
3. Complete the data table for generation #1.
4. At the beginning of generation #2, **double** the number of rabbits left at the end of generation #1. A new lynx immigrates into the meadow. Be sure to disperse the rabbits in the meadow.
5. Eventually the rabbit population increases to a level that allows the lynx to catch 3 rabbits in a single toss.

If the lynx catches 3 rabbits (in a single toss) it not only survives but it reproduces too! It has one baby lynx for each 3 rabbits that it catches. Lynx are not allowed to cheat, but they should try to be efficient.

i.e. 3 rabbits in a single toss = 1 baby born; 6 rabbits in a single toss = 2 babies born, etc...

6. As the number of lynx increases throw the cardboard square once for each lynx. Record the number of rabbits caught by each lynx. The simulation is more realistic if the number of new baby lynx is based on each lynx's catch rather than merely the total number of rabbits caught in a generation.
7. There are always at least 3 rabbits at the beginning of a generation. If and when the entire rabbit population is wiped out, then new rabbits immigrate into the meadow.
8. Remember that the number of rabbits in the meadow needs to be correct at all times. Remove the rabbits caught and add new ones as indicated by your data table.

**Analysis:**

Graph the data for 25 generations. Place both the rabbit and the lynx data (the first two columns of the data table) on the same graph so that the relationship can be easily observed.

X-axis = \_\_\_\_\_

Y-axis = \_\_\_\_\_

Use one color for the rabbits and another for lynx.



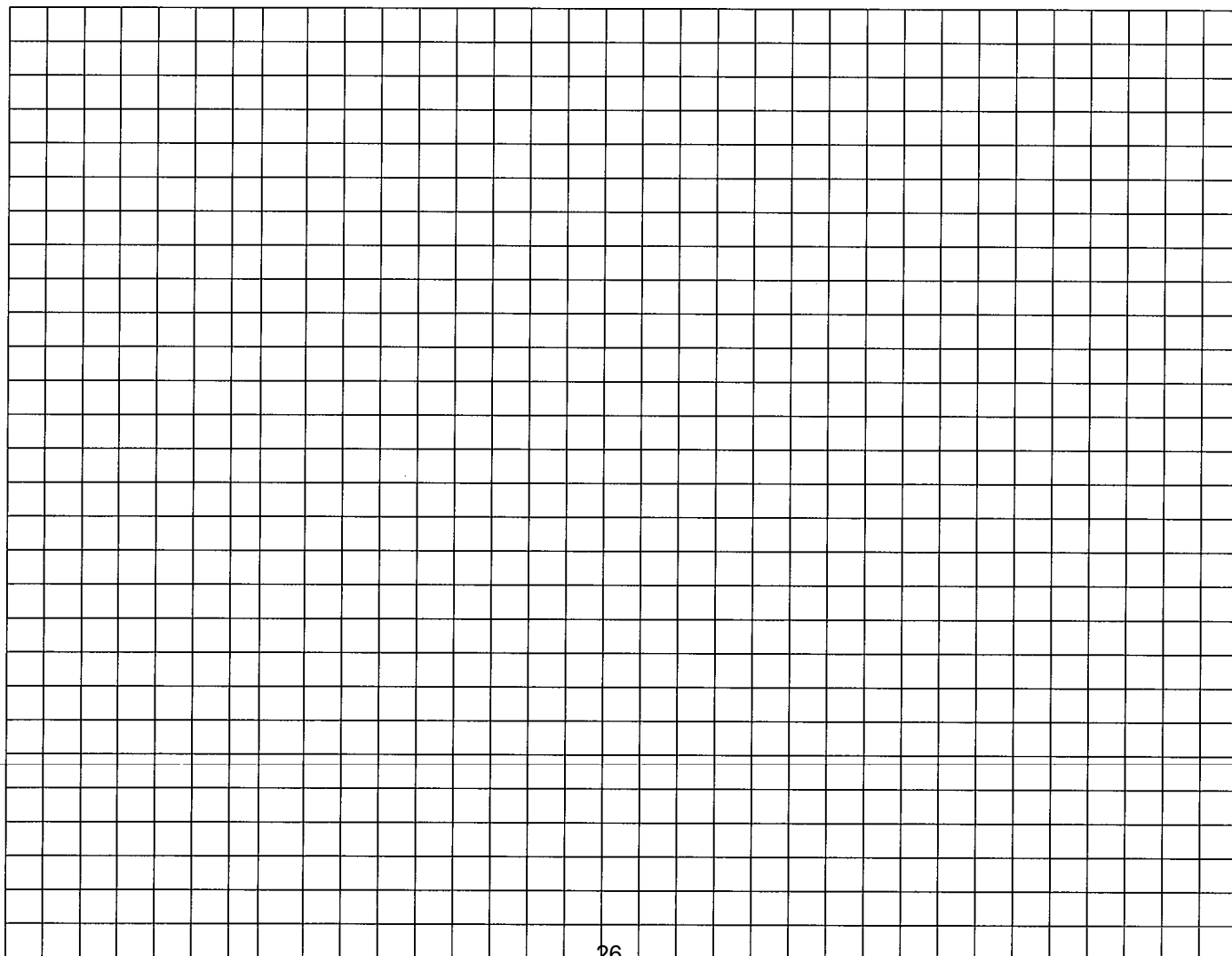
## Predator-Prey Simulation

Generation	Starting # of Rabbits	Starting # of Lynx	Rabbits Caught	Lynx Starved	Lynx Surviving	New Baby Lynx	Rabbits Left
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

## Questions

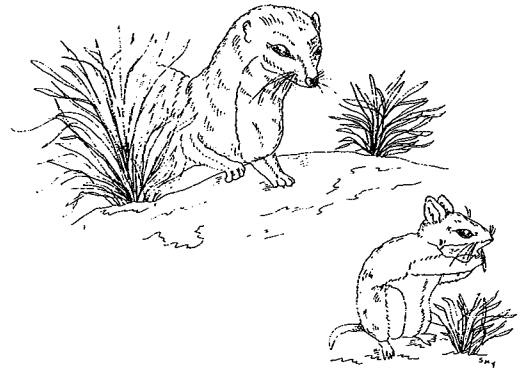
1. Define predator
2. Define prey
3. How would you describe your graph? (what shape is it, how long is one cycle?)
4. What do you predict will be the number of animals after the 30<sup>th</sup> generation?  
Number of Hares \_\_\_\_\_  
Number of Lynx \_\_\_\_\_
5. What is the relationship between the lynx and the hare over time?

**Title:** \_\_\_\_\_





A new meadow develops in a forest as a result of a fire. Mice migrate into the meadow and begin to reproduce. As the mouse population increases, a weasel is also attracted into the meadow. In the following exercise the meadow (habitat) is represented by a shallow dish, the mouse population (prey) by beads, and the weasel population (predator) by a spoon.



#### ASSUMPTIONS

1. The surviving mice of a generation always double their numbers.
2. In each generation at least 10 mice are initially present in the meadow (by immigration if necessary).
3. The maximum number of mice that the meadow can support is 100.
4. In each generation at least one weasel is initially present in the meadow (by immigration if necessary).
5. In order for a weasel to survive in the meadow, it must capture at least 5 mice. (If a weasel does not capture at least 5 mice, it will either starve in the meadow or leave in search of food elsewhere.)
6. For each 5 mice that a weasel captures, it will produce 1 offspring. (If one weasel captures 7 mice and a second captures 2, the first weasel will survive in the meadow and produce 1 offspring, but the second will neither survive in the meadow nor produce offspring.)

#### PROCEDURE

Each team should obtain a spoon, dish, and 100 beads (fill the measuring cup to the 40 ml mark with beads; this will be approximately 100).

To become familiar with the methods of this exercise, use the following directions to complete the first 4 generations of Tables I and II on the Data Sheet. One team member should fill in the Data Sheet while the other works with the dish, beads, and spoon.

#### GENERATION 1

Begin with 10 mice and one weasel in the meadow (place 10 beads in the dish). The capture of mice by the weasel is simulated by scooping the spoon once through the dish for each weasel present. However, we will assume that in the first generation the weasel does not capture any mice. In Table I enter 0 for prey captured by predator 1 of the first generation. Also enter 0 for offspring produced by the predator. Then fill in generation 1 of Table II. The 10 surviving mice double their numbers; therefore, add 10 more beads to the dish for a total of 20.

#### GENERATION 2

As there were no predator survivors or offspring in the first generation, we will assume that another weasel immigrates into the meadow. Scoop once through the dish, picking up 4 beads. In Table I enter 4 for prey captured by predator 1 of the second generation, and 0 for predator offspring. Then fill in generation 2 of Table II. Sixteen mice survive; therefore, add 16 more beads to the dish.

### GENERATION 3

Again, assume that another weasel immigrates into the meadow. Scoop once through the dish, this time picking up 7 beads. In Table I enter 7 for prey captured by predator 1 of the third generation. Also enter 1 for the offspring produced by this predator. Fill in generation 3 of Table II. Twenty-five mice survive; therefore, add 25 more beads to the dish.

### GENERATION 4

There are 2 predators in generation 4 (add predator survivors and predator offspring of generation 3). Scoop once through the dish for the first predator, picking up 13 beads. In Table I enter 13 for prey captured by predator 1 of the fourth generation, and 2 for the offspring produced by this predator. Scoop once through the dish again for the second predator, picking up 7 beads. In Table I enter 7 for prey captured by predator 2 of the fourth generation, and 1 for the offspring produced by this predator. Then fill in generation 4 of Table II. Thirty mice survive; therefore, add 30 more beads to the dish.

### COMPLETING THE EXERCISE

Continue as outlined above to complete Table II. *Important:* In simulating the capture of mice by the predator, scoop the spoon through the diameter of the dish, *do not look at the dish while doing this*, and do not deliberately attempt to scoop up all the beads. In Table II remember that Initial Prey never falls below 10 and Initial Predators never falls below 1. When Table II is complete, graph the results as directed on the Data Sheet.

### QUESTIONS

1. Which population (predator, prey) shows the first increase in numbers?
2. Does a peak in weasel population come at the same time as or after a peak in mouse population? What is the explanation for this?
3. What factor seems to determine the size of the weasel population in the meadow in any given generation?
4. What factor seems to cause the decline of the mouse population in the meadow?

**Carolina Biological Supply Company**

Burlington, North Carolina 27215  
CB510047604

Gladstone, Oregon 97027

# Predator-Prey Populations BioKit®

TABLE I

Data Sheet

PREDATOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	C																			
2	O																			
3	C																			
4	O																			
5	C																			
6	O																			
7	C																			
8	O																			
9	C																			
10	O																			
11	C																			
12	O																			
13	C																			
14	O																			

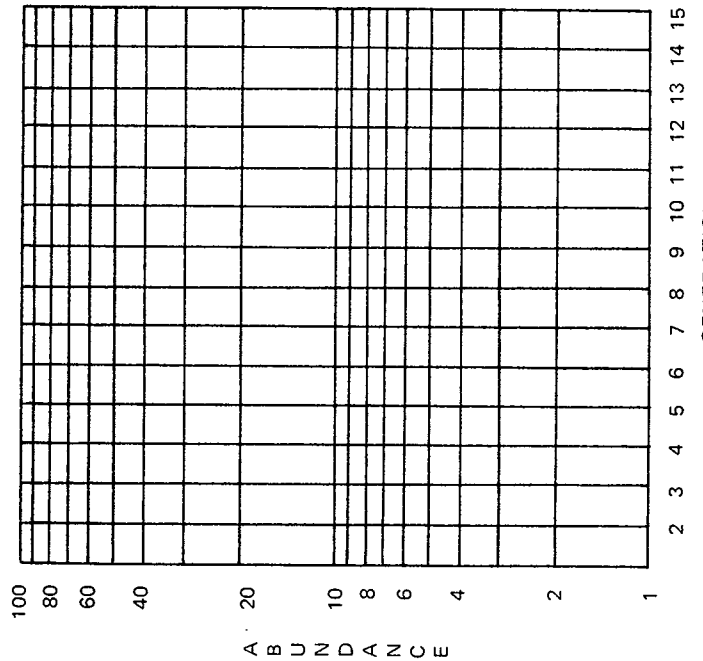
P R E D A T O R   G E N E R A T I O N

TABLE II

Generation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Initial Prey															
Total Prey Captured															
Prey Survivors															
Initial Predators															
Surviving Predators															
Predator Offspring															

## GRAPHING RESULTS

When Table II is complete, graph the results recorded in the Initial Prey and Initial Predator rows. Use an m to locate each point on the graph for prey and a w for each point on the graph for predator (or use different colors). Connect all prey points with a line and each predator point with a separate line to complete the graph.





# Kaibob Plateau Species Interdependence

Lab # \_\_\_\_\_

Modified from Lab 34-1: The Lesson of the Kaibob

## Introduction:



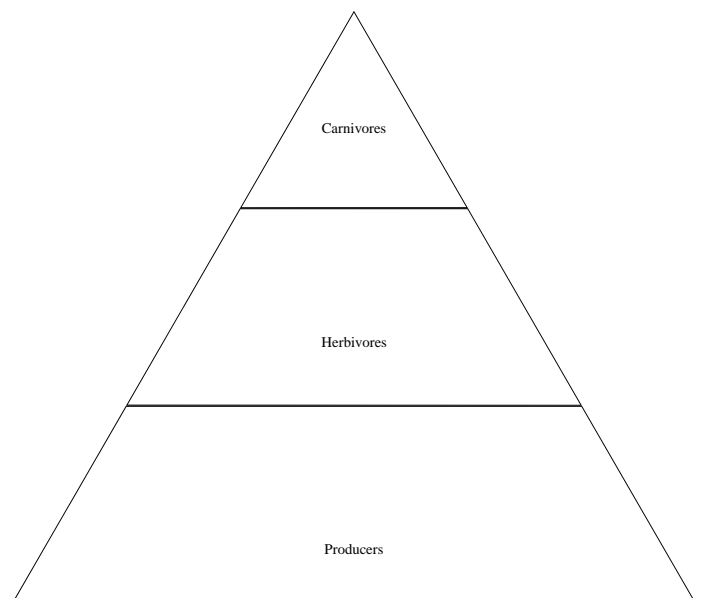
The environment may be altered by forces within the biotic community, as well as by relationships between organisms and the physical environment. The carrying capacity of an ecosystem is the maximum number of organisms that an area can support on a sustained basis. The density of a population may produce such profound changes in the environment that the environment becomes unsuitable for survival of that species. Humans can interfere with these natural interactions and have either a positive or a negative effect.

The Kaibob Plateau in Arizona is a large area covered with evergreen forests and grasslands. Rugged canyons including the Grand Canyon surround the plateau. These canyons form natural barriers to the movement of most animals, including the deer, mountain lions, coyotes, ground squirrels, chipmunks, bobcats, coyotes, and wood rats.

Mountain lions are predators that eat mostly deer. Coyotes and bobcats will occasionally eat injured or weak deer, but these two predators depend mainly upon rabbits and small rodents like chipmunks, rats, and ground squirrels for food. The rodents, rabbits, and deer eat grasses and low shrubs. Deer also eat tender buds and shoots from young trees.

1. Would the above populations be considered **open populations** (where the individuals in the population are free to move in and out of the area), or are they **closed populations**? And why do you think so?
2. Using the above information, sketch a food web that includes all the underlined organisms.

3. Place the names of the underlined organisms in the proper level of the energy pyramid diagram below.





Before the arrival of other people in the late 1800's, Native Americans were the only people who lived on the Kaibab Plateau. They killed approximately 800 deer each year for food and for their hides. These Native Americans seldom killed any predators. During this same time, the deer population did not change greatly from year to year.

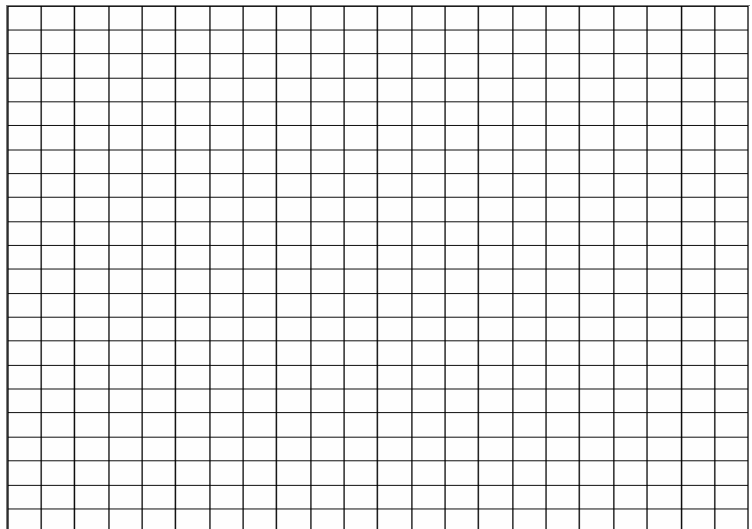
A study was made of the animals on the Kaibab Plateau in 1906. The deer population at that time was estimated to be about 4,000. At that time, President Teddy Roosevelt made the plateau into a large game preserve. The killing of deer was prohibited. Approximately 10,000 predators were killed between 1906 and 1939. By 1924, the size of the deer herd was estimated to be 100,000.

4. Why was there such an increase in the size of the deer herd?
5. What effects would the size of the deer herd have upon the producers on the Kaibab Plateau? Explain.
6. What effects would the size of the deer herd have upon the other herbivores on the plateau? Explain.
7. In 1930, the estimated size of the deer herd was 30,000. Why did the herd size decrease so rapidly?

8. Graph the size of the deer population from 1906 to 1930. Use the X-axis for the years and the Y-axis for the size of the population.

Don't forget to

- Create a title
- Mark and label axes



9. During what years did the natality (birth rate) of the deer exceed mortality rate of the deer? Explain.
10. During what years did the mortality rate exceed natality rate?
11. How many deer might the plateau be able to support without destroying plant life? \_\_\_\_\_  
What is this number known as? \_\_\_\_\_
12. If you were in charge, how would you maintain the size of the deer herd that you suggested in # 11?
13. Could the same methods be used to control the size of the deer herds in Irondequoit? \_\_\_\_\_  
Explain why or why not.





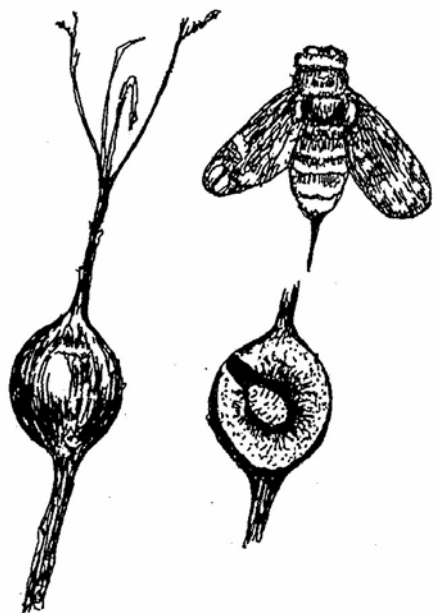
# Goldenrod Gall Size and the Food Chain Lab # \_\_\_\_

Modified from CIBT Lab by Bertino & P. Nolan

## Introduction:

The goldenrod plant can produce a growth on its stem called a gall. This growth is really a 'house' which develops around a fly larva. The goldenrod fly lays an egg in the plant in spring. The stem of the goldenrod begins to swell. Inside the enlarged, oval gall, a fly larva develops. As the fly larva grows, it produces a plant stimulant which, in turn causes the gall to increase in size. The size of the gall is related to the amount of growth hormone produced by the fly.

There is a species of wasp which feed on the fly larvae. This wasp type is called Wasp #1. It can lay an egg on the fly larva in the gall. This egg develops into a wasp larva which becomes a parasite on fly larva and eventually kills it. The wasp larva makes the fly pupate early in the fall instead of its normal time in the following spring. The presence of a small brown pupa case indicates the presence of Wasp # 1. As the egg of Wasp # 1 develops into a larva it consumes the fly larva. If the small brown pupa case is opened, you will find the smaller Wasp # 1 larva inside.



Another type of wasp, Wasp # 2, could also feed on the fly. This wasp kills the fly larva directly but does not act as a parasite as did Wasp # 1. The presence of a white larva, without hooks, indicates wasp #2. The inside of the gall may contain some black fecal matter formed as Wasp #2 eats the gall fly larva.

Certain beetles also could be found inside the gall. They also could eat the fly larva, the Wasp #1 larva or the Wasp # 2 larva. The presence of a small larva with 3 pairs of legs located near the head of the organism indicates the presence of the beetle larva.

In the winter, when food is scarce, a woodpecker or a chickadee might peck into the gall and eat the contents, whatever they might be. The beetle, the woodpecker, and the chickadee all make holes into the side of the gall. The woodpecker hole is the largest followed by the chickadee and the smallest being that of the beetle.

**Problem:** Galls come in lots of different sizes. Let us consider why they are small, medium, or large. Is there any way of guessing what the contents of a gall might be based upon the size of the gall?

## Purpose:

- In this investigation you will dissect goldenrod galls to determine the locations of the gall fly larvae exit tunnels and the bird-pecked holes.
- Then you will calculate the percent of wasp and bird predation on the gall fly larvae.
- Determine if a gall fly has a better chance of survival inside a small, medium or large goldenrod gall.
- To observe the results of co-evolution as different species changed together over time.
- To predict the effect of these relationships on the stability of the field ecosystem.

**Hypothesis:**

- Does the size of a gall determine the organism present inside?
- If so, which organisms will you expect to find in each gall size?

**Materials:**

Galls of various sizes  
Dissection microscope

Hand Lens  
Scalpel or Razor Blade

**Safety:**

Razorblades are SHARP! Be careful not to cut yourself.

**Procedure:**

1. A hundred galls should first be separated into piles of small, medium or large size. There should be at least 10 of each type.
2. Divide the galls among the class members so that each student gets at least 4 – 5 galls.
3. Using a sharp, one piece scalpel or paring knife, cut the call across the middle. If needed, insert a flat blade screwdriver into the cut edge and pry open the gall carefully.
4. Measure the diameter of the gall and record it in the data table.
5. Using the modified key provided, identify the organism inside the gall.
  - If a gall fly larva is present, it will be white/tan and will move when gently touched. Determine whether the tunnel was made in the upper or lower hemisphere.
  - If a wasp pupa is present, it will look reddish brown, and will not move when touched. An empty chamber is also evidence that a wasp consumed the larva
6. There are four jars labeled fly larva, Wasp # 1, Wasp #2 and beetle larva in the front of the room. Place what you find into the correct jar. It may be necessary to view the organism under the stereomicroscope in order to see them clearly.
7. Complete the chart now so that you know which size gall contains which insect.

DICHOTOMOUS KEY TO COMMON GOLDENROD GALL INSECTS

```
=====
1a. Gall with white Larva . . . . . 2
1b. Gall without white larva. . . . . 3
2a. Larva with black mouth hooks. . . . . Gall Fly Larva
2b. Larva without black mouth hooks. . . . . Wasp #2 Larva
3a. Small brown pupa case present . . . . .Wasp #1 Larva
3b. Small brown pupa case absent W/ small worm-like larva . . . . . Beetle
=====
```

Group Data Results:

Gall Diameter (mm)	Organism Present	Gall Diameter (mm)	Organism Present

## CLASS DATA RESULTS

Size of Gall	Gall Fly	Wasp # 1	Wasp # 2	Beetle	Empty
Small Gall Data					
13 mm					
14 mm					
15 mm					
16 mm					
17 mm					
18 mm					
19 mm					
Totals					
Medium Gall Data					
20 mm					
21 mm					
22 mm					
23 mm					
24 mm					
25 mm					
26 mm					
27 mm					
28 mm					
29 mm					
Totals					
Large Gall Data					
30 mm					
31 mm					
32 mm					
33 mm					
34 mm					
35 mm					
36 mm					
37 mm					
38 mm					
39 mm					
40 mm					
Totals					

## Analysis:

1. What factor creates the different gall sizes?
2. Take a look at your group's data and compare it to the class' data, which sized gall provided the best survival advantage for the gall fly? Which data set more reliable? Explain
3. Removing hundreds of galls from an ecosystem could have a negative impact on the food web. Describe two different food chains that exist in the ecosystem from which these galls were removed and specifically describe the organisms in the food web that could be negatively impacted by the removal of these galls.
4. What percent of the gall fly larvae in the intact galls were eaten by wasps?
5. Do you think that the percent predation by wasps and/or birds might change as winter advances into spring? Explain your ideas.
6. Do you think predation by wasps and birds has a big effect on the population size of gall flies? Explain your ideas using class data.
7. Why do you suppose woodpeckers and chickadees feed on gall fly larvae but not blue jays and sparrows?
8. Why can you describe the gall fly larva as both a parasite and an herbivore? What is the difference between the two terms?
9. What do you think is the survival advantage to the gall fly larvae of making an exit tunnel?

## Conclusion

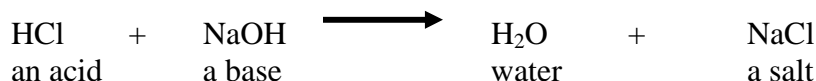
## Introduction

Substances may be acidic, basic, or neutral. Acids and bases are *aqueous* solutions, meaning that they are mixtures of certain substances dissolved in *water*. The degree of acidity or basicity can be measured by using the pH scale, which runs from 1 to 14. The scale is related to the amount of hydrogen ion  $[H^+]$  present in a given substance.

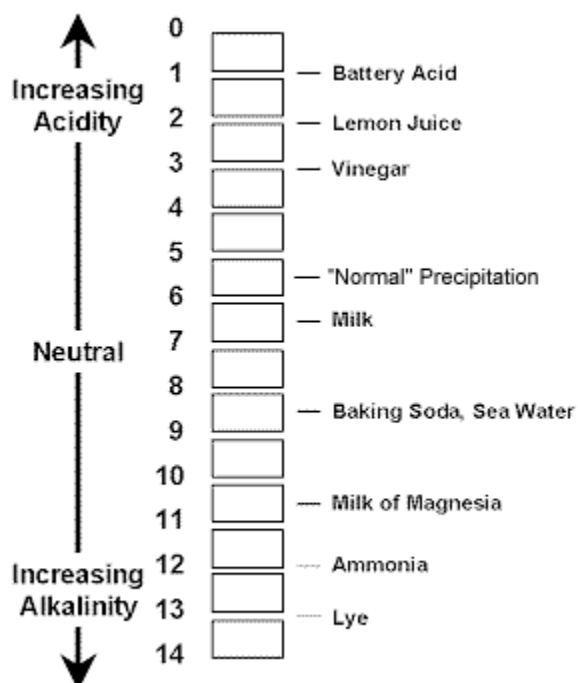
**Acids** have the lowest pH values (less than 7) and the highest concentrations of hydrogen ions. These hydrogen ions give acids their properties, such as sour taste. Acids react with bases to form a salt and pure water. Acids tend to damage living tissue by causing burns upon contact.

**Bases** have the highest values (greater than 7) and the lowest concentrations of hydrogen ions. Instead, bases have higher levels of hydroxide ion  $[OH^-]$  which give bases their identifying properties, such as bitter taste and slippery feel. Bases react with acids to form a salt and pure water. Bases tend to damage living tissue by dissolving it upon contact.

**Neutral** substances, which are neither acidic nor basic, have a pH of 7. Pure water, which has a pH of 7, is one of the substances formed during a neutralization reaction, where an acid and a base mix together. An example of a neutralization reaction is listed below:



Each division on the pH scale either increases or decreases the pH of a substance 10 fold. For example, a substance with a pH of 5 is ten times more acidic than a pH of 6. Pure water has a pH of 7. However, when pure water mixes with other substances, the pH will change. For example, sulfates and nitrates in the atmosphere (from burning coal) will mix with water to form acid rain, which has a pH lower than 7.



## Hypotheses & Data

Fill in the “Substance” and “Hypothesis” columns before you begin.

Substance	<u>Hypothesis</u> Acid, Base or Neutral	pH Value	<u>Actual</u> Acid, Base or Neutral	Teacher Check
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11				
12.				

## Materials

- \* Logger Pro software
- \* pH probe
- \* Go! Link
- \* Water (distilled, if available)
- \* 600 mL beaker
- \* Substances with varying pH

## Safety

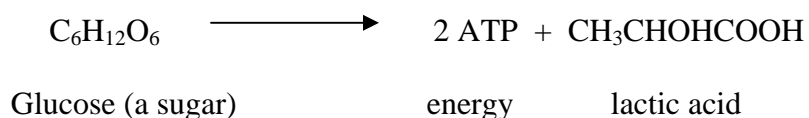
- \* Wear goggles and aprons to avoid skin contact with all chemicals in this lab
- \* Report any skin contact or chemical spills to your instructor immediately
- \* Never eat or drink in the lab room

## Procedure

- 1) Unscrew the pH probe from the storage solution it is stored in.
  - \* LEAVE the cap attached to the probe and *gently* push the cap up toward the top of the probe.
  - \* Place the small bottle of buffer solution in the space provided on the front lab bench.
  - \* The probe **MUST** remain **UPRIGHT**. Place it in the beaker provided when it is not in use.
- 2) Plug in the pH probe to the Go! Link provided. Plug the Go!Link into your computer's USB port.
- 3) Open Logger Pro 3.4.5 (under Vernier Software in Programs).
- 3) Remove the pH probe from the beaker and rinse the probe with water, distilled if available.
- 4) Place the probe in the sample to be tested. Once the value stabilizes (doesn't change), record the pH value on your data table to the **nearest tenth**.
- 5) Once you record your data, rinse the pH probe over the sink with water and place it back in your beaker.
- 6) Repeat steps 3 through 5 with all of the samples to be tested.
- 7) When all samples have been tested, rinse the probe with water and place it back in the storage solution. Screw the cap on tightly and place the probe back in the box in an **UPRIGHT** position.

## Analysis (use brain and "Introduction" of this lab to help you)

1. The pH scale is a measure of the concentration of which ion?
2. Briefly describe why acids and bases have different pH values and properties.
3. Give one possible explanation why the pH value for the tap water was different from the pH value for distilled water.
4. Certain microorganisms, such as bacteria, carry out a process called **anaerobic respiration**, which releases the energy from the foods they ingest. One equation for anaerobic respiration is below:



Based on the pH values you have and the information above, give one possible explanation that explains the difference in pH values between the milk and the buttermilk.

5. a) Which property of bases makes them useful in cleaning away dirt and grime?
- b) What types of substances are often basic?

The diagram below represents the pH ranges in which selected aquatic organisms exist.

A **solid** box represents pH ranges where organisms thrive.

A **shaded** box represents pH ranges in which conditions are less favorable, but can survive.

No **symbol** is placed in a pH range in which that organism cannot survive.

	4.0 – 4.5	4.5 – 5.0	5.0 – 5.5	5.5 – 6.0	6.0 – 6.5	6.5 – 7.0
Yellow Perch						
Brook Trout						
Lake Trout						
Rainbow Trout						
American Toad						
Spotted Salamander						
Crayfish						
Mayfly						
Clam						
Snail						

6. At which pH range do the brook trout thrive?
7. a) Which organisms might signal that the pH of the lake has changed from 5.8 to 5.2?
- b) Explain your choices.
8. a) Define biodiversity.
- b) How would a decrease in pH affect the biodiversity of the freshwater community detailed above?
- c) What effect would this change in biodiversity have on the freshwater community?
- d) Give one reason why the pH of a lake would decrease.

### Conclusion

\* Choose any four (4) of the substances you tested **other** than water and for **each** of them...

- a) Did you get the pH value you expected, or did the value surprise you?
- b) Will you reject or accept your hypothesis for the substance?

\* Why do think pH is a useful concept to biologists?



LE Biology  
Lab- Building Small Molecules

Name \_\_\_\_\_  
date \_\_\_\_\_

Objective: you will learn about the molecular structure of some important and common substances by building small molecules.

Materials:  
molecular model kit

Atom Color	Element	Symbol
10 black	carbon	C
6 red	oxygen	O
28 yellow	hydrogen	H
2 blue	nitrogen	N

Procedure:

1. Using the chemical formulas, construct the molecules listed below.
2. Write the name of the molecule and draw the molecule in color.
3. Have your teacher check your model and paper.

Formulas	Name	Picture	Teacher check
1. O <sub>2</sub>			<input type="checkbox"/>
2. H <sub>2</sub> O			<input type="checkbox"/>
3. N <sub>2</sub>			<input type="checkbox"/>
4. NH <sub>3</sub>			<input type="checkbox"/>
5. CO <sub>2</sub>			<input type="checkbox"/>
6. CH <sub>4</sub>			<input type="checkbox"/>

	FORMULA	NAME
7.	C <sub>3</sub> H <sub>8</sub>	ethyl alcohol
	1. C <sub>2</sub> H <sub>5</sub> OH	water
	2. H <sub>2</sub> O	glycerol
	3. C <sub>3</sub> H <sub>5</sub> (OH) <sub>3</sub>	acetic acid
	4. CH <sub>3</sub> COOH	glycine
	5. NH <sub>2</sub> CH <sub>2</sub> COOH	urea
	6. CO(NH <sub>2</sub> ) <sub>2</sub>	pyruvic acid
	7. CH <sub>3</sub> COCOOH	acetaldehyde
	8. CH <sub>3</sub> CHO	

+ LARGER  
MOLECULES :

Questions- Answer the following in complete sentences.

1. Explain the difference between an ATOM and a MOLECULE using a molecule from this activity as an example.
2. Which of the molecules you constructed represent ELEMENTS and which are COMPOUNDS? Explain the difference.
3. Which of the molecules you made are ORGANIC? Explain.
4. Explain the importance of each of the following molecules to living things. Name metabolic processes or biogeochemical cycles in which any molecule takes part.

Oxygen-

Nitrogen-

Water-

Carbon dioxide-

Ammonia-

**Objectives-** To build molecular models of glucose, maltose, and starch.  
To demonstrate synthesis and hydrolysis reactions.

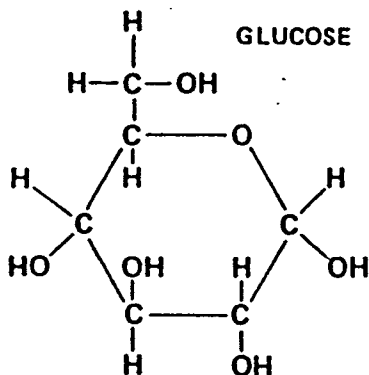
**Prelab-**

Define the following  
*synthesis-*  
*hydrolysis-*

Color	Atom
black.....	carbon
red.....	oxygen
white.....	hydrogen

**Procedure-**

Using your molecular model kit and the picture below, assemble a glucose molecule.



Count the atoms of each element to write the molecular formula of glucose

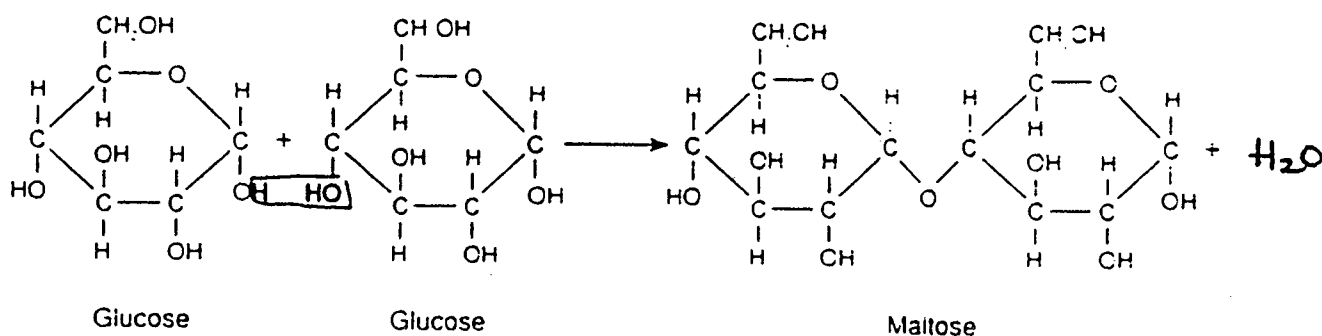
C \_ H \_ O \_

What is the ratio of hydrogen to oxygen atoms in carbohydrates like glucose? \_\_\_\_:\_\_\_\_

teacher check



Join your molecule of glucose with someone else's molecule to synthesize maltose as illustrated in the picture on the back. Joining together small molecules to form large molecules is known as \_\_\_\_\_.



What atoms do you have left over after joining the two glucoses? H \_ O \_  
 Make a water molecule from these atoms.

teacher check



4. Now, repeat step 3, remove another water molecule to join your maltose to another group's maltose to make starch.

teacher check



5. Now, using the atoms of the water molecules, break the starch molecule apart back into four glucoses. Using water to break a larger molecule into smaller molecules is known as \_\_\_\_\_.

teacher check



Questions for Thought (answer in complete sentences).

1. What is the name of the reaction where CO<sub>2</sub> and H<sub>2</sub>O are used to make glucose? Where does this occur? What is the other important product of this reaction?
2. Explain why you think joining two sugars together is sometimes called "dehydration" synthesis?
3. How does a potato plant make starch to put in potatoes? Why does a potato plant make starch anyway?
4. "Enzymatic hydrolysis" is the breakdown of large molecules using enzymes and water. In what parts of your body does this occur most frequently? What is the more common term for this process?
5. Based on what you learned in this lab, explain the difference between synthesis and hydrolysis reactions. Name a process that occurs in a living organism that is an example of synthesis. Name a process that occurs in a living organism that is an example of hydrolysis.

**Introduction**

All foods contain nutrients. However, you cannot tell what nutrients are in food by looking at the food. You can tell if certain nutrients are present in foods by doing certain chemical tests. During this activity, you test 12 different foods to find out if lipids (fats), protein, simple sugars and/or starches are present in each food.

**Purpose**

This exercise will introduce you to the various nutrients found in the foods you eat. It will also test your ability to carry out a **controlled** experiment.

**Hypotheses**

Before you begin, complete the table as to what nutrient(s) you would expect to find in each food.

<b><u>Food</u></b>	<b><u>Lipids</u></b>	<b><u>Protein</u></b>	<b><u>Simple Sugars</u></b>	<b><u>Starch</u></b>
<b>1</b>				
<b>2</b>				
<b>3</b>				
<b>4</b>				
<b>5</b>				
<b>6</b>				
<b>7</b>				
<b>8</b>				
<b>9</b>				
<b>10</b>				
<b>11</b>				
<b>12</b>				

## Materials

- \* test tubes      \* medium beaker      \* spot plate      \* brown paper      \* test tube rack      \* test tube tongs
- \* hot plate      \* 12 different food samples      \* glucose solution      \* starch solution      \* egg albumin
- \* vegetable oil      \* Lugol's Iodine      \* Benedict's solution      \* biuret solution

## Safety

- \*\* **GOGGLES & APRONS** are to be worn throughout this laboratory procedure
- \*\* **CAUTION**: biuret solution is caustic; if contact occurs, rinse immediately with water & inform instructor
- \*\* **CAUTION**: Hot water burns!! Use test tube tongs.
- \*\* **CAUTION**: Iodine will stain clothes and skin!!! Be careful!!!

## Procedure

For ALL Tests,

- Use WATER as a NEGATIVE control
- Use a food known to contain the nutrient in question as a POSITIVE control
- Complete Tests #1-#4 for ALL food samples!!

### **Test #1: Brown Paper Bag Test for Lipids**

1. Set up positive (oil) and negative (water) controls for lipids.
2. Rub a sample of the food onto a **labeled** brown paper bag.
3. Wait 5 minutes before observing the bag & recording results. Compare results to your controls.

### **Test #2: Biuret Test for Protein**

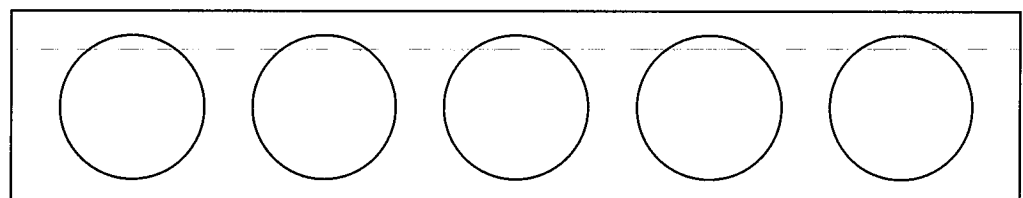
1. Set up positive (albumin solution) and negative (water) controls for proteins
2. Place food samples on a **labeled** Petri dish or plate depression.
3. Add 1-2 drops of biuret solution **DIRECTLY** onto the food sample. **DO NOT HEAT.**
4. Observe and record color. Compare the color to your controls.

### **Test #3: Iodine (Lugol's) Test for Starch**

1. Set up positive (starch solution) and negative (water) controls for starch
2. Place food samples on a **labeled** plate depression or a piece of paper towel.
3. Add 1 to 2 drops of iodine **DIRECTLY** onto the food sample. **DO NOT HEAT.**
4. Observe and record color. Compare color to your controls.

### **Set up for Tests #1 - #3**

Use Paper Bag or  
Depression Plate



Negative  
Control

Positive  
Control

Food  
#1

Food  
#2

Food  
#3

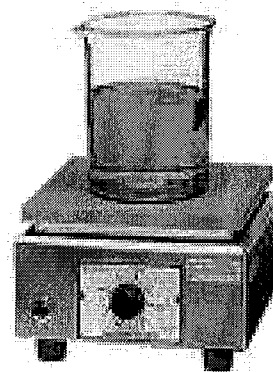
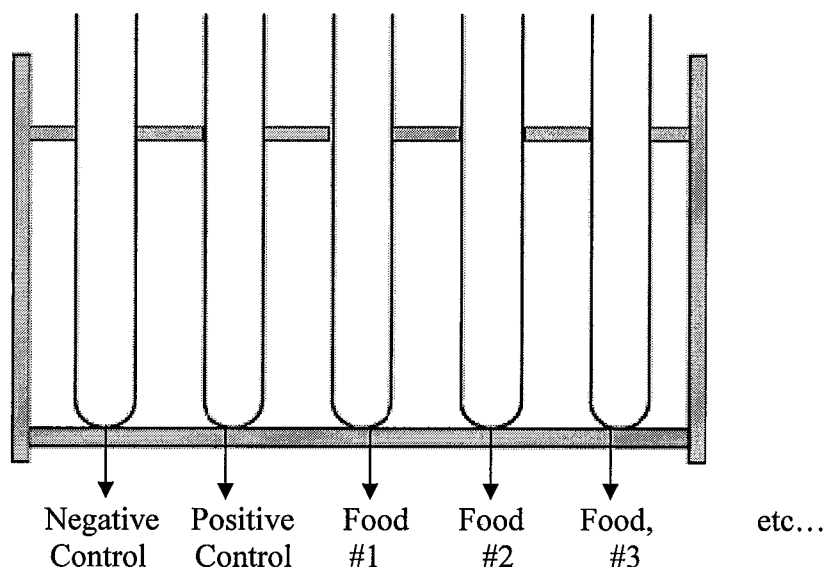
Etc...

#### **Test #4: Benedict's Test for Simple Sugar**

1. Set up positive (glucose) and negative (water) controls for simple sugars
2. Place 2 full squirts of the Benedicts solution in a **labeled test tube**
3. Add about 5mL of water and the food sample to be tested.
4. **HEAT** in a water bath for 2 minutes. Do NOT allow the water bath to boil!!
5. Observe and record color **AFTER** heating. Compare color to your controls.

#### **Set up for Test #4 ONLY (Benedict's Test for simple sugar)**

Use **Test Tubes** and **hot water bath**



**LABEL all test tubes & plates with the FOOD NAME!!!!**

#### **Clean Up**

1. Turn off and unplug your hot plate
2. Clean out **ALL** test tubes with a test tube brush
3. Clean out **ALL** food from the sink drains
4. Wipe down your table with a sponge
5. Goggles need to go back into the goggle cabinet, aprons returned to their hooks
6. Wash your hands with soap and water

## Data

### **Control Data:**

Complete the tests described to establish your CONTROLS for this experiment.

<u>Nutrient</u>	<u>Reagent Used</u>	<u>Heat Needed?</u>	<u>Positive Result</u> (+)	<u>Negative Result</u> (-)
Lipids		NO / YES		
Protein		NO / YES		
Sugar		NO / YES	Green: Yellow: Brick Red:	
Starch		NO / YES		

### **Experimental Data:**

50	<u>Food #1</u>	<u>Food #2</u>	<u>Food #3</u>	<u>Food #4</u>	<u>Food #5</u>	<u>Food #6</u>	<u>Food #7</u>	<u>Food #8</u>	<u>Food #9</u>	<u>Food #10</u>	<u>Food #11</u>	<u>Food #12</u>
<u>Nutrient</u>	—	—	—	—	—	—	—	—	—	—	—	—
<b>Lipid</b>												
<b>Protein</b>												
<b>Sugar</b>												
<b>Starch</b>												

**Indicate** which nutrients are present or absent. **DO NOT** leave any boxes blank.



## Analysis

- 1) Identify any foods that only contain one nutrient. What nutrient do they offer?
- 2) The nutrients tested for today in lab are all considered organic molecules. What is an organic molecule?
- 3) Summarize (2-3 sentences) how the human body uses the following organic molecules... (use your notes/Internet to help you)
  - a) carbohydrates (sugars & starches)
  - b) lipids
  - c) proteins
- 4) Water is used as a negative control for each test performed because water has no nutritional value. Why is water so important to the human body, even though it contains no nutrients?

## Conclusion

- 1) Choose any **3** of the 12 foods you tested and discuss whether or not your data supports your hypotheses for **each** of the nutrients tested.
- 2) What results (at least 2) did you find surprising?
- 3) A friend told me that her homemade cookies are a good source of protein and have no fat. Design a **controlled** experiment to test her statement. Include...
  - a) a procedure describing the two nutrient tests you would need to perform to test this hypothesis
  - b) the substances you will use as a positive and negative **control** for each test



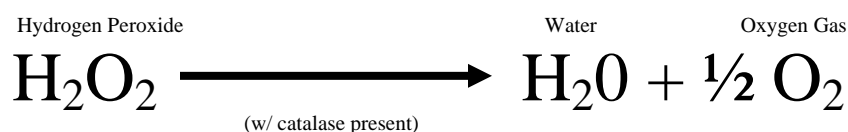
## Background:

Most of the thousands of chemical reactions that take place in your cells require enzymes, “biological catalysts,” protein molecules that speed up and regulate chemical reactions. Each type of enzyme fits a specific molecule, called a substrate. During the reaction, the substrate molecule is either broken apart (hydrolysis) or constructed (dehydration synthesis), but the enzyme is unaffected.” Enzymes are re-used multiple times.

Enzymes are sensitive to variations in temperature and pH. Enzyme activity, or “Reaction Rate,” is typically highest over a narrow range of temperature and pH – the optimal temperature and pH for the enzyme.

Enzyme activity and reaction rates decrease at temperatures and pH values outside of these optimal ranges, because the enzymes tend to change shape and not work as effectively. Like most proteins, enzymes can be denatured, that is, permanently damaged by high temperatures and extreme pH values. At low temperatures enzymes tend to be inactive, but are not permanently damaged.

Living cells synthesize the enzyme, “CATALASE,” in order to break down hydrogen peroxide, a waste product of cellular respiration. This reaction can be detected by the presence of **oxygen gas**, either as **oxygen bubbles** or as **dissolved oxygen (DO)**.



**Objective:** The purpose of this lab is to examine changes in the activity of the enzyme, catalase, over a range of temperatures and substrate concentrations.

<b>Materials:</b>	Enzyme Catalase (from Potato Juice)	Substrate (Hydrogen Peroxide)
	Distilled and Tap Water	Glassware
	Plastic pipette	filter paper disks
	Stopwatch	safety goggles
	Ring stand	computer
	LoggerPro Software	Temperature Probes
		hot plate with stirrer
		Go!Link cables
		Dissolved oxygen probes

**Safety:** Use caution with the hot plates! Tape the probe cords out of the way of the hot plate.

Avoid skin and eye contact with all liquids in this lab

Wear goggles and aprons throughout the activity

Never eat or drink in the lab room

Alert your instructor of any injury, no matter how minor it may seem

## Part 1: Observing Catalase Activity

**Hypothesis:** Predict whether enzyme activity will be greater in unboiled (Solution A) or boiled potato juice (Solution B). Also, will plain water exhibit any enzyme activity?

**Procedure (Part 1):**

1. Add 10 ml of hydrogen peroxide to a clean 10 ml graduated cylinder.
2. Place one paper disk on a clean paper towel. Put 2-3 drops of Solution A (unboiled catalase solution) on the paper disk, and allow it to soak in for 5-10 seconds.
3. Get ready with a stopwatch to record the reaction time. Place the paper disk on the end of the flat end of a glass stirring rod. Push the paper disk to the bottom of the graduated cylinder and start the time.
4. Stop the timer when the paper disk reaches the surface of the fluid in the graduated cylinder. Record the time.
5. Repeat two more times and calculate the average in the data table.
6. Repeat the reaction again, however, this time use Solution B (boiled catalase solution) to observe the effect of extreme temperature on enzyme activity.
7. Repeat the reaction again, but this time place only tap water on the paper disk to observe the reaction without enzyme.
8. Record your data below, and answer the two questions before proceeding.

**DATA TABLE 1:**

Unboiled -vs- Boiled Catalase Activity					
Unboiled Catalase	Reaction time (sec)	Boiled Catalase	Reaction time (sec)	Tap Water	Reaction Time (sec)
Trial 1					
Trial 2					
Trial 3					
Average					

**Analysis Questions (Part I)**

1. Compare the activity of unboiled and boiled catalase, and explain the difference.
2. Based on your observations of the disk with the water on it, what can you infer about the breakdown of peroxide without the enzyme catalase?

**Part II – Effect of Substrate Concentration on Catalase Activity**

**Hypothesis:** Predict whether enzyme activity will be greater at low substrate (hydrogen peroxide) or high substrate concentration.

**Procedure:**

1. Use the average reaction time from data table 1 above for the first data collection with 10 ml of hydrogen peroxide and 0 ml of distilled water.
2. Add 8 ml of hydrogen peroxide to a 10 ml graduated cylinder. Next add 2 ml of distilled water to bring the total to 10 ml.
3. Pour the diluted hydrogen peroxide into a clean reaction beaker. Gently mix them together in the reaction beaker and then return the mixture to the graduated cylinder.
4. Place one paper disk on a clean paper towel. Put 2-3 drops of Solution A (unboiled catalase solution) on the paper disk, and allow it to soak in for 5-10 seconds.
5. Get ready with a stop watch to record the reaction time. Place the paper disk on the flat end of the glass stirring rod. Push the paper disk to the bottom of the graduated cylinder and start the stopwatch immediately. When the disk floats up and touches the surface of the liquid, stop the timer and record the time. Your group will record data in the Group 1 column.
6. Repeat this procedure four more times using new dilutions according to the data table.
7. Record your data, calculate reaction rates, graph your results, and answer the two questions before proceeding.
8. Interview 5 other groups to collect class data and calculate averages.

## Data Table – Substrate Concentration and Enzyme Activity

Amount of Hydrogen Peroxide (ml)	Amount of Distilled Water (ml)	Reaction Time - Amount of Time for Paper Disk to Rise						
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Average
<b>10</b>	<b>0</b>							
<b>8</b>	<b>2</b>							
<b>6</b>	<b>4</b>							
<b>4</b>	<b>6</b>							
<b>2</b>	<b>8</b>							
<b>0</b>	<b>10</b>							

### Analysis Questions (Part II)

1. Summarize the effect of changing substrate concentration on enzyme activity.
2. Why is it important to use 10 ml of solution for each trial?

### Part III – Effect of Temperature on Catalase Activity

**Hypothesis:** Predict the optimal temperature for catalase. In other words, what temperatures will produce the fastest reaction rate? Also, what will happen to reaction rates when temperatures get hot?

**Procedure (Part III):** Set up lab equipment and software in the following sequence.

#### Equipment Setup

1. attach temperature and DO probes to clamps on ring stand.
2. Put 200 ml of hydrogen peroxide into a clean 600 ml beaker with a stirrer bar, and place the beaker on the hot plate/stirrer plate. **(DON'T TURN ANYTHING ON YET!)**
3. Lower probes until tips of probes are submerged in the beaker of hydrogen peroxide.
4. Connect temperature and DO probes to computer via Go!Link cables, and arrange cables so connectors won't be in the way or get wet.

#### Computer Set-up

5. Start computer, start Loggerpro software. The program will recognize both probes.
6. Click on "Experiment," then "Data Collection." Set "Length" to 25 minutes and "Sampling Rate" to 12 samples/minute. Click "Done."
7. Click on the top graph to highlight it. Click on "Options," then "Graph Options," then "Axes Options," and set Y-Axis to "Autoscale." Click "Done."
8. Repeat for bottom graph.

### **Running the Experiment**

9. Turn on stirrer to lowest setting.
10. Start data collection – click on “Collect.”
11. Allow the temperature and DO probes to stabilize for 5 minutes.
12. At 5 minutes, add 0.5 ml of enzyme (potato juice) to the hydrogen peroxide in the beaker.
13. At 7 minutes, turn on the hot plate to “High.”
14. **Watch carefully!** At 9 minutes, or when the temperature probe reads 30°C – whichever happens first – turn OFF the hot plate. Leave the experimental set-up alone until the experiment automatically stops at the end of the 25 minutes.

### **Label & Save Data**

15. Label graphs as instructed (see sample results). Name and save your file, and print your file **twice**. You and your lab partner **both** need to attach a print-out to your lab write-up.

### **Clean-up**

16. Carefully discard hydrogen peroxide and enzyme mixture. Discard any enzyme. Thoroughly rinse all glassware in tap water.
17. Put 100 ml of tap into a clean 200 ml beaker, and place the beaker on the hot plate/stirrer plate.
18. Lower probes until tips of probes are submerged in the beaker of tap water.

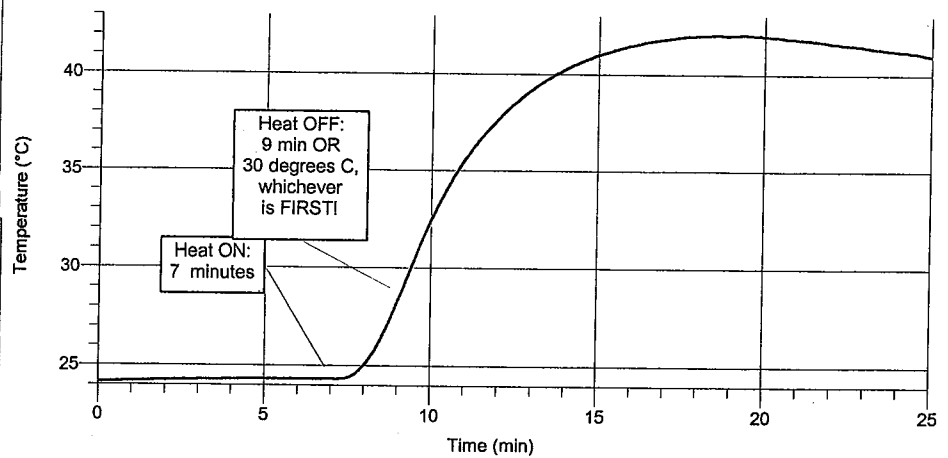
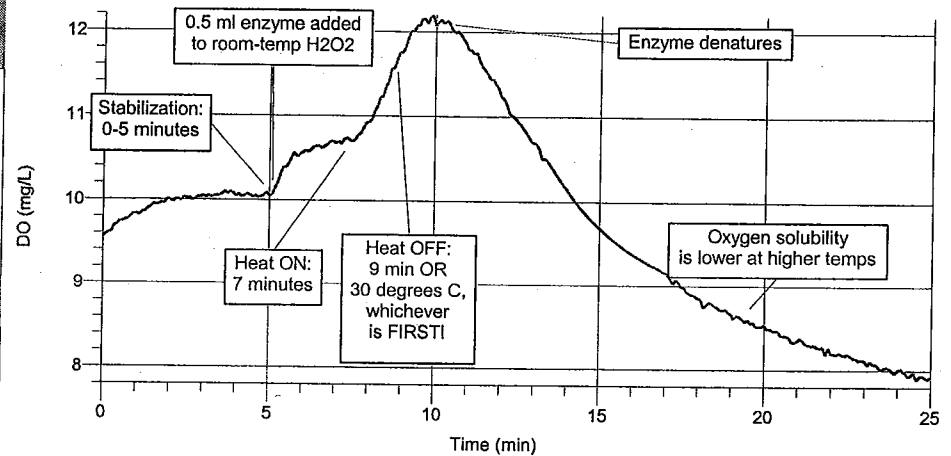
### **Analysis – Part III and Overall**

1. What was the enzyme used for your experiments? What does this enzyme do?
2. What was the substrate used in your experiments? What happened to this substrate when the enzyme was added to it?
3. How did you measure enzyme activity in your experiments?
4. Which part of the overall experiment served as a control? (In other words, what did you do to establish that the enzyme was in fact causing the reaction to occur?)
5. Why were repeated trials important in Part I? Estimate your experimental error compared to the class averages in Parts I and II as in + or - \_\_\_\_\_ seconds.
6. If another group of students used the same methods and materials to conduct the same experiment, what three things could cause their results to differ from yours?
7. How does boiling affect enzyme activity? Why?
8. How does decreasing enzyme concentration affect enzyme activity? Why?
9. How does changing temperature affect enzyme activity? What happens at colder temperatures?
10. What is the optimal temperature for catalase?

### **Conclusions – Overall Experiment**

# SAMPLE RESULTS

	Time (min)	DO (mg/L)	Temperature (°C)
108	8.916667	11.8	28.0
109	9.000000	11.7	28.3
110	9.083333	11.8	28.6
111	9.166667	11.9	29.0
112	9.250000	12.0	29.3
113	9.333333	12.0	29.7
114	9.416667	12.1	30.1
115	9.500000	12.1	30.4
116	9.583333	12.1	30.8
117	9.666667	12.2	31.1
118	9.750000	12.1	31.5
119	9.833333	12.2	31.8
120	9.916667	12.2	32.1
121	10.000000	12.1	32.4
122	10.083333	12.1	32.7
123	10.166667	12.1	33.0
124	10.250000	12.1	33.3
125	10.333333	12.1	33.6
126	10.416667	12.1	33.8
127	10.500000	12.0	34.1
128	10.583333	12.0	34.3
129	10.666667	12.0	34.6
130	10.750000	12.0	34.8
131	10.833333	11.9	35.1
132	10.916667	11.9	35.3
133	11.000000	11.8	35.5
134	11.083333	11.8	35.7
135	11.166667	11.7	35.9







## 2 BIOLOGY AS A SCIENCE

### Activity 2. Tools and Techniques of the Biologist

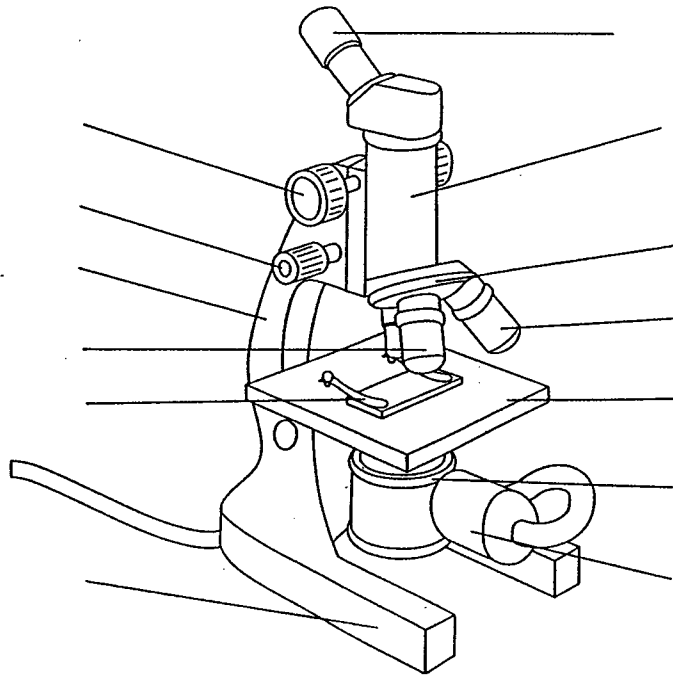
#### COMPOUND MICROSCOPE

A compound microscope has an optical system that contains two types of lenses. In addition to the optical system, it has a mechanical system and an illuminating system.

#### Parts of the Microscope

The three systems of the compound microscope include the following parts:

1. The optical parts are the lenses—the *eyepiece*, or *ocular*, and the *objectives*.
2. The mechanical parts hold the lenses and specimen to permit focusing of the microscope. The mechanical parts are the *coarse* and *fine adjustments*, *body tube*, *nosepiece*, *arm*, *stage*, *clips*, and *base*.
3. The illuminating parts include the *mirror* and the *diaphragm*. Some microscopes have a lamp instead of a mirror.



Give the function of each of the parts listed on the chart below.

PART	FUNCTION
Base	
Light Source	
Diaphragm	
Stage	
Stage Clips	
Low Power Objective	
High Power Objective	
Revolving Nosepiece	
Arm	
Fine Adjustment Knob	59
Coarse Adjustment Knob	
Eyepiece	

## magnification and resolution

**Magnification** is the enlargement of the image brought about by the lenses. The magnifying power of a microscope can be calculated by multiplying the magnifying power of the ocular by that of the objective. If the ocular is marked 10X and the objective 40X, total magnification is  $10 \times 40 = 400$ . This means that the distance between two points in the image is 400 times greater than it is in the actual object.

**Resolution** is the capacity to show as separate two points that are close together. If the resolving power of the microscope lenses is not good, the image, though enlarged, will be blurred. The fine details of structure will not show.

## Questions

1. What is meant by the magnifying power of a microscope? How is this calculated?
2. Fill in the blanks in the chart below.

EYEPIECE POWER	OBJECTIVE POWER	TOTAL MAGNIFICATION
10 X	10 X	
	40 X	200 X
10 X		1000 X
8 X	50 X	

3. What is the resolving power of a microscope?

## field diameter

The approximate size of the microscope field can be determined by actual measurement. This is done by placing a transparent millimeter ruler across the field and measuring the field diameter under low power. Once this information has been obtained, it is possible to estimate the size of specimens in the microscope field.

1 meter (m) = 10 decimeters (dm)
= 100 centimeters (cm)
= 1,000 millimeters (mm)
1 millimeter = 1,000 microns ( $\mu$ )
1 micron     = 10,000 Angstroms ( $\text{\AA}$ )

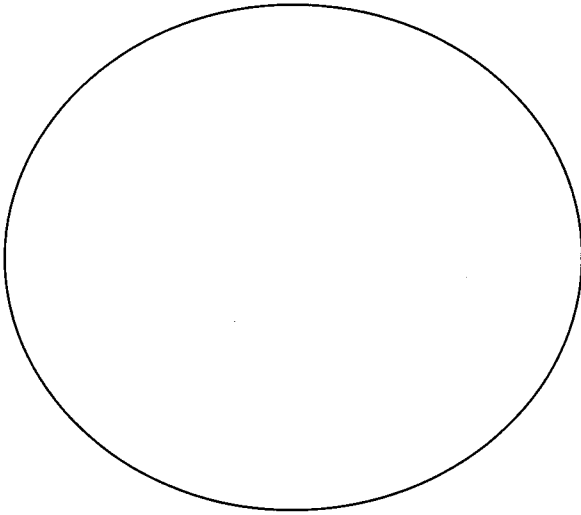
## Questions

1. How many microns are in 1 millimeter? \_\_\_\_\_
2. How many Angstroms are in 1 micron? \_\_\_\_\_
3. If the field diameter of a microscope is about 2 millimeters, an organism that fills half the field is \_\_\_\_\_ microns in length.
4. The field diameter under low power (100X) is 2 millimeters. Under high power (500X) the field diameter is \_\_\_\_\_ millimeters, or \_\_\_\_\_ microns.
5. Under medium power (200X) a student counts a total of 10 cells across the diameter of the field. Under low power (40X) \_\_\_\_\_ cells will appear across the diameter of the field. Under high power (1000X) \_\_\_\_\_ cells will appear across the diameter.

**Procedure:** Follow the procedures in your lab manual, pages 55 – 62.

**Data & Drawings**

A) **“e”**: Draw what you see in your field of view on **HIGH** power.



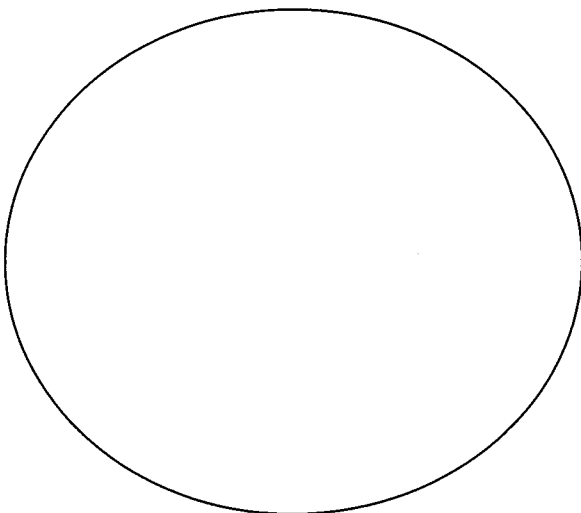
Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

**\*\* Be sure the “e” is facing you on the stage!!**

- 1) Judging from my letter “e”, I conclude that specimens viewed under a microscope appear \_\_\_\_\_ and \_\_\_\_\_.

B) **Onion**: Draw what you see in your field of view on **HIGH** power.



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

Describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

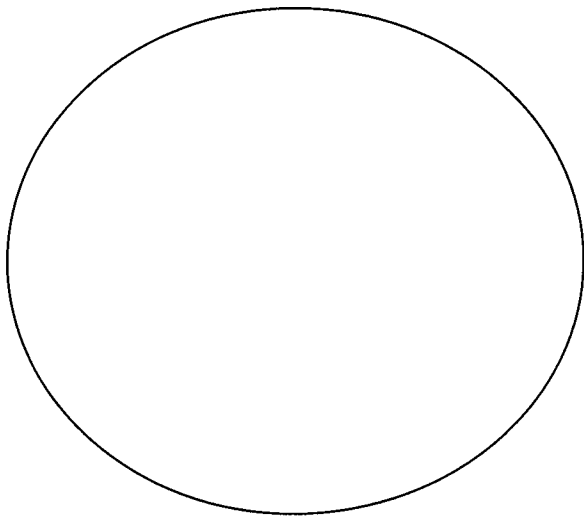
**Labels:** nucleus, cell wall & cytoplasm

Wet mount preparation

**Teacher Check** \_\_\_\_\_

1. Describe a) the shape of this cell **AND** b) the shape of the nucleus.
- 
2. Why was it necessary to use iodine when preparing these cells for viewing?
3. What characteristics did you observe that indicate this is a **plant** cell?

C) **Anacharis (Elodea):** Draw what you see in your field of view on **HIGH** power.



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

Describe: \_\_\_\_\_

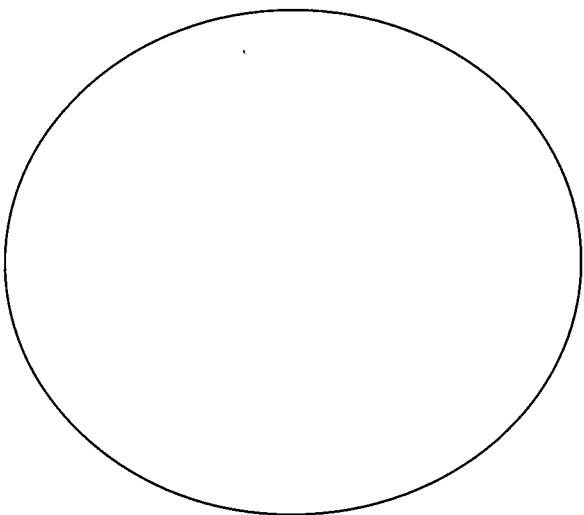
\_\_\_\_\_

\_\_\_\_\_

**Labels:** nucleus, cell wall, chloroplasts & cytoplasm

1. Where are the chloroplasts located in the cell? **WHY** would having chloroplasts here be beneficial?
2. Describe the shape and function of the chloroplasts. **WHY** are they green?
3. Describe any movement observed in the Elodea cell. What purpose does this movement serve?

D) **Human Epithelial Cell (cheek):** Draw what you see in your field of view on **HIGH** power.



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

Describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Labels:** nucleus, cell membrane & cytoplasm

Correct microscope clean-up **Teacher check** \_\_\_\_\_

### **Conclusions**

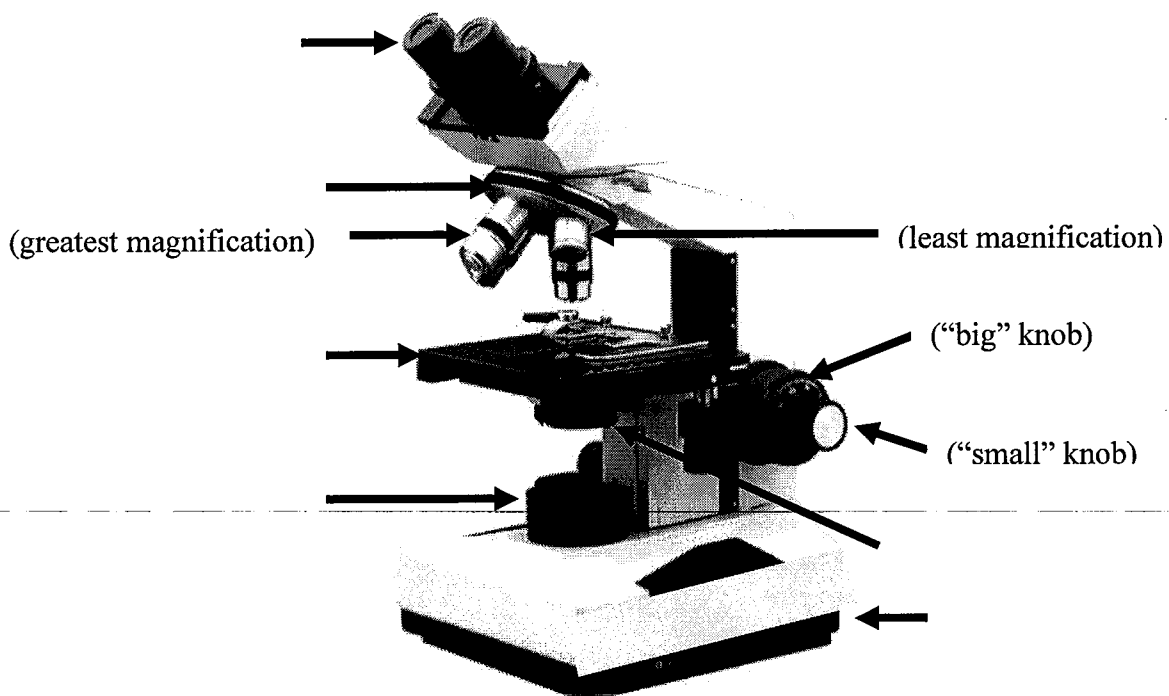
- 1) What similarities & differences (at **least** 2 of each) did you observe between the plant and animal cells?
- 2) Describe any problems you had when preparing a wet mount. What will you do differently next time?

- 1) Describe the correct procedure for preparing a wet mount slide **with stain**.

- 2) Complete the following table

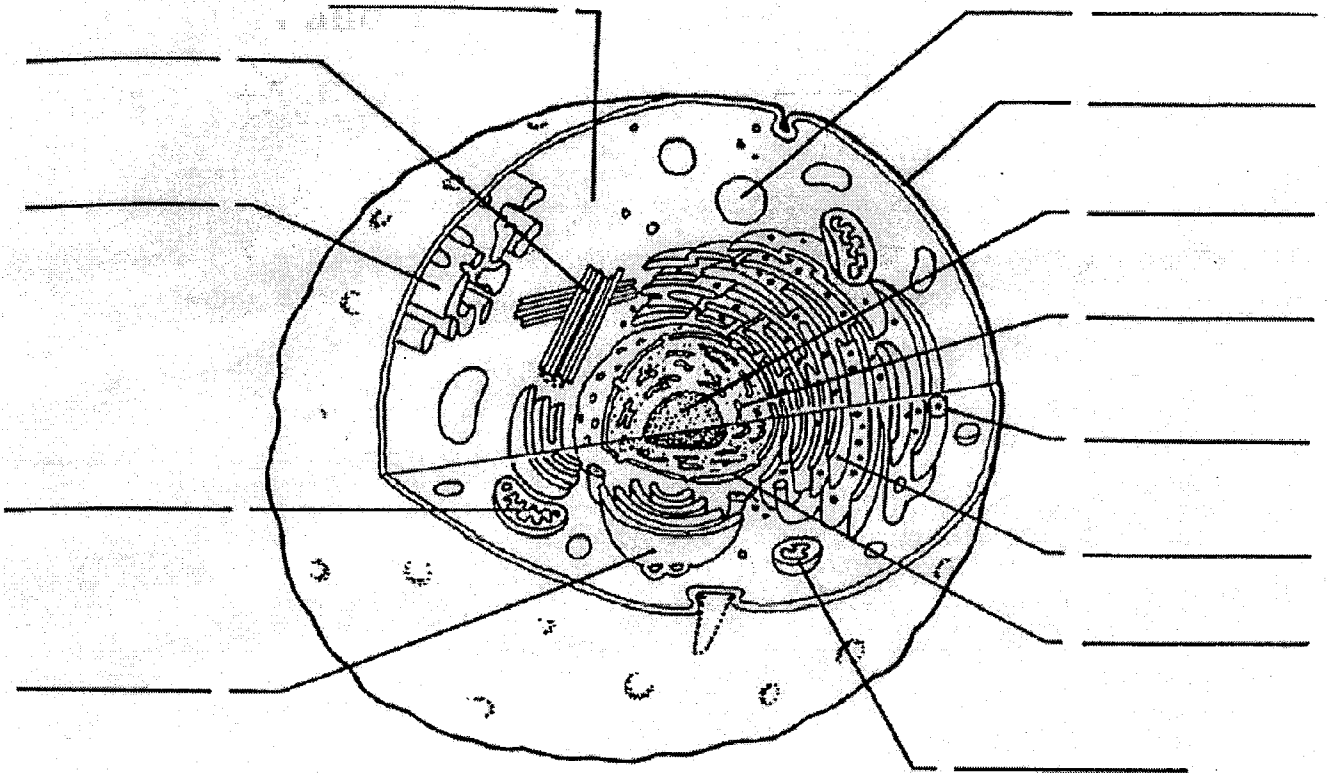
<u>Eyepiece</u>	<u>Objective</u>	<u>Total Magnification</u>
10 X	25 X	
	55 X	275 X
10 X		350 X
	30 X	450 X

- 3) **T or F** *ALWAYS* place objective lens to lowest power before putting the microscope away.
- 4) **T or F** To stain a wet mount, place the stain directly on the specimen, then put on cover slip.
- 5) **T or F** When on high power, it is OK to use the coarse adjustment knob.
- 6) Label the following

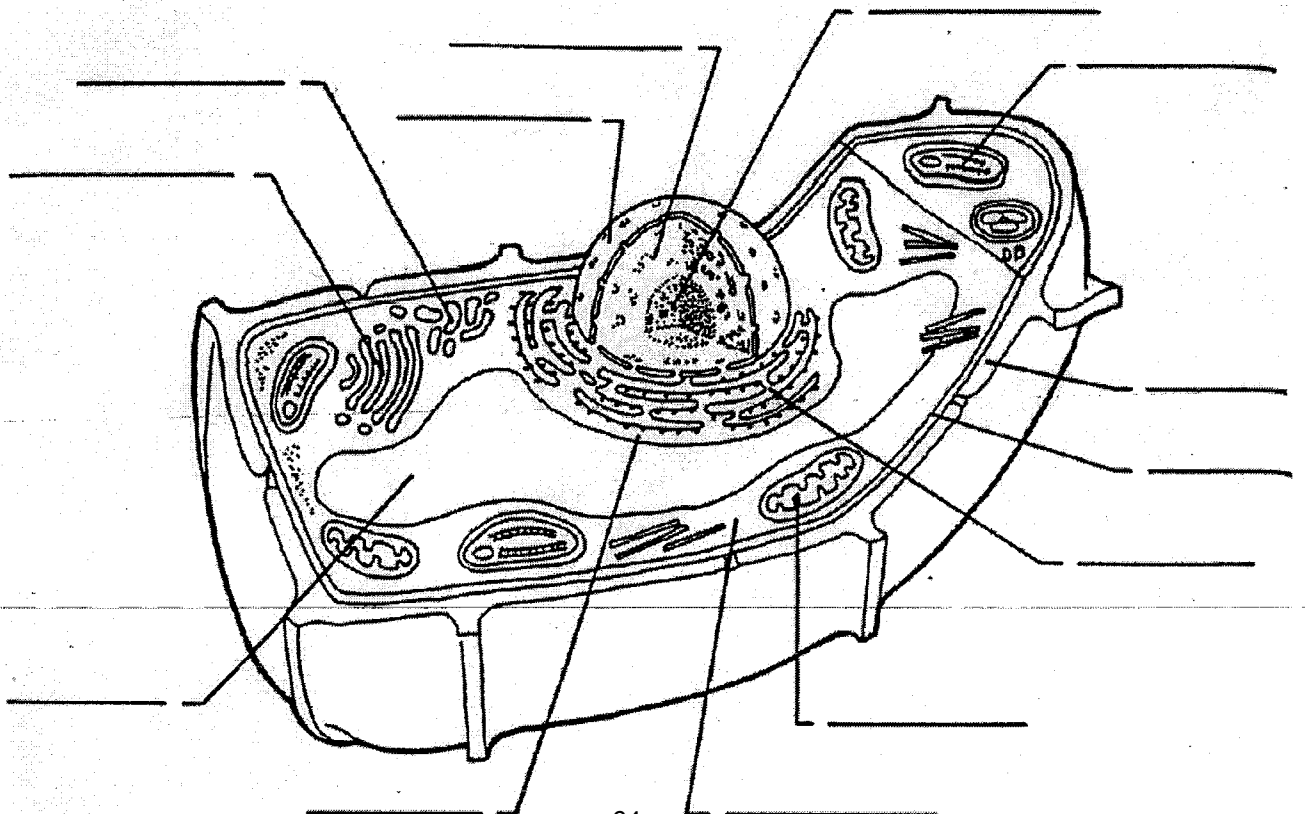


7) Label the following

a) This is a(n) \_\_\_\_\_ cell.



b) This is a(n) \_\_\_\_\_ cell.



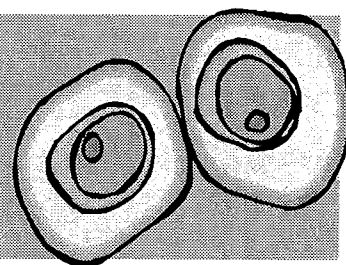
**Post Lab Questions:**

- 1. Describe the correct procedure for preparing a wet mount slide of onion cells (without air bubbles).**
  
- 2. A student places a small piece of text under the microscope and focuses on the letter "F". Draw how the letter "F" will appear through the microscope and on the stage.**
  
- 3. A student is observing some cheek cells under low power. When she turns to high power she notices that the field of view is \_\_\_\_\_ (darker or lighter?). Explain what the student should do to better see the cells. Be specific.**
  
- 4. Imagine on low power (40X), you see a total of 20 Elodea cells in the field of view. Predict how many cells will you be able to see when you switch to the high power objective (400X). Explain.**
  
- 5. Your lab partner is observing some cells under the microscope but he/she doesn't know whether the cells are animal or plant. Explain to him/her three differences between plant and animal cells that can be seen under the microscope.**
  
- 6. Discuss an advantage and a disadvantage of using stains (e.g. methylene blue, Lugol's iodine, etc...) to observe living cells when using the microscope.**





## 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.*



"Diffusion Through a Membrane" is a laboratory activity produced by the State Education Department for use in fulfilling part of the laboratory requirement for the Regents Examination in Living Environment. Reproducing any part of this laboratory activity by other than New York State school personnel is illegal.

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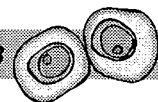
- dialysis tubing or plastic bags
- string or unwaxed dental floss
- Glucose Indicator Solution
- test tube rack
- concentrated glucose solution
- funnel
- tap water
- 7 test tubes
- starch solution
- paper towels
- droppers or pipettes
- safety goggles (1 pair per student)
- Starch Indicator Solution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

- 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.

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	<ul style="list-style-type: none"> <li>• place 10 drops of the substance to be tested in a clean test tube</li> <li>• add 10 drops of Starch Indicator Solution</li> <li>• carefully mix the contents of the tube</li> <li>• observe any color change</li> <li>• record results</li> </ul>
Glucose Indicator Solution	<ul style="list-style-type: none"> <li>• place 10 drops of the substance to be tested in a clean test tube</li> <li>• add 10 drops of Glucose Indicator Solution</li> <li>• heat in a hot water bath for 2 minutes</li> <li>• observe any color change</li> <li>• record results</li> </ul>

### 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.

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## 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.

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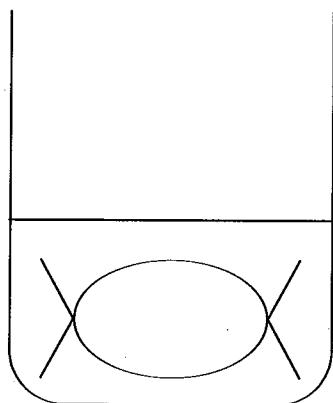


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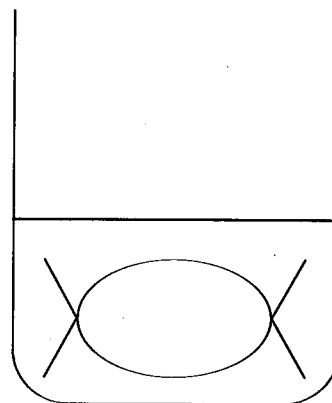


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- Use a pipette to transfer 10 drops of the solution in the beaker (outside the “cell”) to a clean test tube. Test it with Glucose Indicator Solution. Did a color change occur? \_\_\_\_\_ Is this test result positive or negative? \_\_\_\_\_
- Label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

- What is the best explanation for the color change that occurred inside the “cell”?

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- Did any starch diffuse out of the “cell”? \_\_\_\_\_ Explain how you can tell.

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- Did any glucose diffuse out of the “cell”? \_\_\_\_\_ Explain how you can tell.

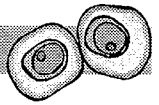
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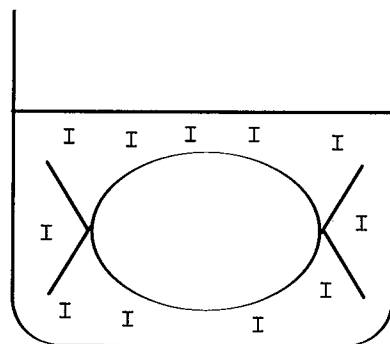
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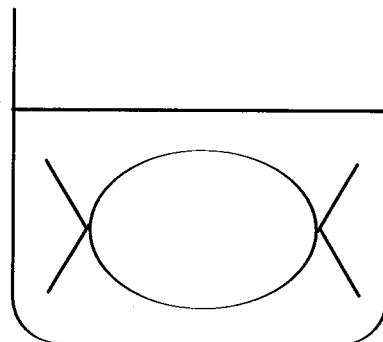
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4. Which substance(s) diffused through the membrane?  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
5. Which substance(s) did not diffuse through the membrane?  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
6. Explain why some substances were able to pass through 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

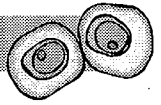


Final State

## 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

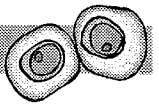
- red onion
- cover slips
- water
- dropper/pipette
- glass microscope slides
- distilled water
- colored pencils (red)
- salt solution
- if the salt solution is not provided:
  - triple-beam or electronic balance
  - 10 mL graduated cylinder
  - salt
  - beaker

## Safety

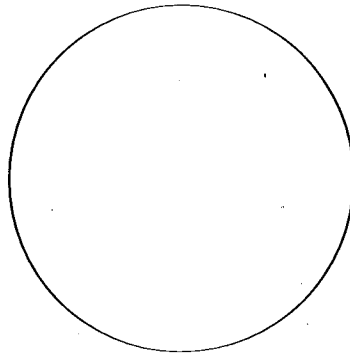
- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Handle slides and cover slips with care.

## Procedures

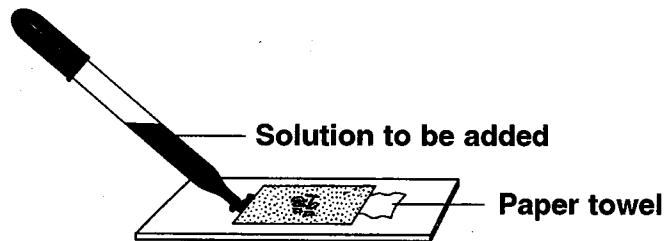
1. If the salt solution is not provided by your teacher, use a balance to measure 1 gram of salt. Measure 10 mL of distilled water with a graduated cylinder. Add both the salt and the water to a 250 mL beaker and mix. This will be your prepared salt solution.
2. Your teacher will provide a small, curved 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.

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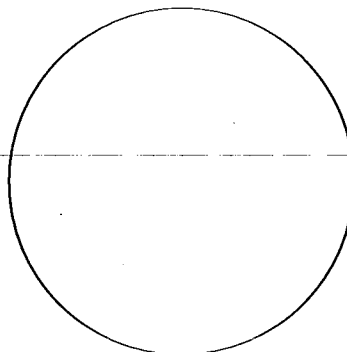


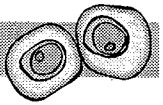
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9. Have your teacher check your slide with the microscope to be sure you are able to observe the effects of salt on cells.
10. Based on your observations, draw and color a typical red onion cell mounted in salt solution. Label the cell wall, cell membrane, and cytoplasm.





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

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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.

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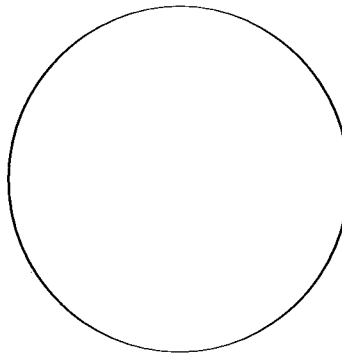
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14. Have your teacher check your slide with the microscope to be sure the effects of distilled water are visible.

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.

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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.

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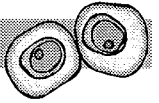


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3. When a person in the hospital is given fluid intravenously (an I.V.), the fluid is typically a saline (salt) solution with about the same water concentration as human body tissues. Explain how the use of distilled water in place of this saline solution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

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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).

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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.

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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.

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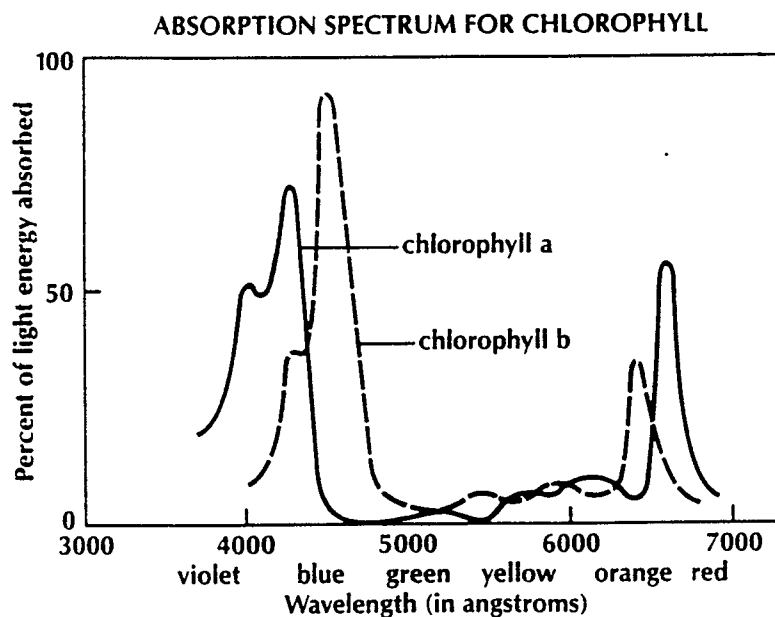
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## Reading Graphs

A pigment is a substance that absorbs light of particular wavelengths. For example, the green-yellow color of a leaf is due to a pigment in the leaf called chlorophyll. When white light (which contains all of the colors of the spectrum) shines on chlorophyll, the chlorophyll absorbs most of the red, orange, blue, and violet, and it reflects most of the green and yellow. That is why you see a green-yellow color. Think of a pigment as a sponge that soaks up all of the other colors of the spectrum except the one you see.

A spectrophotometer is an instrument that is used to measure the amount of light absorbed by a pigment. Below is a graph showing the percent of light energy reflected for the absorption spectrum for chlorophyll. The highest peaks represent colors that chlorophyll absorbs the most. Therefore, they are seen the least.



1-9. Refer to the preceding graph in arriving at your answers.

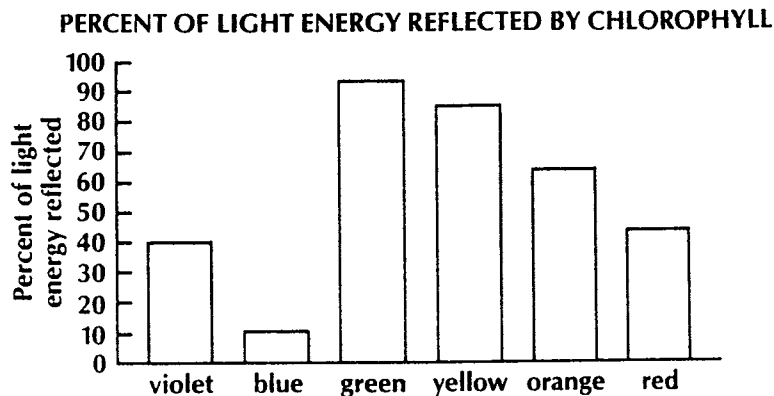
1. Which of the colors absorbed by chlorophyll is seen least? \_\_\_\_\_
2. What is its approximate wavelength? \_\_\_\_\_
3. What percent of light energy absorbed does this peak represent? \_\_\_\_\_
4. How much of this color is being reflected? \_\_\_\_\_
5. What percent of light energy absorbed by chlorophyll does the orange spectrum peak represent? \_\_\_\_\_
6. Why would you say there are no peaks in the range between 5000 angstroms and 6100 angstroms? \_\_\_\_\_

# 17 Reading Graphs (continued)

7. Are you able to see the light in the green-yellow part of the spectrum? Why? \_\_\_\_\_

8. Arrange the colors in the absorption spectrum of chlorophyll in order of their visibility. Put the most visible color first.

9–12. Below is a bar graph of the percentage of light energy reflected by chlorophyll. It was derived from the chlorophyll absorption spectrum. Refer to the graph in answering the questions.



9. Which color in this spectrum is most visible? \_\_\_\_\_

10. What is the approximate percentage of light energy reflected for this color? \_\_\_\_\_

11. What percent of light energy absorbed does this represent? \_\_\_\_\_

12. If everything above 50% of light energy reflected is visible to the human eye, is red light part of the mixture of colors seen in light reflected by chlorophyll? \_\_\_\_\_



## Introduction

The colors in leaves are caused by **pigments**, proteins that reflect and absorb light of particular frequencies. Frequencies of light that are *reflected* by the pigments cause the colors you see when you look at a leaf. Most of the year in our area (temperate deciduous forest), the leaf color you see is green or green-yellow, which is caused by a group of pigments known as **chlorophyll**. In the autumn, however, you are able to see other pigments, such as yellow and orange, known as the **carotenoids**, which are always there, but remain invisible until the autumn when the chlorophylls are broken down to prepare the tree for the long winter ahead. A further group of pigments, the **anthocyanins**, which create deep red and purple hues, are produced by chemical reactions that occur in a leaf in the autumn.

The frequencies of light not reflected by these plant pigments are *absorbed* by them. Therefore, when white light (containing all the colors of the visible spectrum) shines on a leaf, the green and green-yellow frequencies are reflected, while the frequencies of red, orange, blue and violet are absorbed. Think of a pigment as a sponge that soaks up all of the colors of visible light *except* the ones you see.

**Chromatography** is a method of analyzing the chemical makeup of a mixture, such as plant pigments, by separating the mixture into its component parts. There are several different types of chromatography, but they are all based on the fact that different compounds show differing solubilities in a solvent, a substance that materials can be dissolved into. In this exercise, you will use *paper* chromatography to separate the pigments contained in a green leaf. Pigments that are more easily dissolved in the solvent are carried farther up the chromatography paper, while those pigments more difficult to dissolve in the solvent “fall” out of the solvent earlier and are found closer to the bottom of the paper.

## Purpose

- Learn about chromatography and how it works
- Analyze a solution of plant pigments by paper chromatography

## Materials

- Leaf from a green plant
- solvent (TOXIC – don’t inhale)
- test tube with stopper
- chromatography paper
- flask
- penny
- scissors
- ruler
- pencil

## Procedure

1. Trim a strip of chromatography paper to fit test tube. Trim bottom end into a point.
2. Measure 3 cm from the pointed end of paper and make a small **pencil** dot.
3. Use a penny to crush the leaf onto the dot. Repeat this several times until a nice dark green dot appears.
4. Quickly, unstopper the test tube containing the solvent and carefully lower paper strip into test tube so that the pigment spot is **ABOVE** the liquid solvent. **The pigment spot should NEVER touch the solvent!!**
5. Restopper the test tube and place the test tube into the flask. **Do not disturb!!**
6. When the solvent has traveled up nearly to the top of the paper, remove the paper and restopper the test tube.
7. **Immediately** after removing the paper, measure how far the solvent traveled up the paper with a pencil.
8. Allow the solvent to evaporate and then measure how far *each* pigment traveled.

## Data

Distance Solvent Front Moved: \_\_\_\_\_ mm

Band Position	Distance Traveled (mm)	Band Color
Bottom		
Second		
Third		
Top		

**Figure 1** Plant Pigment Colors

<u>Plant Pigment</u>	<u>Color</u>
Carotene	yellow-orange
Chlorophyll a	yellow-green
Xanthophyll	yellow
Chlorophyll b	blue-green

## Analysis

1) Using Figure 1 above, label the plant pigments **in the correct order** on your strip.

2) Define chromatography...

3) Why do molecules of a mixture separate as they travel up the paper?

4) Why do leaves, which contain chlorophyll, look green?

5) Describe what happens in a leaf that allows it to turn color in the autumn.

6) What color(s) of visible light would be most useful to a plant during photosynthesis?

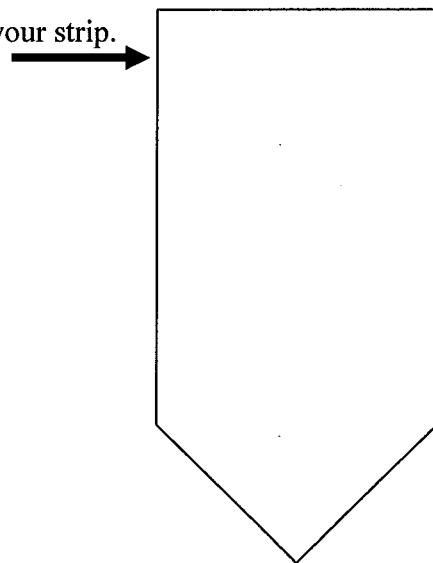
Why?

7) What color(s) of visible light would be least useful to a plant during photosynthesis?

Why?

8) Pigments, such as chlorophyll, allow photosynthesis to take place because they absorb light.

Please write the equation for photosynthesis here...



# Structure of a Leaf

# Lab 25

## Background

Leaves are the main photosynthetic organs of the plant. The flat part of the leaf is called the *blade*. In some plants the blade is attached directly to the stem; in others, the blade is attached to the main stem by a thin stalk, or *petiole*.

A leaf is composed of three types of tissue: epidermis, mesophyll, and vascular tissue. Leaves have an upper and lower *epidermis*, which protect the internal tissues. Covering the epidermis is a waxy *cuticle*, which helps to conserve water. Most of the photosynthesis of the plant takes place in the *mesophyll*. The *xylem* and *phloem* are found in vascular bundles in the veins of the leaf. They are continuous with the *xylem* and *phloem* of the stem and roots.

## Objectives

In this activity you will:

1. Study the tissues that make up the leaves of a plant.
2. Examine the structure of a stomate.

## Materials

prepared slide of lilac leaf (cross section)	beaker
lettuce leaf	pipette
scalpel	slide
forceps	cover slip
	microscope

## Procedures and Observations

### PART I. LEAF TISSUES

1. Observe a prepared slide of a lilac leaf cross section under low power. Focus first on the upper epidermis, then on the lower epidermis. Switch to high power and examine the epidermal cells.
  - a. Do the epidermal cells contain chloroplasts?

Throughout the lower epidermis are tiny openings called *stomates*. Each stomate is surrounded by a pair of *guard cells* that regulate its opening and closing. The stomates allow water vapor, carbon dioxide, and oxygen to pass into and out of the leaf.

2. Switch to low power. Observe the stomates and their guard cells. Note that each stomate opens into an air space.

Most photosynthesis in the leaf occurs in the mesophyll. The mesophyll is made up of two layers. The upper layer, the *palisade mesophyll*, consists of tall, closely packed cells. The lower layer, the *spongy mesophyll*, consists of irregularly shaped, loosely packed cells. The spongy mesophyll layer contains many air spaces.

3. Focus on the mesophyll under low, then high, power. Identify the palisade cells and the cells of the spongy mesophyll.

b. Describe the cell layers in the mesophyll.

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c. What are the most numerous organelles in the palisade cells?

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d. Compare the number of chloroplasts in the cells of the palisade mesophyll with the number in the cells of the spongy mesophyll.

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4. Note the numerous air spaces in the spongy mesophyll.

e. Are the air spaces connected to the outside atmosphere? How?

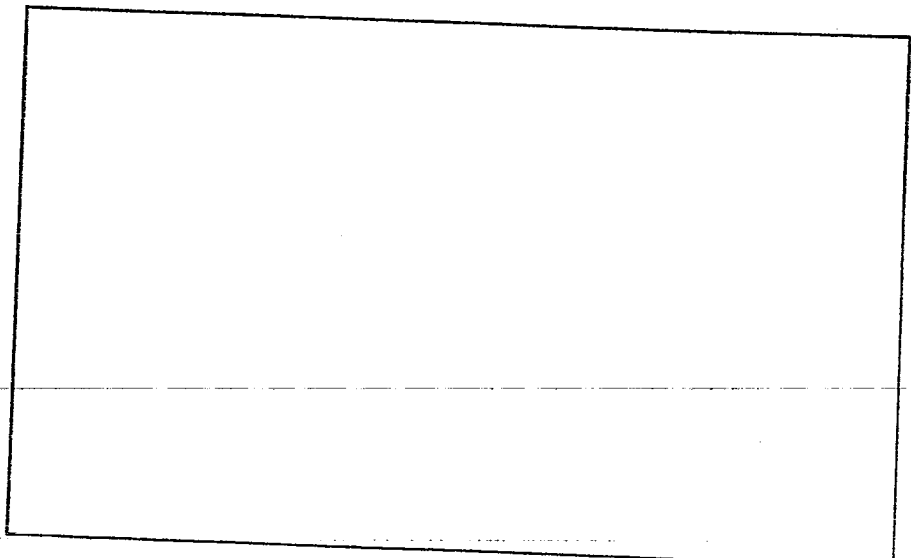
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5. Switch back to low power. Focus on a vascular bundle. Then switch to high power. Observe the xylem cells in the upper part and the phloem cells in the lower part of the bundle. Note that each bundle is surrounded by a layer of thick-walled cells that strengthen the vein.

6. Switch back to low power. Find a section where you can clearly see the epidermis, mesophyll, and vascular tissues of the leaf.

f. Make a drawing of the cross section of the leaf. Make it about 5 cm high. Label the cuticle, upper epidermis, palisade and spongy mesophyll layers, vascular bundle, and lower epidermis.





## PART II. STOMATES

1. Soak a lettuce leaf in a beaker of water for at least 5 minutes. The leaf will become stiff, or turgid.
2. Remove the leaf from the water when it has become turgid. Crack the leaf midrib as shown in Figure 1. With a forceps, peel off a piece of the lower epidermis.

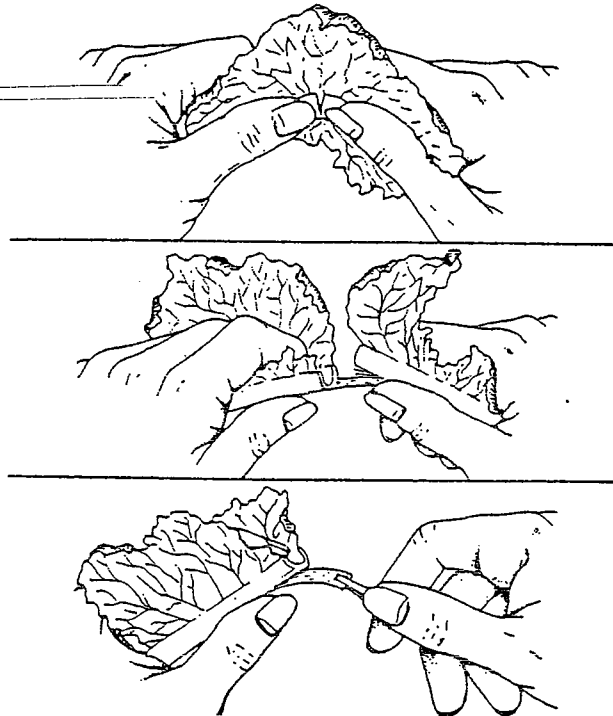


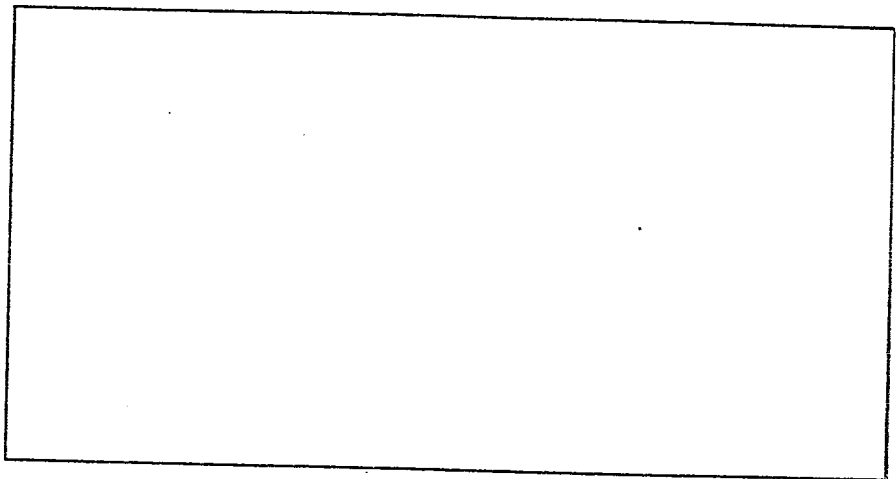
Figure 1

3. Place the epidermis sample on a clean microscope slide. Cut off a small section of it with a scalpel. **CAUTION: Handle the scalpel with care.** Place the section in the center of the slide and discard the rest of the epidermis. Add a drop of water and a cover slip.
4. Examine the slide under low power. Adjust the light to provide the best contrast.
  - a. Describe the shape and color of an epidermal cell.
5. Focus on a stomate and switch to high power. Observe the stomate and the guard cells surrounding it.
  - b. Describe the appearance of the stomate and the guard cells.

6. Switch back to low power. Count the number of stomates you see in the field of the low-power objective.
- c. *Record the number of stomates in the low-power field.*
- 

7. Estimate the number of stomates you see in a square millimeter of epidermis.
- d. *Record your estimate of the number of stomates/mm<sup>2</sup> of epidermis.*
- 

- e. *Make a drawing of a section of lower epidermis. Label an epidermal cell, guard cell, and stomate.*



### Analysis and Interpretations

1. How does the shape of a leaf help it to use sunlight efficiently?
- 

2. Explain the function of the cuticle.
- 
- 

3. In which layer of the mesophyll does more photosynthesis occur? How can you determine this?
- 
- 

4. What is the function of the air spaces in the spongy mesophyll?
- 

5. Name the leaf structures that help to conserve water.
-

## CHAPTER

## 18

## ENRICHMENT ACTIVITY

## Open-Ended Lab

## Determining the Number of Stomates on a Leaf

### Pre-Lab Discussion

Water containing dissolved minerals travels from the soil, through the roots and the stem, to the leaves of plants. The minerals are used by the leaves, but the water passes out of the leaves to the surrounding air so that the upward flow of water and dissolved minerals can continue.

While it is necessary for some water to pass out of the leaves to the surrounding air, this process must be controlled so that the leaves are able to retain the proper amount of moisture. To protect the plant from excessive loss of water, the surfaces of green leaves are covered with a clear, waxy layer of cells, called the cuticle, that is impermeable to the passage of water from the inner regions of the leaf (from the mesophyll).

The mineral-containing water that flows to the leaves from the roots passes out of the leaves through special, microscopic openings in the cuticle. These openings are called stomates. Carbon dioxide and oxygen, the gases that take part in photosynthesis, also pass through the stomates.

The size of the stomate opening is regulated by the two guard cells that surround the opening. In general, the guard cells, by changing shape, can produce the stomate opening when photosynthesis occurs. If conditions are not proper for this food-manufacturing process to occur, the guard cells, by changing shape again, close the opening, thus causing the stomates to disappear. The exact mechanism that regulates the guard cells is still not completely understood.

The leaves of plants show considerable variation in the amount of space between neighboring stomates. A measure of the amount of space between stomates is called the stomate density. Specifically, stomate density is the number of openings appearing in an area of a particular size, commonly expressed as the number of stomates present in a square centimeter of the leaf's surface. Stomate density seems to vary

from one species to another

from one leaf to another, depending upon the age of the leaves, even when the leaves come from the same plant or tree.

Scientists do not agree on what causes variations in stomate density. Some believe that the density is

genetically controlled, while others believe that it is controlled by environmental factors.

### Purpose

To determine the stomate densities of different kinds of leaves and to estimate the total number of stomates on each leaf.

### Materials and Equipment

Microscope with at least 400X magnification  
Micrometer scale for the eyepiece objective  
Forceps for removing the epidermal layer  
Metric ruler

Leaves, ideally a variety that includes leaves of different ages from the same species of plant, leaves of different species of plants, and leaves grown under different environmental conditions

### Safety

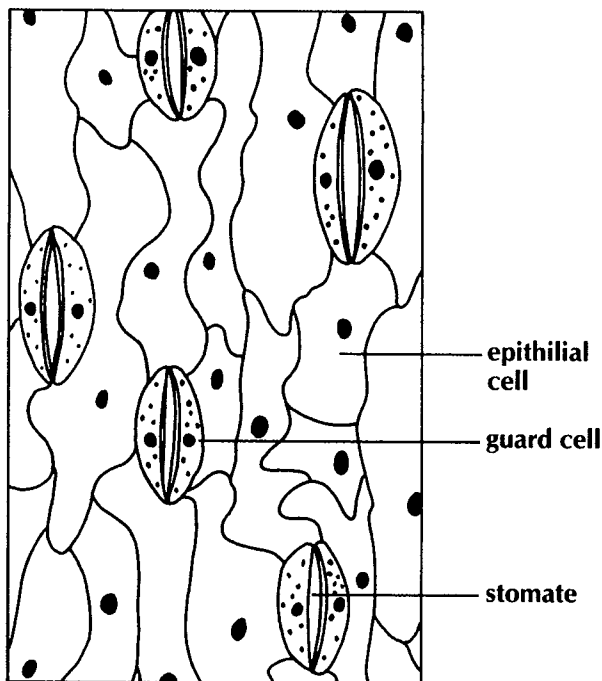
Observe good lab safety practices. Do not climb trees or otherwise run a risk of injuring yourself while collecting leaves.

### Procedure

1. Read the entire remainder of this lab before carrying out the next step of this procedure.
2. Prepare a written plan of action that describes the way you plan to proceed with the work. Get your teacher's approval of your plan before you begin any work.
3. Consider comparing the stomate density of:
  - leaves of different ages from the same plant or tree
  - leaves from different types of plants
  - leaves from plants grown in different types of soil and with different water supplies
  - leaves from the same tree that ordinarily receive different amounts of sunlight
4. Familiarize yourself with the appearance of the cells making up the outer covering of leaves by looking at the illustration on the next page.

# 18 Determining the Number of Stomates on a Leaf (continued)

## THE CELLS ON THE SURFACE OF A LEAF



5. Select one leaf to start with. Determine the stomate density of that leaf.
6. From the result you got in Step 5, estimate the number of stomates on the entire leaf.
7. Repeat Steps 5 and 6 for one or more additional leaves, as time permits.
8. Compare your results with those of other lab teams. What is the relationship, if any, between stomate density and particular characteristics of the plants the leaves came from?

### Preliminary Questions

As part of your plan of action, answer the following questions:

- (A) What is the diameter of the high-power field of your microscope? If you do not know the diameter, assume that its diameter is 0.450 millimeter, which is the diameter for many commonly used microscopes.
- (B) What is the area of the view through the high-power field of your microscope?
- (C) To determine the total number of stomates on the leaf, you will need to know the area of the leaf. How do you plan to get this information?

### Hints

1. When you collect your leaves, be sure to label each leaf as to its characteristics (from which tree it came, whether it came from a part of the tree receiving a lot or a little sunlight, etc.).
2. Before you can count stomates, you will have to remove a small portion of the lower epidermis (underside of the leaf). This can be done by holding the leaf bottom-side-up, and tearing it so that a small portion of the lower epidermis can be removed with a pair of forceps.
3. Before attempting to view the small portion of the epidermis referred to in the preceding hint, transfer it to a clean slide, and then add a drop of water and a cover slide.

### Lab Report

Your lab report should contain 6 parts. (1) A description of the procedures you followed (which must follow the plan that was approved by your teacher before you began the lab work). (2) A table containing the raw data you collected. (3) Calculations that show clearly how you obtained the stomate densities and the total number of stomates on each leaf. (4) A table comparing differences in stomate densities. (5) A statement or statements that summarize the results of your investigation. (6) Answers to the following questions.

### End-of-Lab Questions

1. What do you believe were the three biggest sources of error in your investigation?
2. Why were some of the stomates closed even though it was daylight when you got the leaves?
3. If it is important for the plant to conserve water, why do the stomates open and allow water to escape to the air?
4. If you were to repeat or extend this investigation, what changes would you make in light of what you learned during this experiment?
5. Is there a relationship between stomate density and the characteristics of the plants from which the leaves came?

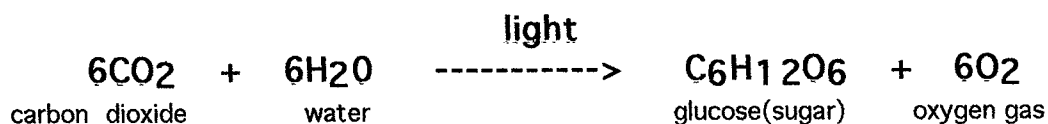
## THE CARBON DIOXIDE CYCLE

### PHOTOSYNTHESIS AND RESPIRATION IN ELODEA

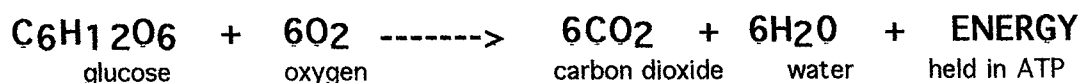
#### Introduction

It hardly seems possible that a giant redwood tree could be produced from a seed only a few millimeters in diameter, yet over a century tons of living material are produced due to this tiny seed. To form a massive living thing, such as a redwood tree, must require tremendous amounts of energy, but what is the source of this energy? The ultimate source is the sun. The sun's energy is stored for all life through a process known as photosynthesis and that energy is then released to drive all functions of life in the process known as respiration.

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 as molecules of the sugar, glucose. The process of photosynthesis can be represented by the chemical equation:



During respiration, plants are releasing the stored energy from glucose. This energy is held by a compound called ATP until its needed to run metabolic processes. The energy from ATP is used by cells to gain nutrients, move materials around within the organism, grow (create new cells) and reproduce, among other things. The process of respiration is represented by the following chemical equation:



Remember that plants respire all the time, just as animals do! Plants are referred to as producers because they have the ability to "produce" or make food from raw materials that alone cannot provide energy for life processes. The sugar glucose is built when the energy from sunlight is used to bond carbon, hydrogen and oxygen atoms taken from the compounds carbon dioxide and water.

Notice that in photosynthesis, CO<sub>2</sub> (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, CO<sub>2</sub> 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 waste products. (While CO<sub>2</sub> is being given off during respiration, it can be

reused during photosynthesis.) The planet earth is a closed system - all life depends upon continual recycling of materials.

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, bromthymol blue, as a means of determining the presence or absence of CO<sub>2</sub>.

### Purpose

- A. To demonstrate that CO<sub>2</sub> is consumed during photosynthesis by Elodea.
- B. To demonstrate that CO<sub>2</sub> is released during respiration by Elodea.
- C. To demonstrate what happens to the net amount of CO<sub>2</sub> produced by Elodea in the light.

### Supplies and Equipment

Elodea plants (vigorous green stems,  
4 " long, each with an end bud)  
Clean test tubes (4/group)  
Bromthymol blue solution  
Glass marking pencil  
Parafilm  
(airtight cover for tops of test tubes)

100 ml graduated cylinder  
250 ml beakers(2/group)  
Straws  
Aluminum foil  
Test tube rack  
Aerator/turkey baster  
Goggles

### Getting Started

Bromthymol blue changes color due to a change in pH. When CO<sub>2</sub> is dissolved in water, it forms carbonic acid. This lowers the pH of the solution and causes the bromthymol blue to change its appearance.

Complete the following and record your results:

1. What is the original color of bromthymol blue in the dropping bottle?

2. Pour 20 ml of bromthymol blue solution into a beaker. Bubble your breath through a soda straw into the bromthymol blue for 1 minute. CAUTION: Be careful not to swallow any bromthymol blue. It is toxic if swallowed.

WEAR GOGGLES

3. What color is the solution now? \_\_\_\_\_ Save one beaker of bromthymol blue for the class and record the color after 24 hours.

4. What was the color after 24 hours? \_\_\_\_\_ Why? \_\_\_\_\_

Note: When CO<sub>2</sub> is removed from solution, the solution turns back to its original color (blue). To prove this, label the 250 ml beaker into which you have just blown CO<sub>2</sub>. Set it aside for 24 hours with the top uncovered. The CO<sub>2</sub> will try to achieve equilibrium with atmospheric CO<sub>2</sub> this way. The air around us has relatively little CO<sub>2</sub> in it, so CO<sub>2</sub> molecules should leave the solution.

5. Now use a turkey baster or an aquarium pump to blow air through another 20 ml of bromthymol blue (also for one minute). Color= \_\_\_\_\_ Use this information later to determine the presence or absence of CO<sub>2</sub>.

Procedure: *Work in Groups of 2 , 3 or 4 as assigned by your teacher.*

1. Label the test tubes # 1-4 with the glass marking pencil.
2. Take 130 ml of bromthymol blue solution; add about 65 ml into each of two beakers.
3. Use a straw to bubble CO<sub>2</sub> into one of the beakers until a bright yellow color results. CAUTION: Bubble slowly so as not to spatter and stop if you become dizzy.
4. Using both solutions and the other materials you will set up test tube to demonstrate the recycling of CO<sub>2</sub> through respiration and photosynthesis in Elodea.

#### **GUIDELINES**

- A. The bromthymol blue will not interfere with respiration or photosynthesis in Elodea.
- B. You will leave your test tubes in the light or wrapped in foil (dark) until the next day.
- C. Be certain that you fill the test tubes completely to the brims with the solutions.
- D. You must stopper each test tube to make it airtight.

hint: place 2 test tubes in light, 2 test tubes in the dark and 2 test tubes should contain Elodea.

**Test Tube #1** Prepare a test tube to demonstrate that Elodea uses CO<sub>2</sub> in the light. *Complete the data chart and write a hypothesis.*

Hypothesis for test tube #1: \_\_\_\_\_

-----  
**Test Tube #2** Prepare a test tube to demonstrate that the light does not reduce the amount of CO<sub>2</sub> in the solution.  
*Complete the data chart and write a hypothesis.*

Hypothesis for test tube #2: \_\_\_\_\_

-----  
**Test Tube #3** Prepare a test tube to demonstrate that Elodea releases CO<sub>2</sub> during respiration. *Complete the data chart, write a hypothesis.*

Hypothesis for test tube #3: \_\_\_\_\_

-----  
**Test Tube #4** Prepare a test tube to demonstrate that the amount of CO<sub>2</sub> in water does not increase at night in the absence of biological processes. *Complete the data chart and write a hypothesis.*

Hypothesis for test tube #4: \_\_\_\_\_

-----





Directions: Please complete the following questions using your notes or other reputable sources. Bring this **completed** sheet to lab with you or you will not be allowed to do the lab!

**Photosynthesis:**

a. Photosynthesis is \_\_\_\_\_  
\_\_\_\_\_.

b. Write the equation for photosynthesis:



c. CO<sub>2</sub> is **used** / **given off** during photosynthesis. (circle one)

d. Consider the following reaction: CO<sub>2</sub> + H<sub>2</sub>O  $\longrightarrow$  H<sub>2</sub>CO<sub>3</sub> (carbonic acid)

If CO<sub>2</sub> is taken away from this reaction, more / less carbonic acid will be present. (circle one)

**Aerobic Respiration:**

a. Cellular respiration is \_\_\_\_\_  
\_\_\_\_\_.

b. Write the equation for aerobic respiration:



c. CO<sub>2</sub> is **used** / **given off** during respiration. (circle one)

d. Consider the following reaction: CO<sub>2</sub> + H<sub>2</sub>O  $\longrightarrow$  H<sub>2</sub>CO<sub>3</sub> (carbonic acid)

If CO<sub>2</sub> is added to this reaction, more / less carbonic acid will be present. (circle one)

**pH Review:**

a. Acidic pH values include numbers \_\_\_\_\_.

b. Basic pH values include numbers \_\_\_\_\_.

c. Neutral pH values include the number \_\_\_\_\_.

d. A pH indicator is \_\_\_\_\_  
\_\_\_\_\_.

# Photosynthesis & Respiration Lab Report

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

## Purpose:

\*

\*

\*

## Safety:

\*

\*

## Materials:

## Procedure:

Part I ("Getting Started"): Briefly *summarize* what you will do in this part of the lab below:

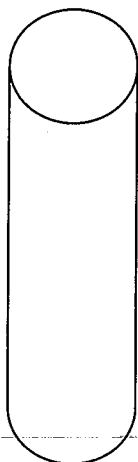
1.

2.

3.

Part II Prepare a CONTROLLED experiment to demonstrate CO<sub>2</sub> is used during photosynthesis.

Describe your set up below using **words** and **colors**

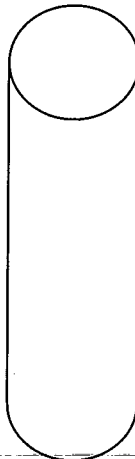


Contents:

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Contents:

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Test Tube #1 (experimental)

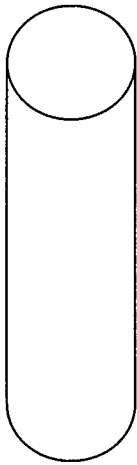
Test Tube #2 (control)

**Hypothesis:** In a water environment where photosynthesis is occurring, the pH will become more \_\_\_\_\_

The indicator should turn from \_\_\_\_\_ 92 \_\_\_\_\_ to \_\_\_\_\_

**Part III** Prepare a CONTROLLED experiment to demonstrate that CO<sub>2</sub> is released during respiration.

Describe your set up below using **words** and **colors**



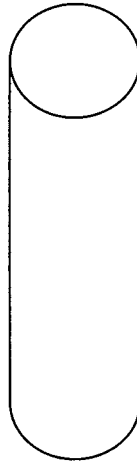
Contents:

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Test Tube #3 (experimental)



Contents:

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Test Tube #4 (control)

**Hypothesis:** In a water environment where respiration is occurring, the pH will become more \_\_\_\_\_  
The indicator should turn from \_\_\_\_\_ to \_\_\_\_\_

**Data**

**Part I Data:**

Beaker #1: Starting color: \_\_\_\_\_ Color after exhaling into beaker: \_\_\_\_\_

Beaker #2: Starting color: \_\_\_\_\_ Color after blowing air into beaker: \_\_\_\_\_

Beaker #3: Starting color: \_\_\_\_\_ Color after 24 hours: \_\_\_\_\_

Bromthymol blue is \_\_\_\_\_ in an ACIDIC pH and \_\_\_\_\_ in a BASIC pH.

**Parts II & III Data:**

<u>Test Tube No.</u>	<u>Elodea Present?</u>	<u>Foil Present?</u>	<u>Starting Indicator Color</u>	<u>Final Indicator Color</u>
#1				
#2				
#3				
#4				

## Analysis

**TRUE or FALSE:** Plants carry out BOTH photosynthesis AND cellular respiration. (Hint: don't pick false!)

1. a) Write the chemical equation for photosynthesis below:

\_\_\_\_\_

b) Is energy released or stored during photosynthesis? \_\_\_\_\_

c) Which gas is used during photosynthesis? \_\_\_\_\_

c) Which gas is released during photosynthesis? \_\_\_\_\_

d) In which test tube was photosynthesis occurring most? \_\_\_\_\_

e) How can you tell? \_\_\_\_\_

2. a) Write the chemical equation for aerobic cellular respiration below:

\_\_\_\_\_

b) Is energy released or stored during respiration? \_\_\_\_\_

c) Which gas is used during respiration? \_\_\_\_\_

c) Which gas is released during respiration? \_\_\_\_\_

d) In which test tube was respiration occurring most? \_\_\_\_\_

e) How can you tell? \_\_\_\_\_

## Conclusion

3. a) Describe how plants "recycle" some of the oxygen they make during photosynthesis.

\_\_\_\_\_

b) Describe how plants "recycle" some of the carbon dioxide they make during respiration.

\_\_\_\_\_

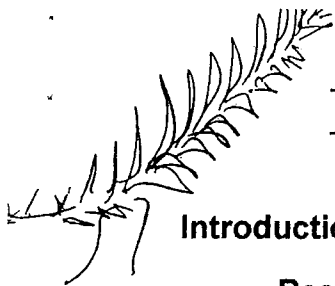
4. a) Which test tubes served as controls during this experiment? \_\_\_\_\_

b) Why is a control necessary? \_\_\_\_\_

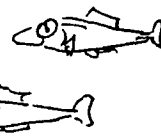
5. Revisit your hypotheses here: will you accept or reject? Based on what *specific* evidence?

Photosynthesis: I \_\_\_\_\_ my hypothesis because \_\_\_\_\_

Respiration: I \_\_\_\_\_ my hypothesis because \_\_\_\_\_



# Respiration and Photosynthesis Lab



## Introduction:

**Respiration** and **photosynthesis** are the main processes of **cellular energetics**. All living organisms engage in some form of aerobic or anaerobic respiration in order to obtain energy. Some organisms can synthesize energy-containing organic molecules using light (photosynthesis) or other chemical compounds (chemosynthesis). Many organisms must consume energy-containing molecules ("food") in order to obtain energy.

Respiration and photosynthesis also affect the **environment** outside of the cell. Aerobic respiration, in particular, produces **carbon dioxide** gas – rapidly converted to **carbonic acid** when dissolved in water. Photosynthesis utilizes these carbon compounds. *In addition*, aerobic respiration uses oxygen, whereas photosynthesis produces oxygen.

## Purpose:

1. Examine the production and utilization of oxygen and carbon dioxide in a closed system.
2. Develop an understanding of the changes in **oxygen, carbon dioxide, and pH levels** that occur on a daily basis in streams and lakes.
3. Analyze **dissolved oxygen (DO) levels** and **pH**.
4. Graph and interpret **DO and pH data**.

## Hypothesis:

When will DO levels be highest? Why?

When will pH values be highest or lowest? Why?

## Materials:

Fish (minnows or goldfish)  
Aquarium water  
Stirrer plate  
DO probe  
Laptop computer  
Light

Plants (*Elodea* or other)  
Jar with lid  
Magnetic stirrer bar  
pH probe  
Go!Links  
Misc. (glassware, nets, etc.)

## Procedure:

### Set Up Jar for Respiration Experiment:

1. Fill jar to overflowing with aquarium water. Add six fish and a stirrer bar. (Don't worry about spilling water – you want to avoid having an airspace.)
2. Each jar needs a DO and pH probe. One of each has been inserted into jar lid by your teacher. (Probe tips are **fragile**. Please keep immersed in water, and do not touch or poke probe tips.)
3. Remove jar lid with probes from storage beaker containing clean tap water.
4. Carefully place lid on jar and tighten finger-tight.
5. Place jar on stirrer plate, and turn stirrer ON at lowest setting.
6. Clean up any spilled water.

### Set Up Probes & Computer:

1. Connect probes to Go!Links, and connect Go!Links to laptops (two Go!Links per laptop).

2. **Very Important:** You need to collaborate with your pod-mates. **Both** DO probes must be connected via Go!Links to one laptop, and **both** pH probes must be connected via Go!Links to the other laptop. Please check to verify that probes are properly connected!
3. Turn on laptops and start LoggerPro. The software will recognize the probes and will automatically load calibration information for any probe that is connected.
4. Using the pull-down menu in LoggerPro, open **Experiment**, then **Data Collection**. Set the experiment to run for **30 minutes**, sampling once each minute.

### Respiration Experiment:

1. When you and your pod-mates are ready, start your experiments at the same time by simultaneously clicking on the green Collect button on the menu. Click on the Autoscale button to view the data as values are plotted on the LoggerPro graph.
2. **Note:** Stop experiment and release fish if DO drops below 3.0 mg/l.
3. **After 30 minutes** LoggerPro will stop data collection.
4. Save your LoggerPro file.
5. Copy the LoggerPro data table and paste it into an Excel spreadsheet.
6. Save your Excel file to the shared Living Environment Lab Data class folder for your class: "**S:**" drive → Student Community folder → Class Folders → Living Environ Lab Data Period \_\_\_\_.
7. **Save** the oxygen-depleted water, but return the fish back to the aquarium. (Scoop them out – **don't** dump or pour out your water.)

### Photosynthesis Experiment:

1. Repeat experiment, substituting a handful of aquatic plants for the fish, re-using the same water and experimental set-up. Place a light near the stirrer plate.
2. Save all files as you did for the fish experiment.
3. Clean up as necessary, and proceed to Data Analysis.
4. Rinse jars and lids. Set jars on paper towels on counter to drip dry. Leave probes in jar lid, and place back into beaker of clean tap water for temporary storage.

### Results:

- Graph the results for your jar. You will need to share data with your pod-mates. Two of you have the DO data for both jars, and the other two of you have the pH data.
- Label and title your graphs carefully.
- Print your data table and graphs.

### Analysis:

1. Do your results indicate photosynthesis and/or respiration? Explain briefly for each of your experiments. (Hint: compare **starting** and **ending** conditions.)
2. This experiment was conducted as a "closed" system. Would your results have been different if you had left the jars uncapped or if the jars had a large airspace? Explain briefly.
3. Did you have a "balanced" jar that would sustain its inhabitants in terms of DO levels and pH? (Note: Most fish die at DO < 2 mg/l. Also, most fish and plants need pH between 6.5 and 8.0.)

4. Compare your results with those of another group. Are your results similar, or do they show different patterns? What might account for similarities or differences among results?
5. Make a *sketch* graph showing the daily cycle of DO, carbon dioxide, and pH. Place time (hours) on x-axis; DO, Carbon dioxide & pH on y-axis. Label "day" and "night" portions of the graph.
6. During the summer, many lakes become "stratified" or layered, with warm and less-dense water floating above colder, denser water. Why is it common for oxygen to be abundant near the surface but nearly depleted near the bottom of lakes in the summer?

### Conclusion:

- Evaluate the parts of your hypothesis. Were your expectations accurate? Any sense for where *and* why you made accurate or inaccurate predictions?
- Summarize the main points of the lab!

### Self-Reflection:

Evaluate your performance and provide feedback to your teacher. What did you think of the lab? Please share anything that you feel is important that has not already been discussed.

### Extension Activity:

Set up an experiment to try to construct a balanced ecosystem in your jar, where DO consumption (respiration) is balanced by DO production (photosynthesis). Run for 30 minutes.

### Teacher Information:

Set up pH probes:

1. Take pH probe out of storage solution. (Save pH storage solution.)
2. Push pH probe through grommet in jar lid.
3. Place jar lid so pH probe is in a beaker of clean tap water.

Set up DO probes:

1. Unscrew end piece (with fragile membrane) from end of DO probe.
2. Push partially disassembled DO probe through grommet in jar lid. (**Careful** – exposed end of DO probe is also fragile.)
3. Put 1 ml of "DO probe filling solution" in end piece, and screw back onto DO probe. (Excess filling solution will leak out. End piece should be finger-tight.)
4. Place jar lid so ends of pH and DO probes are submerged in clean tap water.

Fish:

1. Each jar needs six medium-large goldfish (or equivalent biomass).
2. Remind students to stop experiment and release fish if DO levels drop below 3.0 mg/l.

Plants: Each jar needs a handful of aquatic plants. Stirrer bar needs room to spin.

S: drive folders: These must be set up ahead of time.





GOLD  
^

# Fish Respiration and Water Temperature

# Lab 51

## Background

Cold-blooded animals do not maintain a constant body temperature. Instead, the body temperature varies with the temperature of the environment. In these animals, the metabolic rate, which is also affected by temperature, can vary over a wide range.

The fish is a cold-blooded animal in which the exchange of respiratory gases occurs as water flows across the gills. The rate of respiration can be measured indirectly by observing how often the *operculum*, or gill cover, opens and closes. Changes in environmental temperature can affect the rate of respiration in fish.

## Objectives

In this activity you will observe the effect of temperature on the respiration rate of a goldfish.

## Materials

500-mL and 1-L beakers  
aquarium water  
thermometer  
goldfish  
fish net

crushed ice  
stirring rod  
water  
hot plate

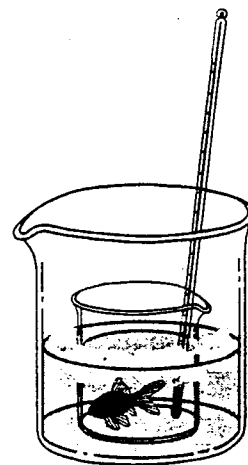
## Materials

Minnows or other hardy fish can be substituted for goldfish. "Feeder goldfish" are available at aquarium stores and are inexpensive.

## Procedures and Observations



1. Fill a 500-mL beaker about three-fourths full with aquarium water at room temperature. Using a thermometer, measure the water temperature.
  - a. Record the temperature of the water in the data table.
2. With a fish net, remove a goldfish from the aquarium and place the goldfish in the beaker. **CAUTION:** Be careful handling the fish throughout this lab activity to avoid injuring it. Observe the behavior of the fish while it gets used to its new environment.
  - a. Record your observations in your data table.
3. Count the number of times the fish opens its operculum in 15 seconds. Do this three times.
  - a. Record the respiration rate—operculum openings per 15 seconds—for each trial in the spaces below.  
Trial 1: \_\_\_\_\_  
Trial 2: \_\_\_\_\_  
Trial 3: \_\_\_\_\_
  - d. Find the average respiration rate from the three trials and record it in your data table.



4. Fill a 1-L beaker about one-third full with cold tap water and crushed ice. Use a glass stirring rod to gently stir the ice and water. Remove the stirring rod and place the beaker with the fish in the ice bath. Gently stir the water in the smaller beaker, being careful not to disturb the goldfish. Use the thermometer to check the water temperature in the beaker holding the goldfish. Observe the behavior of the fish while the water temperature drops. As soon as the temperature has dropped at least  $10^{\circ}\text{C}$ , remove the beaker from the ice bath.

e. In your data table, record the water temperature at which you removed the fish from the ice bath.

5. Count the number of times the fish opens its operculum in 15 seconds. Do this three times.

f. Record the respiration rate per 15 seconds for each trial in the spaces below.

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

g. Find the average respiration rate from the three trials and record it in your data table.

h. How does this respiration rate differ from that at room temperature?

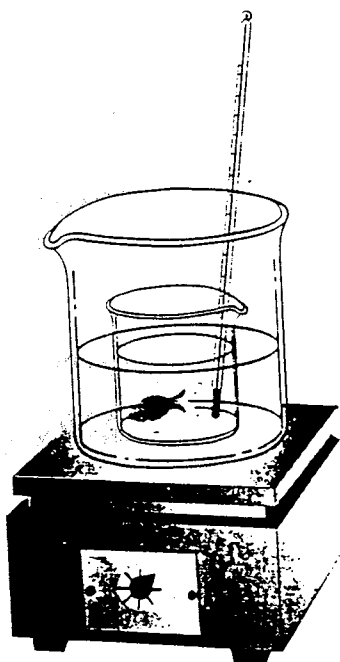
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6. Fill a 1-L beaker about one-third full with hot tap water. Heat the water on a hot plate. Stir the water with the glass stirring rod. Place the thermometer in the small beaker holding the fish, then place the small beaker in the hot-water bath. Use the glass stirring rod to carefully stir the water in the small beaker. Observe the behavior of the fish while the water temperature rises  $10^{\circ}\text{C}$  above the temperature of the water in the aquarium. **CAUTION:** Do not allow the water temperature in the beaker holding the fish to rise above  $35^{\circ}\text{C}$ , or the fish may die. Continue to record your observations in your data table. As soon as the temperature has risen sufficiently, remove the small beaker from the hot-water bath.

7. Count the number of times the fish opens its operculum in 15 seconds. Do this three times.

i. Record the respiration rate per 15 seconds for each trial in the spaces below.

Trial 1: \_\_\_\_\_

Trial 2: \_\_\_\_\_

Trial 3: \_\_\_\_\_

j. Find the average respiration rate from the three trials and record it in your data table.

k. How does this respiration rate differ from that at room temperature?

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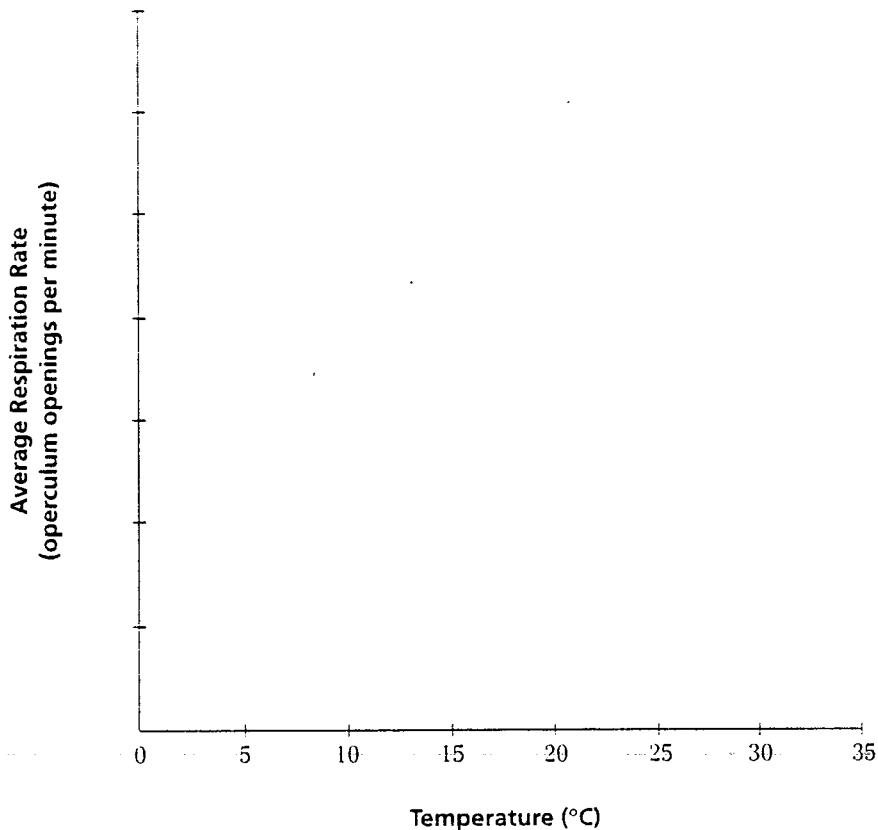
35°C  
is  
MAX!  
(FISH WILL  
DIE)

**Fish Respiration and Water Temperature****51**

8. Record your observations as you watch the respiration rate of the fish return to normal. Allow the temperature of the water to drop to room temperature gradually. Check the temperature of the water in the small beaker; when it returns to the temperature of the water in the aquarium, return the goldfish to the aquarium.
9. Graph your data in the space provided, showing how respiration rate changed with temperature. The x-axis of the graph shows the temperature in °C. Using the average respiration rate for 15 seconds, calculate the average respiration rate per minute. Add the appropriate numbers to the y-axis and plot your data.

**Data Table**

Temperature of Water (°C)	Average Resp./15 sec	Average Resp./min	Observations
At room temperature			
In ice bath			
In hot-water bath			

**Respiration and Temperature**

## Analysis and Interpretations

1. How did the respiration rate change as the temperature changed?

For

2. At what temperature did the fish need the most food and oxygen?  
How can you tell?

3. At what temperature was the fish's metabolic rate highest? Explain.

4. What do you think happens to the activity of fish in cold climates  
during the winter months? Explain.

Base your answers to questions 5 through 9 on the information and data table below and on your knowledge of biology.

**For Teacher  
Use Only**

The rate of respiration of a freshwater sunfish was determined at different temperatures. The rate of respiration was determined by counting the number of times the gill covers of the fish opened and closed during 1-minute intervals at the various temperatures. The following data were collected.

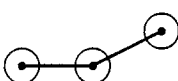
**Data Table**

Temperature (°C)	Gill Cover Opening and Closing Per Minute
10	15
15	25
18	30
20	38
23	60
25	57
27	25

5- 7

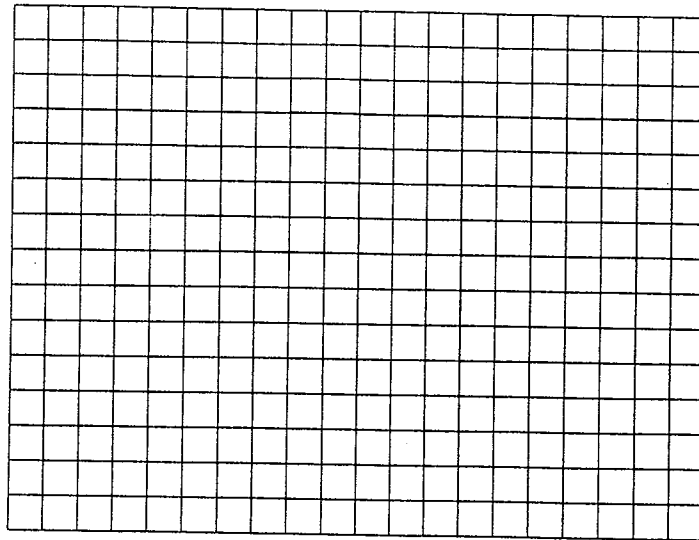
*Directions* (5-7): Using the information in the data table, construct a line graph on the grid provided on the next page, following the directions below.

5. Label the  $x$ -axis and indicate the units. [1]
6. Mark an appropriate scale on each axis. [1]
7. Plot the data from the data table. Surround each point with a small circle and connect the points. [1]

Example: 

(CUT & PASTE GRAPH  
INTO YOUR LAB NOTEBOOK)

Number of Times Gill Covers  
Opened and Closed per Minute



5. ☐

6. ☐

7. ☐

8. According to the data, as the temperature increases, the rate of respiration of the sunfish

- (1) increases steadily
- (2) decreases steadily
- (3) increases, then decreases
- (4) decreases, then increases

8. ☐

9. Which title is appropriate for this graph?

- (1) The Effect of Temperature on Rate of Respiration in Sunfish
- (2) The Effect of Gill Movement on Rate of Respiration in Sunfish
- (3) The Relationship Between Temperature and Dissolved Oxygen
- (4) The Relationship Between Sunfish Population and Temperature Change in Freshwater Habitats

9. ☐

★ REMEMBER - CONCLUSION &  
SELF-REFLECTION!

## MITOSIS

**INTRODUCTION:** Before cells divide, the chromosomes replicate; and the two identical sets of chromosomes are separated in the process of mitosis. Each set of chromosomes becomes part of the nucleus of a new daughter cell. Your task is to observe and draw each of the stages of mitosis as seen in stained onion root tip cells. Only the tips of the roots actually grow; therefore, it is only in the cells of the root tip that we can see the process of mitosis. To observe mitosis in animal cells, biologists will often look at whitefish blastula. These are cells from the embryo of a fish. Embryonic cells are also dividing rapidly by mitosis.

### PROCEDURE:

#### Part I.

1. Carefully, using scissors, cut out the pictures of cells on the following page.
2. Separate the cells into two piles: animal vs. plant cells.
3. Sequence the animal cells to illustrate the steps of mitosis in order. Repeat this for the plant cells.
4. Using tape or glue stick, attach both groups of cells to your lab paper in sequence.  
Note: tape/glue the animal and plant cells in the same phase together for comparison.
5. Label each stage of mitosis and write a brief description of the important events of each stage.

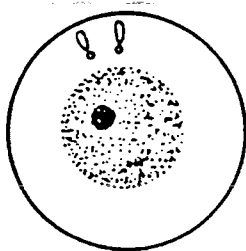
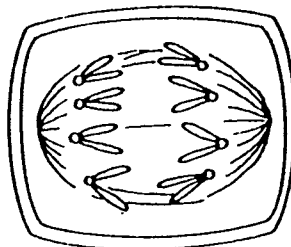
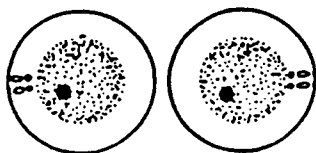
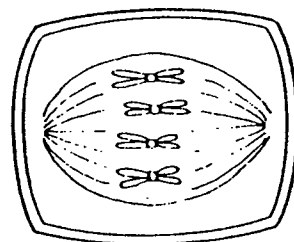
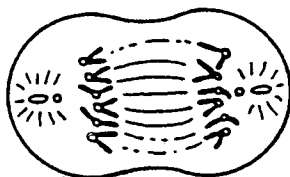
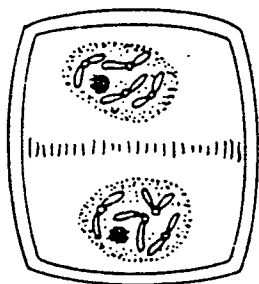
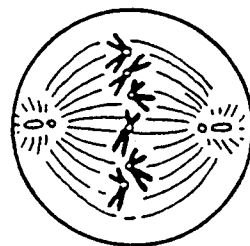
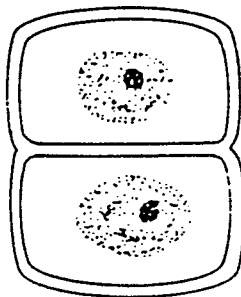
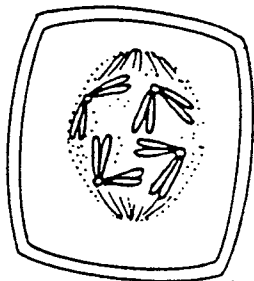
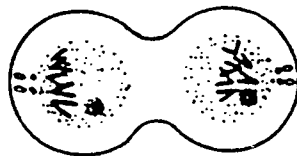
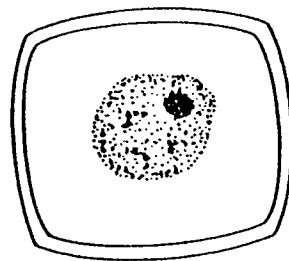
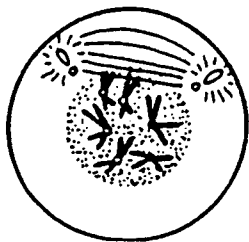
#### Part II.

1. Obtain a slide of stained onion root tip (*Allium*). Observe the cells under low, then medium power. Look for cells in which you can see chromosomes (as opposed to a nucleus).
2. Switch to high power (400X) and find a field of view that has many dividing cells.
3. In the cell cycle flow chart provided with your lab, sketch one cell in each of the phases of mitosis (PMAT). Label the following parts: chromosomes, spindle fibers, cell wall, cell plate.
4. Count the number of cells in interphase (with nuclei) and in each stage of mitosis (PMAT) and record this in the chart provided in this lab.
5. Calculate the percentage of cells in interphase and in each stage of mitosis (PMAT).

	Interphase	Prophase	Metaphase	Anaphase	telophase	total
No. of Cells						
% of Cells						











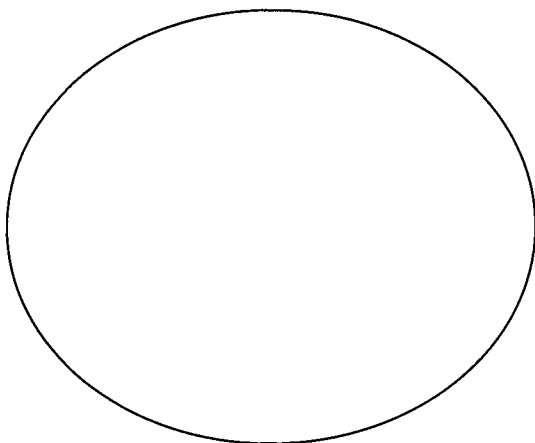
## Questions

- 1) How many chromosomes were present in your starting (parent) cell? \_\_\_\_\_ Each daughter cell? \_\_\_\_\_
- 2) Describe the size of your daughter cells to the size of your parent cell.  
\_\_\_\_\_
- 3) Why must a cell's DNA be replicated before mitosis occurs?  
\_\_\_\_\_
- 4) In what phase does the cell spend most of its time? \_\_\_\_\_
- 5) Why are chromosomes unwound (uncoiled) during interphase?  
\_\_\_\_\_
- 6) What is the name given to chromosomes that are of similar shape, size and genetic information?  
\_\_\_\_\_
- 7) Are the cells represented in this activity haploid or diploid? HAPLOID / DIPLOID.  
EXPLAIN: \_\_\_\_\_  
\_\_\_\_\_
- 8) Mitosis results in two SIMILAR / DIFFERENT / IDENTICAL cells. (circle one)
- 9) Each new cell made during mitosis is known as a \_\_\_\_\_ cell.
- 10) Give 2 reasons why a cell might undergo mitosis (divide).  
\*  
\*

**Mitosis Drawings - Onion**

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

1. Interphase: **Label** nucleus & chromatin (DNA)



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

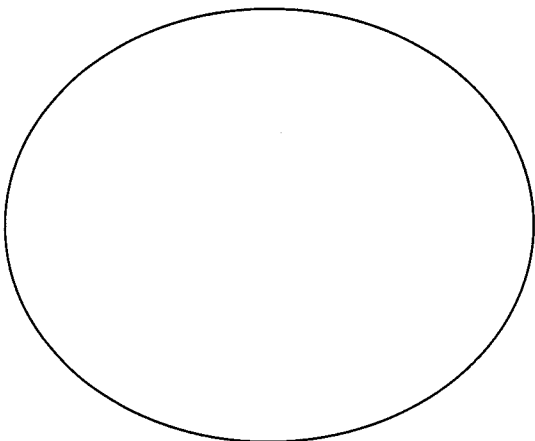
Describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2. Prophase: **Label** chromosomes and spindle fibers



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

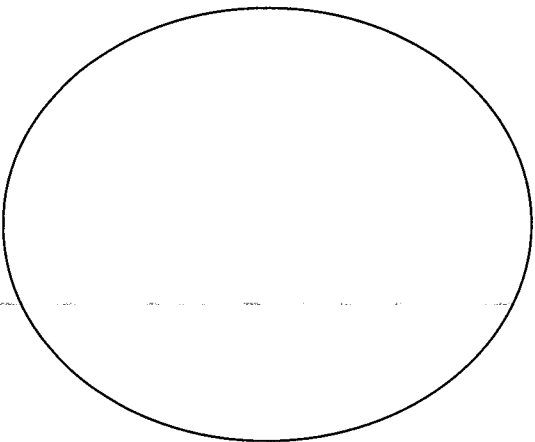
Describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3. Metaphase: **Label** chromosomes and spindle fibers



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

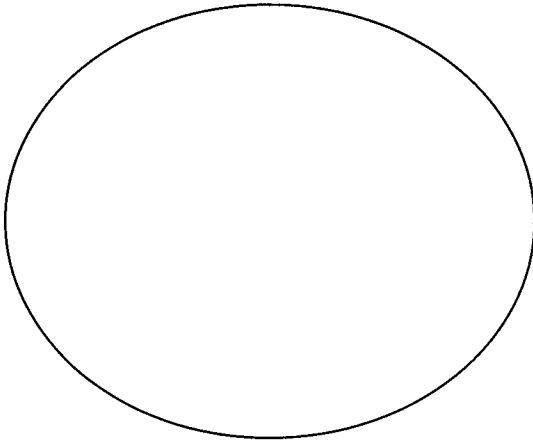
Describe: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. Anaphase: **Label** chromosomes and spindle fibers



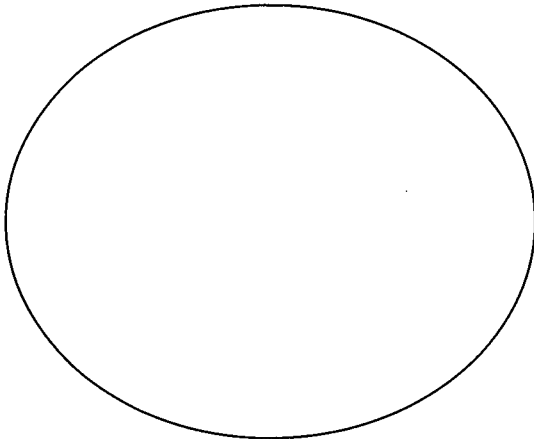
Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

Describe: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. Telophase & Cytokinesis: **Label** nucleus, chromosomes/chromatin



Title: \_\_\_\_\_

Magnification: \_\_\_\_\_

Describe: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

1. Mitosis results in two DIFFERENT / SIMILAR / IDENTICAL cells. (circle one)
2. During which stage does the new nuclear form? \_\_\_\_\_
3. In which stage(s) are individual chromosomes uncoiled as DNA? \_\_\_\_\_
4. During which stage are chromosomes attached to spindle fibers? \_\_\_\_\_
5. During which stage does DNA replication occur? \_\_\_\_\_
6. Which structures are lacking in these *plant* cells that would be present if this was your cell?  
(HINT: what kingdom do you belong to??) \_\_\_\_\_  
\_\_\_\_\_
7. During what stage do sister chromatids move to away the “poles” of the cell? \_\_\_\_\_

## Mitosis in Onion Root Tip

The diagram below represents an artist's drawing of a X-section of onion root tip. The cells were interrupted at various stages of mitotic cell division.

1. Select a numbered cell from the diagram below that shows each stage:

\_\_\_\_\_ INTERPHASE

\_\_\_\_\_ ANAPHASE

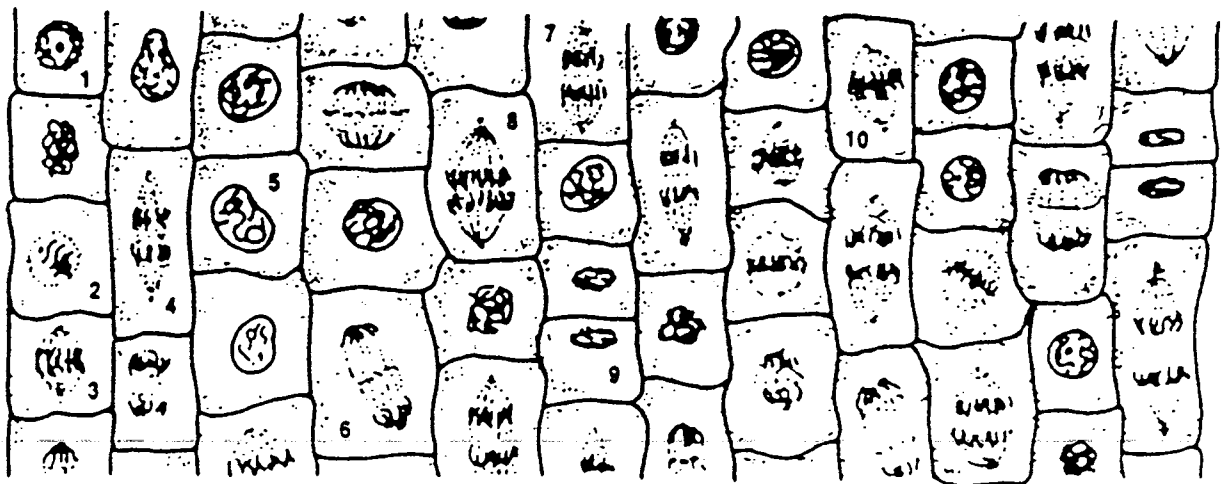
\_\_\_\_\_ PROPHASE

\_\_\_\_\_ TELOPHASE

\_\_\_\_\_ METAPHASE

\_\_\_\_\_ CYTOKINESIS

2. During which stage does the new nuclear envelop (membrane) form? \_\_\_\_\_
3. During which stage does the cell plate begin to form? \_\_\_\_\_
5. What is the probable composition of the spindle fibers? \_\_\_\_\_
6. In which stage(s) are individual chromosomes invisible but exist in the "uncoiled state" as chromatin material? \_\_\_\_\_
7. During which stages are the chromosomes visible as doubled attached by centromeres? \_\_\_\_\_
8. When does replication occur? \_\_\_\_\_
9. During which stage do chromosomes uncoil? \_\_\_\_\_
10. Which structure lacking in these cells will be visible in white fish cells? \_\_\_\_\_







PLEASE FOLLOW DIRECTIONS AND ANSWER QUESTIONS AS YOU GO. THESE SHEETS ARE YOUR REPORT.

1. What is the purpose of meiosis?

2. Where does meiosis take place in a human male? \_\_\_\_\_

in a human female? \_\_\_\_\_

. You will be simulating meiosis in a primary sex cell that has 4 chromosomes.

1. The first thing that happens in meiosis is that the chromosomes replicate and then become visible in the cell:

Using the available materials (paper and/or pieces of wool and string, tape) make 2 large CHROMOSOMES and 2 small chromosomes. Each chromosome should be made of two CHROMATIDS attached together near the middle (the CENTROMERE). Please draw your chromosomes here and label the parts on one of the chromosomes you have just drawn:

2. The next thing that happens is that TETRADS form: (Synapsis)

Place the two large chromosomes on top of each other; this is one TETRAD. Place the two small chromosomes on top of each other; this is another TETRAD. Please draw your TETRADS here.

3. The next thing that happens is called DISJUNCTION:

Separate the chromosomes in the large tetrad and move them to opposite sides of this paper; this separating process is called DISJUNCTION. Separate the chromosomes in the small tetrad and move them to opposite sides of this paper so each one is with a large chromosome. Please draw the chromosomes.

4. The cell then divides into two cells. This completes the first meiotic division.

How many chromosomes were in the original cell when you started this exercise? \_\_\_\_\_. This number is called the DIPLOID NUMBER.

5. The next thing that happens is that the chromatids separate.

Take each pile of chromosomes and pull the chromatids apart. Put a long chromatid and a short chromatid together. You should have 4 different groups of chromatids, each containing one long and one short chromatid. Please draw your 4 separate piles of chromatids here:

pile 1

pile 2

pile 3

pile 4

6. The cytoplasm divides and the result is 4 separate cells (called daughter cells). The chromatids are now called chromosomes.

How many chromosomes are in each of the final 4 cells? \_\_\_\_\_. Is this the monoploid number or the diploid number? \_\_\_\_\_.

Meiosis is also called REDUCTION DIVISION. In this kind of cell division, what is reduced in number?  
\_\_\_\_\_

7. In males, meiosis is called spermatogenesis, the birth of sperm. In males, each daughter cell becomes a sperm.

Draw 4 sperm cells below, and draw the two chromatids(chromosomes) in the head of each sperm:

8. In females, meiosis is called oogenesis, the birth of eggs, BUT in females only one daughter cell becomes an egg or OVUM, and this cell gets all the cytoplasm. The other three daughter cells get no cytoplasm and become tiny useless cells called POLAR BODIES.

Please draw one HUGE OVUM and three tiny polar bodies and draw the two chromatids(chromosomes) in each polar body and in the OVUM.

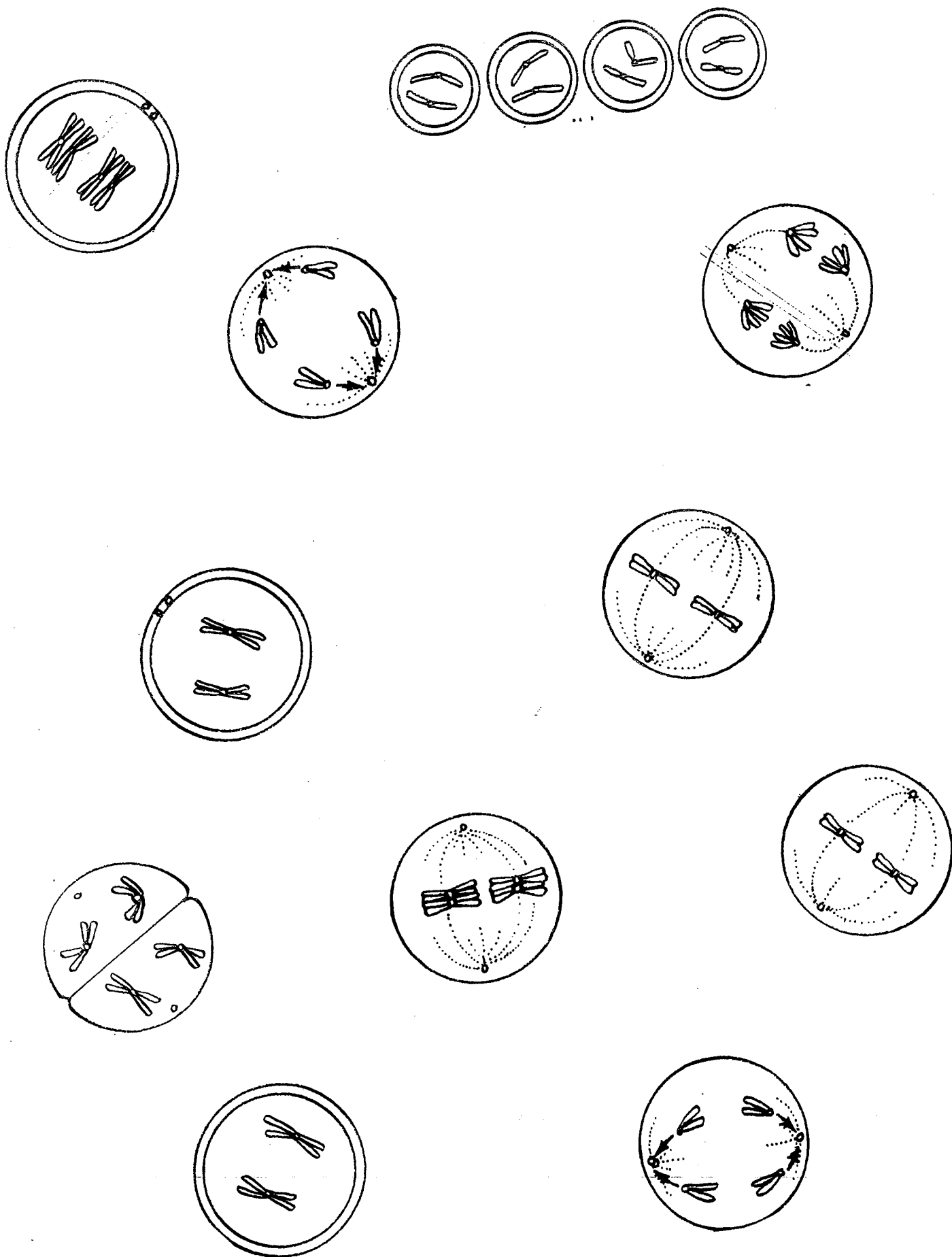
9. In what ways does spermatogenesis differ from oogenesis?

10. NONDISJUNCTION, A MISTAKE THAT CAN OCCUR DURING MEIOSIS:

Occasionally, at the tetrad stage (see page 1 if you have forgotten what that is), the 2 chromosomes that form the tetrad fail to separate and both chromosomes end up in the same daughter cell. This gives some sperm or ova too many chromosome and some too few. Please draw 4 sperm that might form as a result of NONDISJUNCTION in one tetrad and draw in the chromosomes (two sperm will have 3 chromosomes and two sperm will have only 1 chromosome each).

Nondisjunction is often a lethal condition.

11. SUMMARY: PLEASE SUMMARIZE WHAT HAPPENS DURING MEIOSIS, USING THE INFORMATION IN THIS EXERCISE:



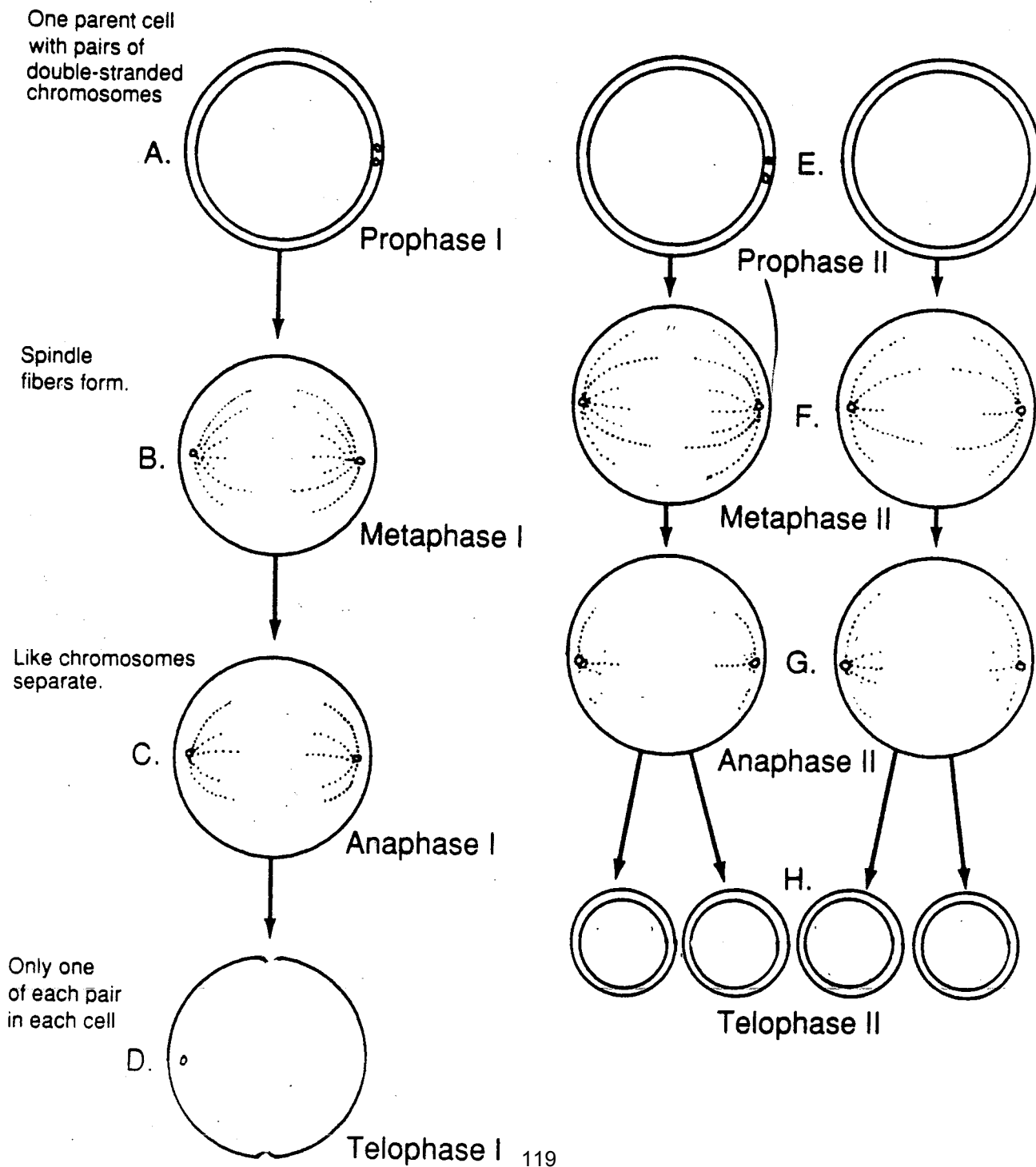


# TRANSPARENCY 6

## Cell Reproduction

Chapter 4

### MEIOSIS



## Questions

- 1) How many chromosomes were present in your starting cell? \_\_\_\_\_ Each gamete? \_\_\_\_\_
- 2) What happens during Prophase I that helps create greater genetic variation?  
\_\_\_\_\_
- 3) What would happen to a new organism if its parents' sex cells (sperm and egg) were made by mitosis instead of meiosis?  
\_\_\_\_\_
- 4) How do homologous chromosomes line up during Metaphase I, producing the essential difference between mitosis and meiosis?  
\_\_\_\_\_
- 6) If the "gametes" you made were created in a male animal, the gametes produced would be called \_\_\_\_\_.
- 7) If the "gametes" you made were created in a female animal, the gametes produced would be called \_\_\_\_\_.
- 8) Is the cell you started with at the beginning of the activity haploid or diploid? HAPLOID / DIPLOID.  
EXPLAIN: \_\_\_\_\_  
\_\_\_\_\_
- 9) Are the gametes you made haploid or diploid? HAPLOID / DIPLOID.  
EXPLAIN: \_\_\_\_\_  
\_\_\_\_\_
- 10) Why is meiosis called a reduction division?  
\_\_\_\_\_

## DNA Model Lab Analysis

Name \_\_\_\_\_  
date \_\_\_\_\_

### Part I. Sequencing

Number the statements below to sequence the steps of DNA replication (1 = first)

- \_\_\_ DNA polymerase inserts a complementary base onto the template strands
- \_\_\_ Ligase catalyzes the formation of a bond between two adjacent nucleotides
- \_\_\_ the double helix unwinds
- \_\_\_ the enzyme Helicase unzips the double stranded DNA
- \_\_\_ two identical strands of DNA are produced
- \_\_\_ base pairing of new nucleotides continues

### Part II. Fill in the Blank

complementary  
template

helicase  
nucleotide

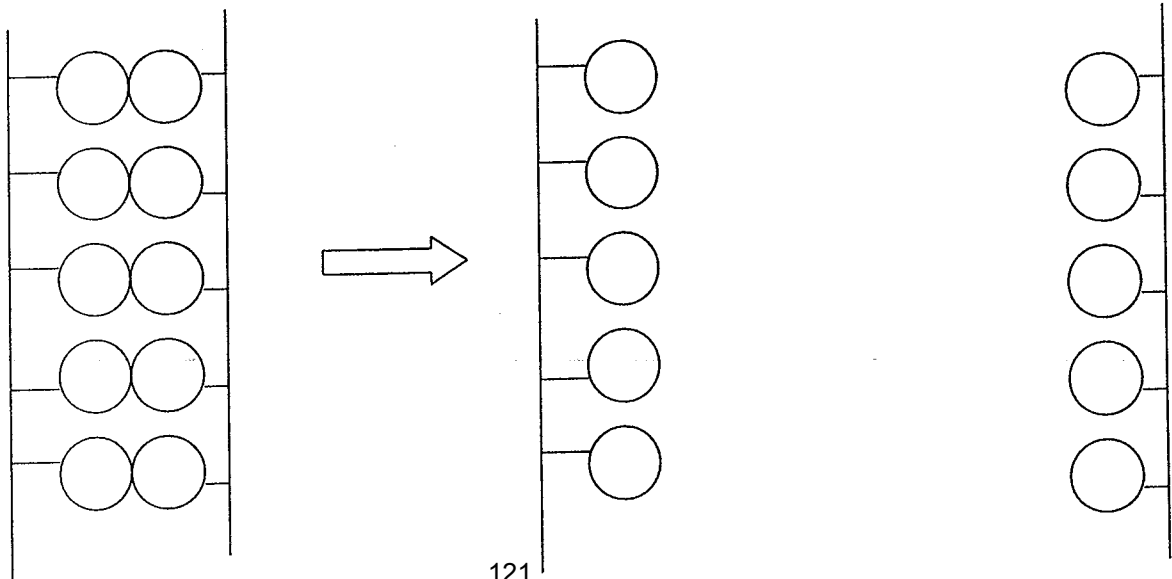
ligase  
weak

DNA polymerase  
strong

1. The enzyme that creates a new strand using the template strand is \_\_\_\_\_
2. The enzyme that separates the two strands of DNA is called \_\_\_\_\_
3. The enzyme that permanently bonds nucleotides into a new strand is called \_\_\_\_\_
4. The "old" strand of DNA is called the \_\_\_\_\_ because it determines the sequence of the "new" strand.
5. The "new" strand of DNA is said to be \_\_\_\_\_ because it "matches" the template strand.
6. Double stranded DNA can "unzip" because the forces of attraction between paired nucleotides (i.e. hydrogen bonds) are very \_\_\_\_\_ forces.
7. The bond between adjacent nucleotides of a single strand of DNA are not usually broken because they are very \_\_\_\_\_

### Part III. Illustrate

Draw a picture to show the process of replication using the DNA strand below:



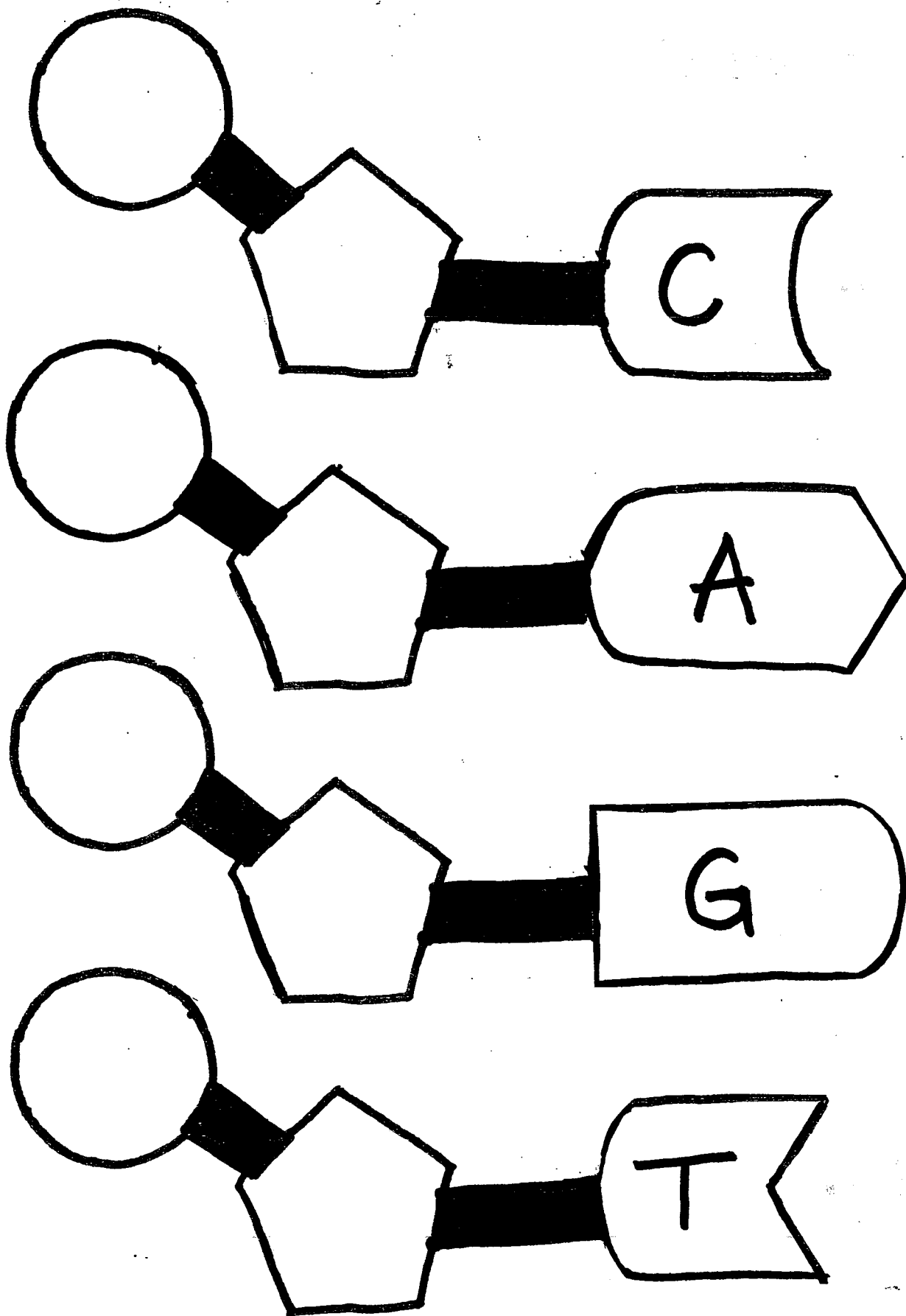
#### **Part IV. Synthesize and Communicate**

**In a well written paragraph, describe the process of DNA replication. Begin with a double strand of DNA and finish with two identical copies of that DNA. To be complete, you must use each of the steps in Part I:**

#### **Part V. Reinforcement**

- 1. The "new" strand of DNA created during DNA replication is really not a "copy" of the template strand. Explain.**
- 2. A common form of mutation occurs when the wrong base is inserted into a new DNA strand (e.g. the substitution of a C instead of a T). Why is it important to copy the DNA exactly without such errors?**
- 3. Describe the structure of DNA. Use the terms: nucleotide, double-stranded, base pairs, A,G,C,T, and double helix.**







Name: \_\_\_\_\_  
Regents Biology

## GENETICS "CREATE-A-CHILD" LAB

### Introduction:

Have you ever wondered why so much variation in appearance and other characteristics is present even when people are closely related? This phenomenon is present not only because of a large variety of traits exist in a human population, but also because people continue to create variation as they reproduce. Even relatives as close as brother and sister can vary widely in their appearance. Why siblings are different in both genotype and phenotype is the question we want to address. This activity should help you answer that question and stimulate other questions. You are going to be a parent! Congratulations!

### Words you should know:

This vocab list was your first night's homework in this project; it should be done before you begin. In order to understand the concepts explored in this activity, you need to know the meanings of each of these words. We will go over them as a class before you begin.

gamete	autosomes	genotype
sperm	sex chromosomes	phenotype
egg	genes	homozygous
zygote	alleles	heterozygous
homologous chromosomes	dominant	punnett square
meiosis	recessive	carrier

### Directions:

1. I will give you either an egg or a sperm. On the top there will be a number. This number will determine who your partner will be. Find the other class member who has the same number written on their gamete and sit with them.
2. On your gametes there are many letters (1 - 25). These letters represent only a few of the thousands of genes it takes to produce a human. Your gametes together show the allele pair that will determine each trait for your child. The only two numbers that do not show alleles are #1 and # 25; these both represent entire chromosomes.
2. Make sure you have a "Traits Booklet" in front of you both. One of you should be the reader and the other the recorder for now. The reader will read from the traits booklet and the recorder will be writing in the information on your "Create-A-Child" worksheet.
3. Look at the #1 position on each gamete. These represent the sex chromosomes. You will have either an X or a Y chromosome in this space. Record the pair in the appropriate space on your worksheet. Name your child according to its sex.
4. Now you are going to look at the alleles from the egg and the sperm for each trait #2 - #24. Remember one of these alleles is coming from the mom (in the egg) and the other allele is

coming from the father (in the sperm). Since egg and sperm cells are haploid, they contain only one allele for each trait (they only have one of each chromosome), but once a sperm fertilizes an egg, the zygote is diploid - it has 2 of each chromosome and therefore two alleles for each trait. With your sperm and egg you are creating your zygote!

Now go to the eye shape characteristic. Look at the letters that are in the #2 positions of both your egg and sperm. You may have two capital letters, two small letters, or one of each. These letters represent your child's **genotype** for eye shape. Use the traits booklet to help you determine what the **phenotype** would therefore be. Remember - the **genotype is the allelic pair (aa)** and the **phenotype is the characteristic expressed (round eyes)** due to the genotype. Don't forget to be filling in your worksheet as you go!

7. If you have questions or do not understand exactly what you are doing - ASK ME!!!

## TRAITS BOOKLET

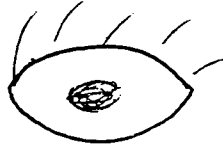
### #1: The Sex Chromosome

XX = girl

XY = boy

### #2: eye shape (This trait shows **dominance**: the almond trait is dominant, this means that it is expressed when both forms of the allele are present - Aa)

Almond (AA, Aa)



Round (aa)



### #3: eye size (This trait shows **incomplete dominance**: the heterozygous condition - Dd - results in a third phenotype)

Large (DD)

Medium (Dd)

Small (dd)

1" wide

3/4" wide

1/2" wide

### #4: eye color

Some traits require more than one gene to determine the phenotype. Darker eyes are produced in the presence of more active alleles. In this situation, the dominant alleles (A or B) represent alleles which are active in depositing dark pigment. Small letters, the recessives (a and b) represent alleles which deposit little pigment. The actual determination of eye color is actually much more complex than our simulation here.

AABB = dark brown

AABb = brown

AaBB = brown

AaBb = hazel

AAbb = dark blue

aaBB = dark blue

Aabb, aaBb = light blue

aabb = pale blue

### #5: eye lashes - length

Long (LL, Ll)

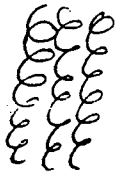


Short (ll)



#6: hair type

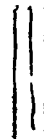
Curly (AA)



Wavy (Aa)



Straight (aa)



#7: hair color

This is another trait that involves two genes. Once again, we are going to use a simplified version, compared to reality.

BBRR = black

BBRr = dark brown

BBrr, Bbrr = brown

BbRR = light brown

bbRR = dark red

bbRr = bright red

BbRr = blonde

bbrr = very light blonde

#8: eyebrow thickness

Bushy (DD, Dd)

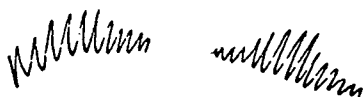


Fine (dd)



#9: eyebrow placement

Not connected (EE, Ee)



Connected (ee)



#10: Mouth - width

Long (MM)

1 1/2" wide

Medium (Mm)

1" wide

Small (mm)

3/4" wide

#11: Lips

Thick (LL, Ll)

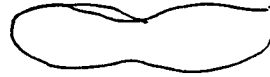


Thin (ll)



#12: Dimples  
Present (DD, Dd)

Absent (dd)



#13: Nose size  
Big (NN)

Medium (Nn)

Small (nn)

#14: earlobe attachment  
Free (FF, Ff)

Attached (ff)

#15: Deafness

Deaf mutism is a condition where the person is unable to hear or speak. This is determined by two genes and one of the genes has control over the expression of the other gene. If the person does not have a capital E, no matter what the other genotype is (DD, Dd, or dd) the person will be deaf. This suppressive effect of one gene on another gene is called epistasis.

DDEE, DDEe, DdEE, DdEe, ddEE, ddEe = normal  
DDee, Ddee, ddee = deaf

#16: Freckles on cheeks  
Present (FF, Ff)

Absent (ff)

#17: Tasting for PTC  
Taster (TT, Tt)

Non-taster (tt)

#18: Tongue roller  
Roller (RR, Rr)

Non-roller (rr)

#19: Cystic Fibrosis

Cystic Fibrosis is an inherited disease of the exocrine glands that affects the pancreas, respiratory pathways, and salivary and sweat glands. It is characterized by the production of thick secretions that do not drain easily from the lungs. This leads to inflammation and difficulty breathing.

No disorder (DD)

No disorder, but you are a carrier (Dd)

Disorder (dd)

## #20: Blood Type

There are three alleles which help determine blood. It is not like hair and eye color, where different genes are involved, this is still just one gene, but there are **multiple alleles**.

AA = type A blood

AO = type A blood

BB = type B blood

BO = type B blood

AB = type AB blood

OO = type O blood

## #21: Colorblindness

Colorblindness is when a person is unable to distinguish between certain colors (red and green, blue and black, blue and green, etc.) The gene for colorblindness is carried on the X-chromosome. (We will discuss some examples of this in class). When a gene is carried on a sex chromosome (either the X or the Y) it is called a **sex-linked trait**.

Remember that males are XY and therefore only have one X. If their sperm donates an X, they will pass along an allele for colorblindness or normal vision. If the sperm donates a Y, they will not pass along an allele for the trait. (So if the sperm has a Y, #21 should be blank). All eggs should have an allele for #21, since females are XX, and both X's have an allele for the trait.

$X^R Y$  = normal vision

$X^r Y$  = colorblind

$X^R X^R$  = normal vision

$X^R X^r$  = normal vision, but is a carrier

$X^r X^r$  = colorblind

## #22: Hemophilia

Hemophilia is when your blood is unable to clot normally. This disorder is also found only on the X chromosome.

$X^H Y$  = normal

$X^h Y$  = hemophiliac

$X^H X^H$  = normal

$X^H X^h$  = normal, but is a carrier

$X^h X^h$  = hemophiliac

## #23: Sickle cell anemia

Sickle cell anemia is a condition in which your red blood cells have a sickle shape and the hemoglobin in the red blood cell is unable to hold oxygen. The presence of these sickle-shaped cells reduces the amount of oxygen your blood carries to the organs and muscles. This can be very dangerous and cause people such problems as weakness, dizziness, fainting, and may even lead to coma, convulsions, blindness and possible death. Depending on your genotype, the phenotype varies.

Normal r. b. cells (AA)

Some r.b.c's are sickled (Aa)

Sickle Cell anemia (aa)



#24: Baldness

Baldness is a **sex-influenced trait**. Its alleles are expressed differently in males than in females. A capital B in males causes baldness and the homozygous recessive bb causes normal hair growth. A capital B in females causes normal hair growth and the homozygous recessive bb causes baldness.

For Males

BB = baldness

Bb = baldness

bb = normal hair

For Females

BB = normal hair

Bb = normal hair

bb = baldness

#25: Down Syndrome

Down Syndrome is a genetic disorder caused by having 3 of chromosome #21. Every diploid cell should have two of each type of chromosome. But in some cases **nondisjunction** occurs. This means that during anaphase one or two of meiosis the chromosomes fail to separate from each other and they both get pulled to one pole. This means that some of the gametes will have one copy of chromosome #21 and others will have two of chromosome #21. If a gamete with two copies of chromosome #21 fertilizes a gamete with the normal one chromosome #21, the zygote will have 3 copies of the 21st chromosome. This causes Down Syndrome.

2 copies of chromosome #21 = normal

3 copies of chromosome #21 = Down Syndrome

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

Lab #: \_\_\_\_\_

Regents Biology

## CREATE-A-CHILD WORKSHEET

Mother's Name: \_\_\_\_\_

Father's Name: \_\_\_\_\_

Baby's Name: \_\_\_\_\_

TRAIT	MOM'S GENE	DAD'S GENE	BABY'S GENOTYPE	BABY'S PHENOTYPE
1. sex chromosome	_____	_____	_____	_____
2. eye shape	_____	_____	_____	_____
3. eye size	_____	_____	_____	_____
4. eye color	_____	_____	_____	_____
5. eye lash length	_____	_____	_____	_____
6. hair type	_____	_____	_____	_____
7. hair color	_____	_____	_____	_____
8. eyebrow thickness	_____	_____	_____	_____
9. eyebrow placement	_____	_____	_____	_____
10. mouth width	_____	_____	_____	_____

TRAIT	MOM'S GENE	DAD'S GENE	BABY'S GENOTYPE	BABY'S PHENOTYPE
11. lips	_____	_____	_____	_____
12. dimples	_____	_____	_____	_____
13. nose size	_____	_____	_____	_____
14. earlobe attachment	_____	_____	_____	_____
15. deafness	_____	_____	_____	_____
16. freckles	_____	_____	_____	_____
17. tasting for PTC	_____	_____	_____	_____
18. tongue roller	_____	_____	_____	_____
19. cystic fibrosis	_____	_____	_____	_____
20. blood type	_____	_____	_____	_____
21. colorblindness	_____	_____	_____	_____
22. hemophilia	_____	_____	_____	_____
23. sickle cell anemia	_____	_____	_____	_____
24. baldness	_____	_____	_____	_____
25. Down Syndrome	#copies = _____	# copies = _____	# copies = _____	_____

Name: \_\_\_\_\_  
Lab #: \_\_\_\_\_

Regents Biology

## CREATE-A-CHILD LAB FINAL QUESTIONS SHEET

1. List two traits for which your child was homozygous recessive:

\_\_\_\_\_  
\_\_\_\_\_

2. List two traits for which your child was homozygous dominant:

\_\_\_\_\_  
\_\_\_\_\_

3. Name two traits which showed incomplete dominance:

\_\_\_\_\_  
\_\_\_\_\_

4. Which traits involved more than one allelic pair:

\_\_\_\_\_  
\_\_\_\_\_

5. Which trait contained multiple alleles?

\_\_\_\_\_

6. Name one trait that was sex linked.

\_\_\_\_\_

7. What does it mean to be a carrier?

\_\_\_\_\_  
\_\_\_\_\_

8. If a man has hemophilia and his wife is a carrier, will their children have hemophilia? Explain in detail.

\_\_\_\_\_  
\_\_\_\_\_

9. Why is it more likely for a male to have hemophilia?

\_\_\_\_\_  
\_\_\_\_\_

10. When a trait involves two allelic pairs (A and B), how many different combinations of alleles could appear in a woman's eggs if she was heterozygous for both alleles? List the possibilities.

\_\_\_\_\_

**Introduction**

You have already determined the genotype and phenotype of your child for 25 traits. Now your child is going to magically age 25 years and be matched up with another one from the class. You will then determine the *probability* that your grandchildren will certain traits!! You will do this by completing several Punnett squares to simulate genetic crosses. Be sure everyone in your group completes the Punnett squares.

**Directions**

1. Find the parents of the child your child will be matched up with: 1 will be with 2, 3 will be with 4, etc...
2. Use the genotypes from your 2 children (not the egg & sperm) and set up genetic crosses.
3. Complete a Punnett square for **EACH** of the 10 traits below. This will give you the *probability* that your grandchild will have the traits below.
4. Use the "Traits Handbook" from the Create a Child lab to help you determine phenotypes.
5. Draw a picture of what your grandchild using the traits that are *most* likely. If a trait has a 50% chance of occurring, randomly chose which trait they will have.

**Examples**

**"Normal" Punnett Square** (complete, incomplete or co- dominant traits or traits with multiple alleles)

i.e. Dimples      Mom = DD (dimples present)      Dad = dd (no dimples)  
                          Eggs = all have the D allele      Sperm = all have the d allele

Cross:

	d	d
D	Dd	Dd
D	Dd	Dd

Genotype = 100% heterozygous

Phenotype = 100% have dimples

**Sex Linked Traits**

i.e. Colorblindness      Mom =  $X^C X^c$  ("carrier")      Dad =  $X^c Y$  (colorblind)  
                          Eggs =  $\frac{1}{2}$  the X's have the C allele      Sperm = all X's have the c allele  
                           $\frac{1}{2}$  the X's have the c allele      All Y's have no allele

Cross:

	$X^C$	Y
$X^C$	$X^C X^c$	$X^C Y$
$X^c$	$X^c X^c$	$X^c Y$

Genotype = 25% heterozygous  
                  50% homozygous recessive  
                  25% homozygous dominant

Phenotype = 50% colorblind  
                  50% "normal"

## Polygenic Traits (more than one gene)

e. Eye color

Mom = AaBb (hazel)

Dad = AaBb (hazel)

Eggs =  $\frac{1}{4}$  AB alleles  
 $\frac{1}{4}$  Ab alleles  
 $\frac{1}{4}$  aB alleles  
 $\frac{1}{4}$  ab alleles

Sperm =  $\frac{1}{4}$  AB alleles  
 $\frac{1}{4}$  Ab alleles  
 $\frac{1}{4}$  aB alleles  
 $\frac{1}{4}$  ab alleles

Cross:

	AB	Ab	aB	ab		
AB	AABB	AABb	AaBB	AaBb	<u>Genotypes</u> 1/16 AABB	<u>Phenotypes</u> dark brown
Ab	AABb	AAbb	AaBb	Aabb	2/16 AABb	brown
aB	AaBB	AaBb	aaBB	aaBb	1/16 AAbb	dark blue
ab	AaBb	Aabb	aaBb	aabb	2/16 AaBB	brown
					4/16 AaBb	hazel
					2/16 Aabb	light blue
					1/16 aaBB	dark blue
					2/16 aaBb	light blue
					1/16 aabb	pale blue

## Data

Complete the attached table.

<u>Trait</u>	<u>Mom's Genotype</u>	<u>Dad's Genotype</u>	<u>Cross</u>	<u>Baby Genotype(s)</u>	<u>Baby Phenotype(s)</u>
Sex Chromosomes (1)			<div> <div></div> <div></div> <div></div> <div></div> </div>		
Eye Shape (2)			<div> <div></div> <div></div> <div></div> <div></div> </div>		
Eye Color (4) (*you may <b>not</b> need all 16 squares for your cross)			<div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>		

<u>Trait</u>	<u>Mom's Genotype</u>	<u>Dad's Genotype</u>	<u>Cross</u>	<u>Baby Genotype(s)</u>	<u>Baby Phenotype(s)</u>
Eyelash Length (5)			<div> <div></div> <div></div> <div></div> <div></div> </div>		
Hair Type (6)			<div> <div></div> <div></div> <div></div> <div></div> </div>		
Nose Size (13)			<div> <div></div> <div></div> <div></div> <div></div> </div>		
Freckles (16)			<div> <div></div> <div></div> <div></div> <div></div> </div>		



<u>Trait</u>	<u>Mom's Genotype</u>	<u>Dad's Genotype</u>	<u>Cross</u>	<u>Baby Genotype(s)</u>	<u>Baby Phenotype(s)</u>				
Blood Type (20)			<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>						
Hemophilia (22)			<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>						
Sickle Cell Anemia (23)			<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>						

## Questions

- What traits will your “grandchild” definitely inherit (100% likely)? (if none, write *none*)  
\_\_\_\_\_
- What traits will your “grandchild” definitely NOT inherit (0% likely)? (if none, write *none*)  
\_\_\_\_\_
- Why can’t you determine the probability that your “grandchild” will have Down’s Syndrome?  
\_\_\_\_\_  
\_\_\_\_\_
- What causes Down’s Syndrome? (Specifically, what happens during meiosis to cause it?)  
\_\_\_\_\_
- What term describes that the gene for a trait is found on the X (most of the time) or Y chromosome?  
\_\_\_\_\_ trait
- What term is used to describe two alleles that are *both* dominant?  
\_\_\_\_\_
- What term is used to describe if there are more than two different alleles for a trait?  
\_\_\_\_\_
- Grandparents Names:  

a)	b)	c)	d)
----	----	----	----
- Draw a sketch of what your grandchild will most *probably* look like...
- Grandchild's Name:

# Protein Synthesis

# Lab 37

## Background

DNA carries the information for the synthesis of all the proteins of an organism. Protein molecules are large and complex, composed of hundreds of amino acid units. In each kind of protein, the amino acid units are linked together in a definite sequence. The sequence of amino acids in a protein molecule is determined by the sequence of the nucleotides in the DNA of the organism. All the different proteins that occur in organisms are composed of only twenty kinds of amino acids.

In the first step leading to protein synthesis, the nucleotide sequence of the DNA is *transcribed* (the process is called *transcription*) into a long single-stranded molecule of RNA, termed *messenger RNA (mRNA)*. The mRNA moves out of the nucleus into the cytoplasm through pores in the nuclear membrane.

In the cytoplasm, ribosomes temporarily attach to the mRNA. Triplet sequences of nucleotides, called codons, in the mRNA form a sort of pattern, or code, that specifies the order in which the amino acids of a protein are to be linked. While a ribosome is attached at each codon along the mRNA, molecules of another kind of RNA—*transfer RNA (tRNA)*—bring amino acids into place, each according to the code or sequence in the mRNA. As the ribosomes move along the mRNA from codon to codon, the appropriate amino acids are brought into place and linked together according to the sequence of codons. Thus, the code in the mRNA is *translated* into a special sequence of amino acids. The order of the amino acids in the protein, therefore, is specified by the mRNA, which in turn is transcribed from the DNA.

## Objectives

In this activity you will:

1. Follow the steps of protein synthesis.
2. Translate the genetic code for specific amino acids.
3. Use paper models to simulate protein synthesis.

## Materials

1/2-inch transparent tape                      scissors

## Procedures and Observations

During transcription, the DNA double helix unwinds and "unzips." The two strands separate as the hydrogen bonds binding the nitrogen bases break. Then, nucleotides present in the cell line up along one strand of the DNA, the order of the nucleotides determined by the order of the nucleotides in the DNA. As the mRNA forms, uracil (U) nucleotides match with adenine (A) nucleotides; cytosine (C) nucleotides match with guanine (G) nucleotides. **Note:** RNA contains uracil (U) nucleotides where thymine (T) nucleotides would occur in DNA.

The nucleotides in the newly formed mRNA are *complementary* to the nucleotides of the DNA segment on which it formed. For example, where the DNA contained guanine, the mRNA contains cytosine. Where the DNA contained adenine, the mRNA contains uracil. After the single-stranded molecule of mRNA is formed, it moves out of the nucleus into the cytoplasm.

1. One strand of DNA has the base sequence: CGATTGGCAGTCAT. Determine the sequence of bases in the complementary strand of mRNA that would form next to this DNA strand.

a. Write the sequence of bases in the complementary mRNA strand below.

The information carried on the mRNA is in a code—the *genetic code*. A group of three nucleotides on a molecule of mRNA is called a *codon*; each codon specifies one of the 20 amino acids, except for three codons that are stop, or termination, signals. There are 64 codons in the genetic code.

2. The 64 codons are shown in Table 1. Notice that the first two nucleotides of each codon (abbreviated by their first letter) are shown in the column on the left. To find out the amino acid specified by a given codon, find the first two letters in the column on the left, then follow that row to the column showing the last nucleotide (letter) of the codon. Note that most amino acids are coded for by more than one codon.

Table 1. The Genetic Code: Codons and Their Amino Acids

First Two Nucleotides of Codons	Last Nucleotide of Codons				The Amino Acids	
	U	C	A	G	Abbreviations	Names
UU	phe	phe	leu	leu		
UC	ser	ser	ser	ser	gly	glycine
UA	tyr	tyr	term	term	ala	alanine
UG	cys	cys	term	trp	val	valine
CU	leu	leu	leu	leu	ile	isoleucine
CC	pro	pro	pro	pro	leu	leucine
CA	his	his	gln	gln	ser	serine
CG	arg	arg	arg	arg	thr	threonine
AU	ile	ile	ile	met	pro	proline
AC	thr	thr	thr	thr	asp	aspartate
AA	asn	asn	lys	lys	glu	glutamate
AG	ser	ser	arg	arg	lys	lysine
GU	val	val	val	val	arg	arginine
GC	ala	ala	ala	ala	asn	asparagine
GA	asp	asp	glu	glu	gln	glutamine
GG	gly	gly	gly	gly	cys	cysteine
					met	methionine
					trp	tryptophan
					phe	phenylalanine
					tyr	tyrosine
					his	histidine
					term	termination

**Protein Synthesis** (continued)**37**

3. Use Table 1 to read the codons below. Find the name of the amino acid and write it in the space provided. If the letters code for more than one amino acid, separate the names by dashes.

b. UUA: \_\_\_\_\_

c. GAG: \_\_\_\_\_

d. UAUCUA: \_\_\_\_\_

e. AUCUUG: \_\_\_\_\_

f. AAGAGUUCG: \_\_\_\_\_

g. AAAUUUGGG: \_\_\_\_\_

h. CCAGCUAGAGGGUGGCUGUCA: \_\_\_\_\_

Molecules of transfer RNA (tRNA) are formed in the nucleus and migrate into the cytoplasm. There are twenty different types of tRNA, one for each kind of amino acid. The tRNA molecule has two ends. One end can carry only one kind of amino acid molecule. The opposite end has a three-base segment called an *anticodon*, which is complementary to a codon on mRNA.

In protein synthesis, with a ribosome attached to an mRNA, a tRNA molecule carrying its special amino acid molecule briefly attaches to mRNA at its complementary codon. Next, a tRNA molecule complementary to the adjacent codon briefly attaches to the mRNA. The ribosome moves along the mRNA to that point of attachment. During each brief attachment among tRNA, mRNA, and ribosome, peptide bonds form between the amino acids. As these bonds form, the tRNA molecules are released from their amino acids, and also from the mRNA. Each is free to attach to another molecule of its special amino acid and carry it to another point along the mRNA. The ribosomes move along the mRNA as amino acids are added, one at a time, to a growing chain. This continues until a termination codon is encountered.

4. Determine the anticodon for each codon below. Write it in the space provided.

i. GGU: \_\_\_\_\_

j. CGC: \_\_\_\_\_

k. AUG: \_\_\_\_\_

l. UCG: \_\_\_\_\_

m. AAA: \_\_\_\_\_

n. CUG: \_\_\_\_\_

5. Cut out the tRNA models with amino acids attached, found in Figure 1 on the last page of this activity. Then cut out the mRNA strands and tape them together, so that strand 1 forms the left end of a long strand, strand 3 forms the right end, and strand 2 is between them.
6. Starting at the left of the mRNA strand, find a tRNA molecule with an anticodon complementary to the first codon. With a small piece of tape, attach the tRNA to the mRNA strand, anticodon to codon.
7. For the next codon, find a tRNA with the complementary anticodon. Tape the tRNA in place to the mRNA. Also, use a small piece of tape between the two amino acids to represent a peptide bond.
8. Once the peptide bond has been formed, the tRNA molecule attached first is released. Carefully cut the tape attaching the first tRNA to the mRNA, and cut the line that separates the tRNA and the amino acid. You may set the tRNA model aside and discard it later.

There are three termination codons in the genetic code. When a termination codon is read, the strand of amino acids is released, folding and twisting to form the final, complex structure of the protein.

9. Repeat Steps 7 and 8 along the mRNA strand. When you have used up all the tRNA-amino acid models provided, you will notice that there is one codon left on the mRNA—a termination codon. Cut the tape between the mRNA and the tRNA, and the line between the last tRNA and amino acid, thus releasing the chain of amino acids.
  - a. Starting at the left, write the sequence of the amino acids formed by translation of the mRNA strand.*

## Analysis and Interpretations

1. Write the order of nucleotides in mRNA that would be transcribed from the following strand of DNA:

GTATACCAAGTCATTTGTC

Then list in order the amino acids coded by this sequence.

mRNA \_\_\_\_\_

amino acids \_\_\_\_\_

2. Sometimes a mistake occurs in the translation of an mRNA strand. Suppose that the reading of the mRNA strand in question 1 began, by mistake, at the second nucleotide instead of the first. The first codon would be AUA. Write the sequence of amino acids that would be formed.

3. Suppose the bases of the DNA strand in question 1 were not transcribed correctly and the mRNA read:

CACAUGGUAGUAAGCAG

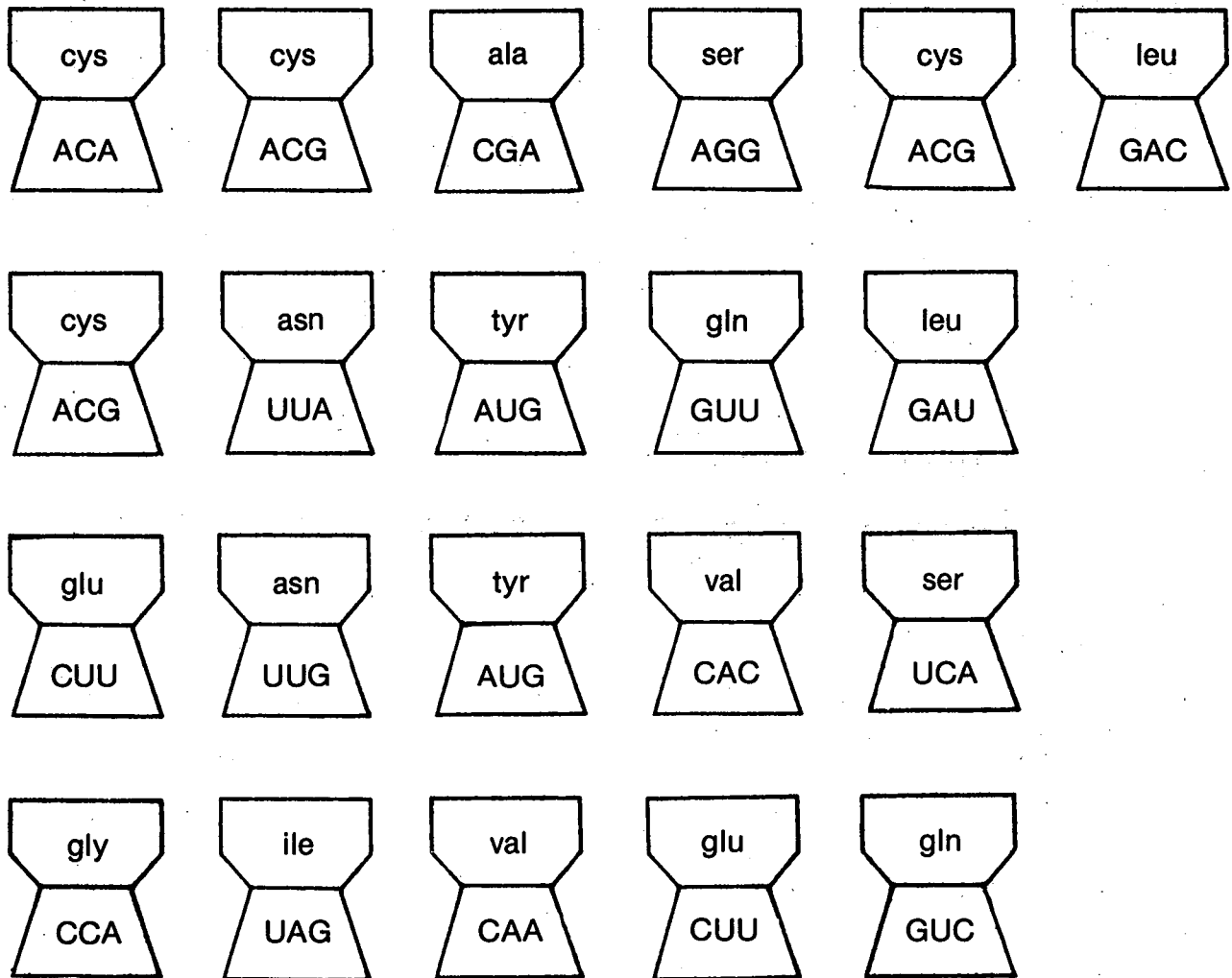
How many mistakes were made in transcription? Write the abbreviations for the amino acids that would be formed by translation of the mRNA.

Name \_\_\_\_\_

# Protein Synthesis (continued)

37

Models for tRNA attached to amino acids:



Models for mRNA (tape these, left to right, into one long strand):

GGU	AUC	GUU	GAA	CAG	UGU	UGC	GCU
UCC	GUG	UGC	AGU	CUG	UAC	CAA	
CUA	GAA	AAC	UAC	UGC	AAU	UAA	

-89-



**Introduction**

In this activity you will simulate **gene splicing**, the basic technique scientists use to make recombinant DNA. **Recombinant DNA** is DNA made from two **different** organisms that has been “glued” together to make one DNA molecule. In this activity you will splice a human gene into a **vector** (bacterial DNA) which will hold the gene we want. This process allows a bacterium to make a human protein, such as the hormone insulin, which will be used by diabetics.

To splice a gene...

- \* “Cut” both types of DNA with a **restriction enzyme** which “reads” a DNA sequence and “cuts” DNA at a specific sequence it recognizes, causing “sticky ends” to be produced.
- \* Since both the plasmid and the human DNA are “cut” with the same restriction enzyme, the DNA strands are *complementary*, and will line up easily.
- \* The DNAs are then “glued” together using the enzyme **ligase**.

**Materials:**

Human DNA sequence      Bacterial plasmid      Scissors      Tape      Colored pencil (any color)

**Procedure****1) Make a Plasmid:**

Cut out the 2 strips of *E. coli* DNA and tape the **matched** ends together. Color this with your colored pencil.

**2) Make Human DNA:**

Cut out the 4 strips of *H. sapiens* DNA and tape the **matched** ends together.

**3) Gene Splicing:**

- a) Use your scissors, which represent a restriction enzyme called Eco RI, to cut the plasmid DNA at its marked site (G/AATTC). Do this by cutting along the dotted line.
- b) Using the same scissors, which still represent the restriction enzyme Eco RI, to cut out the gene of interest from the human DNA. The gene of interest is the gene which produces the protein hormone insulin. Do this by cutting along the dotted lines.
- c) Using your tape, which represents the enzyme ligase, “glue” together the gene of interest with the cut bacterial plasmid DNA. Do this by lining up the complementary “sticky ends” and taping these ends together.

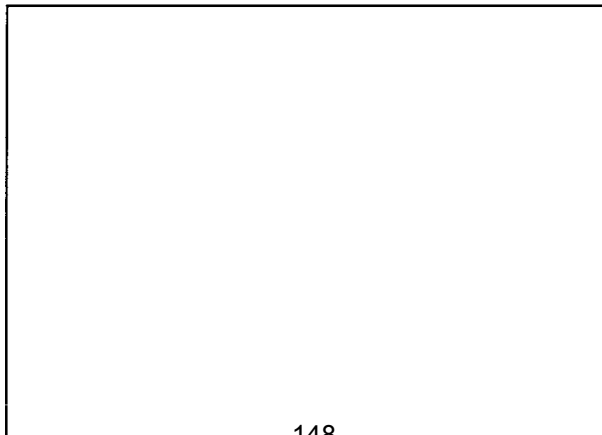
You now have **recombinant DNA!!**

## Analysis

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

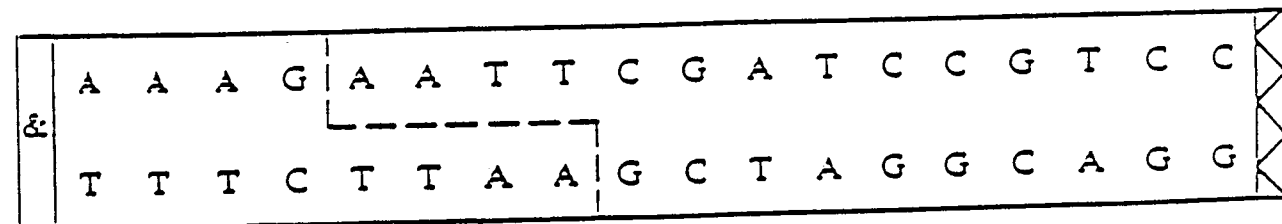
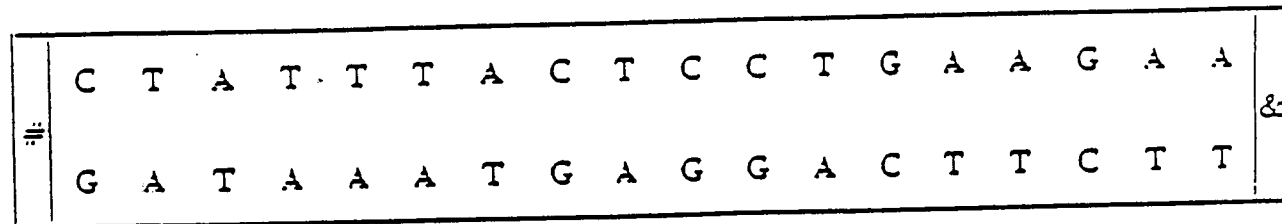
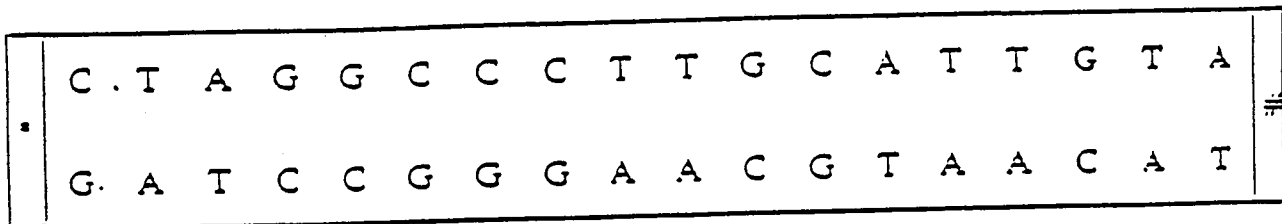
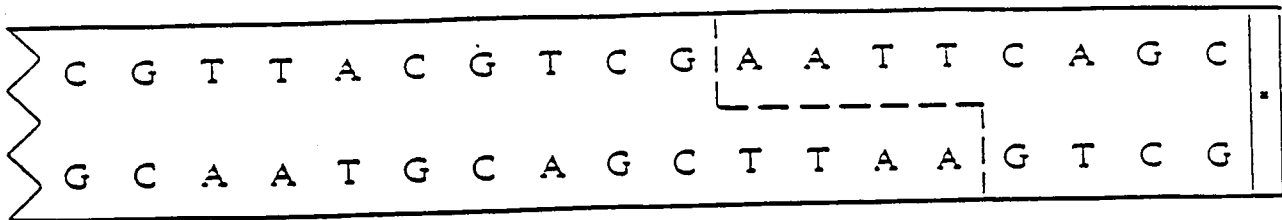
- 1) Define the following: (use notes and Introduction of lab)
  - a) vector:
  - b) restriction enzyme:
  - c) recombinant DNA:
  - d) gene splicing:
- 2) During this activity, identify what items represented the following:
  - a) restriction enzyme? \_\_\_\_\_
  - b) ligase? \_\_\_\_\_
  - c) vector? \_\_\_\_\_
- 3) Describe 2 different ways humans use recombinant DNA technology
  - a)
  - b)
- 4) Why did we use the same restriction enzyme to cut both the human DNA and the bacterial DNA?
- 5) Draw a picture of your recombinant DNA (No, you do not have to write the base sequences).

**Label:** bacterial DNA & gene of interest



# CHROMOSOME DNA

(from humans)

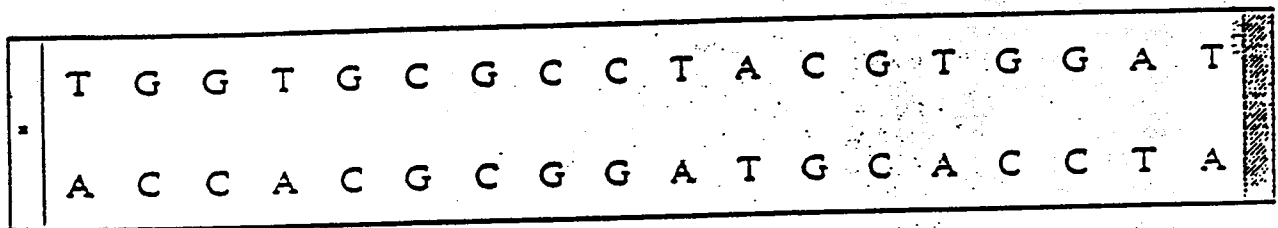
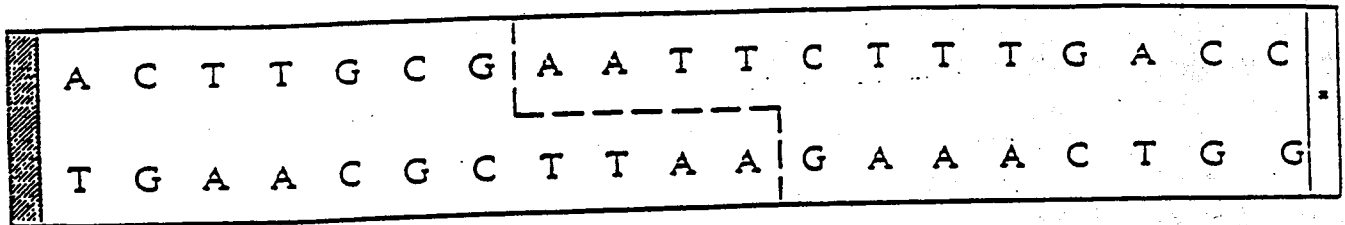


TAPE TOGETHER INTO ONE LONG STRAND.

MATCH UP THE ■ # AND & SYMBOLS.

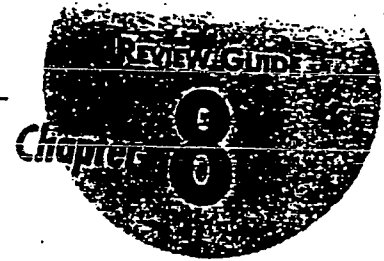


# PLASMID DNA (from E. coli bacteria)



TAPES TOGETHER TO FORM A LOOP.  
(PLASMID DNA FROM BACTERIA  
FORMS LOOPS.)





# Gene Technology Today

## RETEACHING

### Molecular Cutting and Pasting

One of the early successes of genetic engineering has been the creation of bacteria that produce insulin for humans. By cloning the bacteria in large numbers, insulin is made in such large quantities that there is enough for everyone who needs it, and at prices lower than would otherwise be possible.

The diagram below illustrates the procedure for removing the gene responsible for insulin production in humans and transferring it to bacteria cells. The procedure is basically the same as the one used by Cohen and Boyer in their famous experiment involving a frog rRNA gene.

Study the diagram until you understand the procedure. Put the number of the step in the diagram by its description in the list of steps, which are not in the correct order. Then answer the questions below.

#### Steps in the Procedure (Not in order)

- ☐ Human gene is spliced into plasmid.
  - ☐ Bacteria cell with new gene divides.
  - ☐ Plasmid is removed from bacteria cell and cut open.
  - ☐ Gene is cut from human DNA.
  - ☐ Bacteria cell division continues.
  - ☐ Plasma is put back into bacteria cell.
1. Describe how the plasmid is cut open by genetic engineers.

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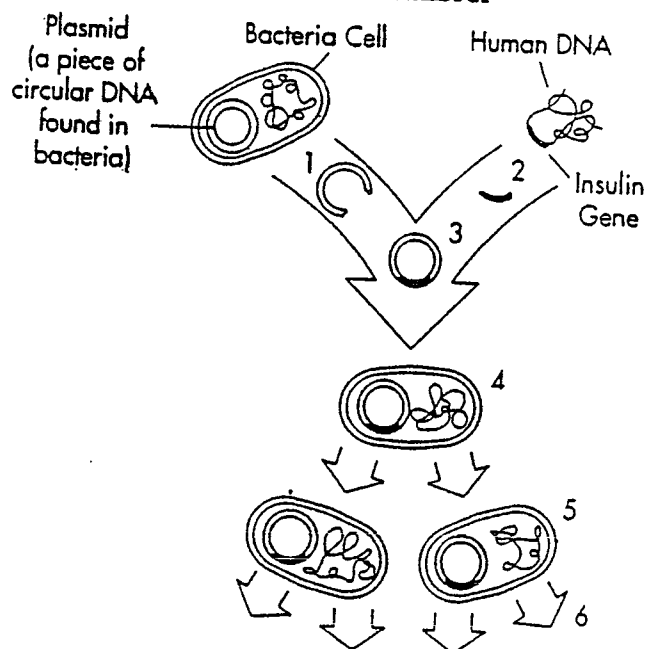


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#### Insulin Gene Transfer



2. How is the insulin gene removed from the strand of human DNA? \_\_\_\_\_
3. Explain why the gene fits into the opening in the plasmid. \_\_\_\_\_





# Restriction Enzyme

Lab # \_\_\_\_

**Purpose:** In this activity, you will use different restriction enzymes that cut at the following base sequence sites.

## Restriction Enzymes:

**Bam HI** GGATCC (cuts between the G's)  
CCTAGG

**Hae III** GGCC (cuts between the G and the C)  
CCGG

Part 1: Restriction Digestion – Restriction Digestion is the cutting up of DNA into RFLP's by restriction enzymes. Restriction enzymes are found in bacterial cells and cut up the DNA of invading viruses. Genetic engineers have been able to isolate these enzymes and use them to cut DNA for various manipulations of genes.

1. On the three sequences of DNA shown below, locate the gene sequence that Bam HI will cut, put a box around the bases and shade it in red.
2. Using a dark pen or marker, draw in the line that represents the cut the Bam HI restriction enzyme makes.
3. Count the length of each fragment of DNA in base pairs (bp).
4. On the gel diagram shown on the back of this paper, draw in where the fragments would end up after they were run through a gel electrophoresis.

## Crime Scene DNA

TACCTTTCGGATCCATATTATACGCATCGGCCCCGTAATCCGGCCGTCTAGCAAACCTACGGCGGGATCCTAC  
ATGGAAAGCCTAGGTATAATATGCGTAGCCGGGCATTAGGCCGGCAGATCGTTTGATGCCGCCTAGGATG

## Suspect #1 DNA

TACCTTTCGGATCCATATTATACGCATCGGGCCGTAATCCGCCCGTCTAGCAAACCTACGGCGGGCTCCTAC  
ATGGAAAGCCTAGGTATAATATGCGTAGCCCGGCATTAGGCCGGGCAGATCGTTTGATGCCGCCGAGGATG

## Suspect # 2 DNA

TACCTTTCGGATCCATATTATACGCATCGGCCCCGTAATCCGGCCGTCTAGCAAACCTACGGCGGGATCCTAC  
ATGGAAAGCCTAGGTATAATATGCGTAGCCGGGCATTAGGCCGGCAGATCGTTTGATGCCGCCTAGGATG

**Part II. Gel Electrophoresis**

Illustrate the DNA profile for the three samples in the “Gels” below by drawing the fragments in their appropriate lanes and migration points using the markers of known size (bp = “base pairs”)

The first gel is DNA digested with Bam HI only; the second HaeIII only; and the third is DNA digested with both restriction enzymes.

**BamHI only**

bp	marker	CS	S1	S2
100	<div></div>			
80	<div></div>			
60	<div></div>			
40	<div></div>			
20	<div></div>			
10	<div></div>			

**HaeIII only**

bp	marker	CS	S1	S2
100	<div></div>			
80	<div></div>			
60	<div></div>			
40	<div></div>			
20	<div></div>			
10	<div></div>			

**BamHI and HaeIII**

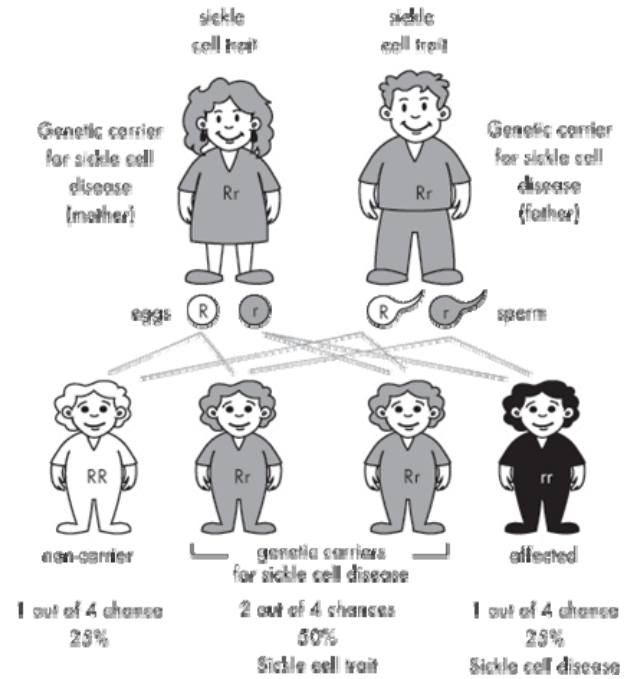
bp	marker	CS	S1	S2
100	<div></div>			
80	<div></div>			
60	<div></div>			
40	<div></div>			
20	<div></div>			
10	<div></div>			

### Part III: Genetic Screening

Another use of RFLP analysis (Restriction Fragment Length Polymorphism) is diagnosis of genetic diseases and identification of disease carriers. If a polymorphic region is close to the area responsible for a disease, they are said to be linked. Sometimes the polymorphic region that is capable of being cut with a restriction enzyme is known WITHIN the gene responsible for a disease. This is the case with Sickle Cell Anemia

In 1978, Yuet Wai Kan and Andrees Dozy of the University of California-San Francisco showed that the restriction enzyme Mst II, which cuts normal  $\beta$  globin DNA at a particular site, will not recognize (and therefore will not cut) DNA that contains the sickle cell mutation. Mst II recognized the sequence CCTNAGG (where N = any nucleotide). Sickle cell disease is due to a single point mutation in the  $\beta$  globin gene on chromosome 11 that changes CCTGAGG to CCTGTGG. **Therefore, the A to T mutation that causes sickle cell anemia also causes the loss of the recognition site for the restriction enzyme Mst II!**

Thus, the DNA from normal homozygous individuals (RR), heterozygous carriers of the trait (Rr), and the homozygous sickle cell patients (rr) produces different sizes of restriction fragments when cut the Mst II. In Southern blot analysis, these RFLPs are detected as characteristic banding patterns, using a radioactive  $\beta$  globin gene probe.



### CASE STUDY: THE JENE FAMILY

James and Josie Jene have four sons: Jamal, Jamar, Jamone, and James Jr. Due to the fact that both Mr and Mrs. Jene are carriers of this autosomal recessive condition, there is a chance that one or more of their children may suffer from this disease or be carriers.

Draw a Punnett Square to illustrate the possibility of inheriting the Sickle Cell anemia from Mr. and Mrs. Jene


In this activity, you will use RFLP analysis to determine which children have inherited the disease.

**Part A:** Show where the Jene family's genes would be cut with enzyme Mst II that cuts between the C's on the **CCTGAGG** sequence.

Name	Allele 1	Allele 2
Mr. James Jene	TACAGTCTGAAGGCCTGAGGTGCA	TACAGTCTGAAGGCCTGTGGTGCA
Mrs. Josie Jene	TACAGTCTGAAGGCCTGTGGTGCA	TACAGTCTGAAGGCCTGAGGTGCA
Jamal Jene	TACAGTCTGAAGGCCTGAGGTGCA	TACAGTCTGAAGGCCTGAGGTGCA
Jamar Jene	TACAGTCTGAAGGCCTGTGGTGCA	TACAGTCTGAAGGCCTGAGGTGCA
Jamone Jene	TACAGTCTGAAGGCCTGAGGTGCA	TACAGTCTGAAGGCCTGTGGTGCA
James Jene Jr.	TACAGTCTGAAGGCCTGTGGTGCA	TACAGTCTGAAGGCCTGTGGTGCA

Part B: Draw the DNA profiles of each family member below. Be sure to include fragments from each of the two beta globin alleles.

bp	marker	Mr. Jene	Mrs. Jene	Jamal	Jamar	Jamone	James Jr.
50	■						
40	■						
30	■						
20	■						
10	■						

### Post Lab Analysis:

1. Which of the Jene children will suffer from the disease Sickle Cell Anemia? How do you know?
2. Which of the Jene children are carriers of the disease? Explain how RFLP analysis can be used to diagnose a carrier of sickle cell disease.
3. Summarize the role of restriction enzymes in DNA technology.
4. Summarize the roles of gel electrophoresis in DNA technology.

## Introduction

Gel electrophoresis is a separation technology that uses gel, a substrate (like gelatin), electricity and movement. “Phoresis” means “to carry across” and “electro” refers to the electricity used to “carry” fragments of DNA across the gel. The partially negative fragments of DNA are attracted to the positive end of the electrophoresis chamber. DNA fragments that are large get “stuck” in the gel early on. The smaller DNA fragments travel farther along the gel.

Of the three billion nucleotides in human DNA, more than 99% are identical among all individuals. The remaining 1% that is different, however, adds up to a significant amount of code variations between individuals. Due to the very large number of possible variations, no two people (except identical twins) have the same DNA sequence.

The differences in DNA from person to person are known as **polymorphisms** (poly = many; morphism = forms). When these polymorphisms are “cut” with **restriction enzymes**, the resulting fragments are known as **RFLPs** (Restriction Fragment Length Polymorphisms). The exact number and size of these fragments produced by a specific restriction enzyme digestion varies from person to person. These RFLPs vary in length and can be separated, and their size determined, by a process known as **electrophoresis**.

Most of the DNA in a chromosome is not used for the genetic code. In other words, most of the DNA does NOT contain instructions for how to make proteins. Because these regions are not essential to an organism’s development, it is more likely that the variations in DNA from person to person occur in these non-essential regions. These regions contain repeating nucleotide sequences ( i.e. GTCAGTCAGTCAGTCAGTCA) that repeat from 20 to 100 times, which are the strands that are cut with restriction enzymes to create RFLPs.

The difference in the fragments can be quantified to create a “**DNA fingerprint**.” Distinct RFLP patterns, or banding patterns, can be used in criminal cases to identify a person who has committed a violent crime (exact banding match) or to establish paternity of a child (50% banding match). DNA fingerprints can also be used to track hereditary diseases passed down family lines and can be used to find the closest possible matches for organ transplants. It can also be used to ascertain the level of inbreeding of endangered animals, aiding in the development of breeding programs to increase animals’ genetic health and diversity.

\* Adapted from Ward’s DNA Fingerprinting Lab Activity 2002.

## Objectives

- \* Perform the process of agarose gel electrophoresis.
- \* Identify the guilty suspect in a criminal investigation.

## Materials

- |                                |                           |                           |
|--------------------------------|---------------------------|---------------------------|
| * 0.8% Agarose gel             | * Micropipettes           | * Heatproof gloves        |
| * TBE running buffer 1X, 350mL | * Clean micropipette tips | * Electrophoresis chamber |
| * DNA stain                    | * Goggles                 | * Masking tape            |
| * Staining tray                | * Aprons                  | * <u>DNA samples</u>      |

The DNA samples used in this activity have already been digested with restriction enzyme to save time.

## **Procedure**

### **1) Preparing the Gel**

- \* Prepare the electrophoresis chamber as demonstrated by your instructor.
- \* Obtain the Agarose gel from the hot water bath. Pour the gel into your chamber.

**CAUTION: Agarose is incredibly hot. Wear heat proof gloves, goggles and apron while pouring!!**

- \* Place the comb into your gel on the black electrode end. This creates the wells for your DNA.
- \* Allow ~20-30 minutes for your gel to set

### **2) Load the Gel**

- \* Once your gel is set, remove the comb carefully from your gel.
- \* Carefully add buffer into one side of the chamber until the buffer is level with the top of the gel. Add buffer to the other side until the buffer is level with the top of the gel. Continue adding buffer slowly until the buffer is ~2-3 mm above the top of the gel.
- \* Use the micropipette as demonstrated by your instructor to load the DNA into the wells of your gel. Micropipettes are expensive equipment, use only as directed.
- \* Use a fresh micropipette tip for each sample to avoid contamination.

### **3) Establish Electrical Current**

- \* Place the lid on your electrophoresis chamber.

**BLACK** = should be at the end of the gel where your DNA samples are loaded into the wells  
**RED** = should be at the other end of the gel

**CAUTION: Electrocutation hazard!!**

**Do not plug in your apparatus without instructor check.**  
**Never touch live electric wires!!**

- \* Have your teacher check your apparatus. Your instructor will turn on your electric current.
- \* Run gel for 60- 90 minutes

### **4) Staining/Destaining the Gel (your instructor may do this for you)**

- \* Carefully remove gel from the electrophoresis chamber.
- \* Place gel into staining dish and add enough DNA stain to completely cover your gel. Leave gel to stain for about an hour. **Be sure to wear gloves when handling stain.**
- \* Rinse the gel with plenty of distilled water to remove excess stain. Leave to destain overnight.

### **5) Analyze your DNA Fingerprints**

## Lab Activity

Date: \_\_\_\_\_

## ANALYSIS

[illegible]

## Analysis

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

- 1) Compare the banding patterns formed on each lane of the gel. Do you think the three DNA samples tested are the same? Explain.
- 2) Which of the two suspects do you believe is the real burglar? Explain your answer.
- 3) If you have a restriction enzyme that cuts a piece of DNA at 2 recognition sites, how many DNA fragments would you see on a gel? \_\_\_\_\_
- 4) Briefly describe the purpose of each component used during this lab:
  - a) Agarose gel:
  - b) TBE buffer:
  - c) Power supply:
  - d) DNA stain:
  - e) Restriction enzymes (used before lab):
  - f) DNA marker, standard:
- 5) List 2 *other* ways, besides criminal investigations, that scientists use gel electrophoresis.
  - a)
  - b)
- 6) What are Restriction Fragment Length Polymorphisms (RFLPs)?
- 7) What would have happened to your DNA fragments if you reversed the red and black electrodes on your chamber?
- 8) When using a DNA fingerprint to determine paternity, would you look for an exact banding match or a 50% banding match with the child? Explain!





## **RAT ISLANDS: An Exploration in Speciation**

### **Leslie Tong**

#### **Teacher Introduction:**

This activity allows students to use some of their creativity to imagine how rats would adapt to a particular island in order to survive. You can make up a story as elaborate as you want to explain how the rats ended up on their Island (A, B, C or D) and how long they have been on the island in order to change so much.

#### **Activity:**

Each group gets an island and must design a rat which has adapted to the conditions of the island. I have the students draw island, the rat with its adaptations and explain how each adaptation allows the rat to survive. You could then have the groups present their rats. It is interesting to see how different the rats are even with the same island conditions.

Give each group one of the following islands:

#### **ISLAND A**

The island is fairly flat, with an occasional hill. The ground is soft dirt, and several species of shrubs grow towards the center of the island. There is no animal life on land; but the water is teeming with fish. The island is surrounded by a coral reef which keeps the predators out. The shore is sandy with no algal growth. Fresh water is available.

#### **ISLAND B**

The island has a rocky shoreline. Numerous tide pools dot the island along the shore where the wave action is somewhat sheltered by rock outcrops. The tide pools host barnacles, chitons, abalone, sea urchins and crabs. Algae grows all around the island; however, it is quite sparse in the tide pools where the various animals feed. The current is quite strong along the rocky outcrops where the algae grows best. Fresh water is available.

#### **ISLAND C**

The island is somewhat barren. A few species of cactus thrive on the bare rocks. A large cactus-eating tortoise inhabits the island. A species of very large bird nest on the island annually. They build their nests on the rocks, and protect their eggs from the sun by standing over the nests with outspread wings. The nests are always found on the windy side of the island which is somewhat cooled by offshore breezes.

#### **ISLAND D**

The island is an extinct volcano. Vegetation on the island changes with the altitude moving up the volcano. Grasses grow at the base. Further up the slope the grasses give way to low shrubs. Half way up, the island becomes quite lush; tropical plants and trees dominate the landscape. At this altitude, the island experiences frequent rain showers. There are two species of birds that inhabit the island. One is a raptor which preys upon the smaller birds. The other fishes the waters approximately one mile offshore. Both nest in trees.

**Data:** Island Letter \_\_\_\_\_

Draw a rough sketch of your rat below. **Label** and **Describe** 3 features your rat has that make it well adapted to life on its island.

### Analysis

- 1) According to Lamarck...
  - a) How did your rat evolve the traits it has?
  - b) Was Lamarck correct in his theory of evolution? YES / NO (circle one)
- 2) According to Darwin...
  - a) How did your rat evolve the traits it has?
  - b) Do scientists believe Darwin's theory of evolution is correct? YES / NO (circle one)
- 3) Let's pretend your rat was taken to one of the **other** islands and left there to live.
  - a) How would **ONE** of its adaptations make it *unsuitable* for life on the new island.  
(You may choose any island you wish to show this.)
  - b) Your rat's features make it **MORE** / **LESS** able to survive on the new island. (circle one)
- 4) Suppose you created a time machine and were able to travel into the future 100,000 years from now. Assuming there were still rats living on your island, do you think the rats will look the same as they do today? **Support** your answer with good science reasoning.

# Evidence of Evolution

## Lab

### Background

Much evidence has been found to indicate that living things have evolved or changed gradually during their natural history. The study of fossils as well as work in embryology, biochemistry, and comparative anatomy provides evidence for evolution.

### Objective

In this lab you will learn about homologous, analogous, and vestigial structures and their significance in evolution theory.

### Materials

colored pencils

### Procedures and Observations

#### PART I. HOMOLOGOUS STRUCTURES

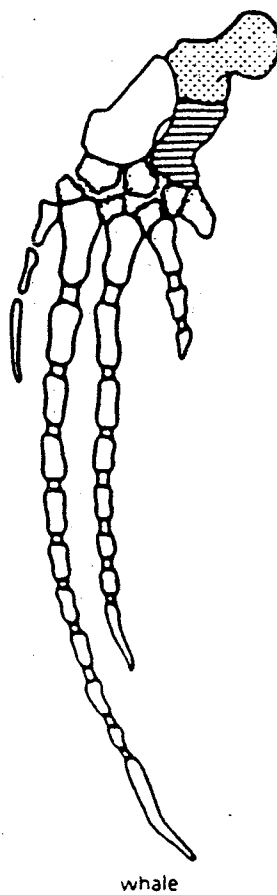
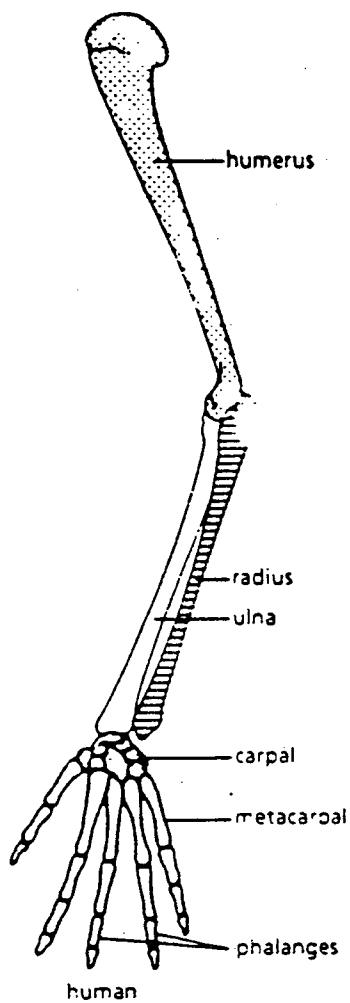
1. Carefully examine the drawings of the bones shown in Figure 1 on the next page. Look for similarities among the various animals.
  - a. Color each part of the human arm a different color. (All bones of the wrist should be a single color, the bone groups of the hand should be a different single color.) Then color the corresponding bone in each of the other animals the same color as the human bone.
  - b. Describe the function of each set of bones below:

Animal	Function
human	
whale	
cat	
bat	
bird	
crocodile	

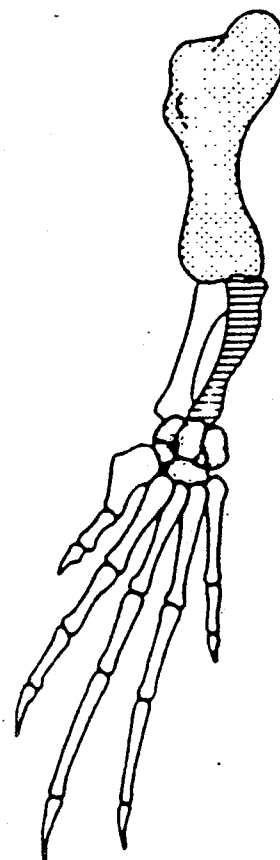
- c. Are the bones arranged in a similar way in each animal?

These structures are formed in similar ways during embryonic development and share like arrangements; however, they have somewhat different forms and functions. They are called *homologous structures*.

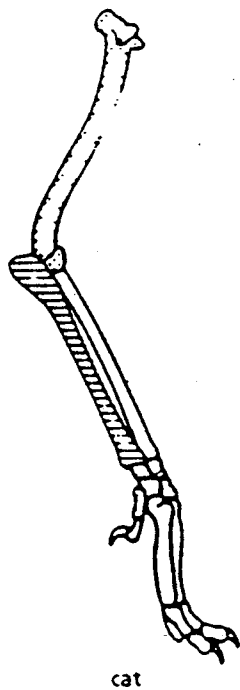
Allyn and Bacon



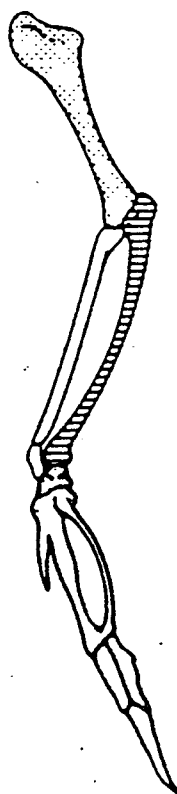
whale



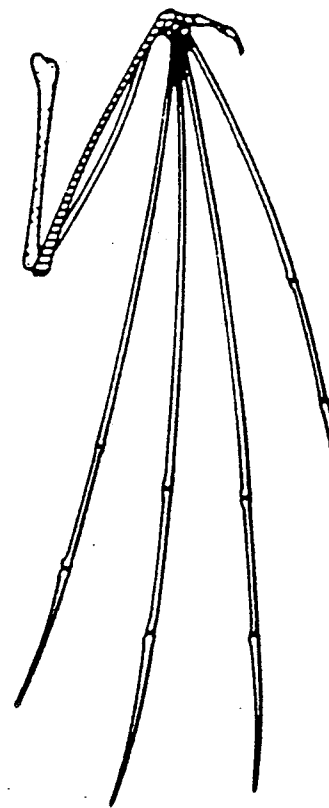
crocodile



cat



bird



bat

Name \_\_\_\_\_

## Evidence of Evolution (continued)

### PART II. ANALOGOUS STRUCTURES

1. Examine the butterfly wing and the bird wing shown in Figure 2.

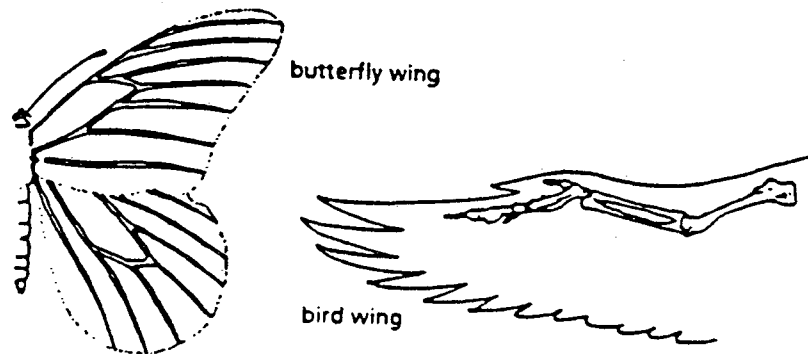


Figure 2

- a. What function do these structures share?

- b. How do the structures differ?

- c. Do birds and insects share any structural similarities that would suggest they are closely related taxonomically?

Some apparently unrelated animals have organs with similar functions, yet are very different in structure and form. These structures are called *analogous structures*.

### PART III. VESTIGIAL STRUCTURES

Gradual changes have occurred through time that have in some cases reduced or removed the function of some body structures and organs. The penguin's wings and the leg bones of snakes are examples of this phenomenon.

1. The cave fish and minnow shown in Figure 3 are related, but the cave fish is blind.

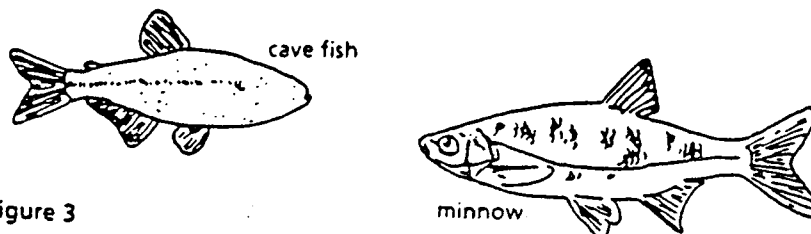


Figure 3

a. Explain why eyesight is not an important adaptation to life in a cave.

b. Does the appearance of the cave fish and minnow suggest common ancestry? Why?

Organs or structures that have lost their function in the organism and become reduced in size (because of efficiency) are called vestigial structures. Human vestigial organs are well documented.

2. Read the list of human *vestigial structures* shown in Table 1.

c. Suggest a possible function for each structure and explain why it became vestigial. Record your answers in the table.

Table 1.

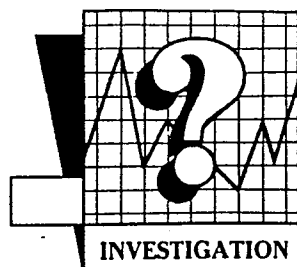
Structure	Probable Function	Why Vestigial?
appendix		
coccyx (tail bones)		
muscles that move ears		
muscles that make hair stand up		
little toe		
wisdom teeth		

## Analysis and Interpretations

1. Explain why the homologous structures in Part I are evidence of evolutionary relationships.

2. Explain the evolutionary relationship between the fin of a fish and the flipper of a whale.

3. List two structures (not from Table 1) that you think are vestigial and explain why.



# How Do Paleoanthropologists Study Fossils?

11-2

LAB

When paleontologists discover fossils, they need to determine whether they have discovered fossils of recent organisms or ancient organisms. Then they must determine the kinds of organisms the fossils represent. If a skull were discovered and determined to be a primate skull, the next step would be to determine whether it were that of an ape or a human. Because humans and apes evolved along separate lines, certain physical characteristics can be used in an attempt to classify the fossil skull as either ape or human. Techniques similar to the ones used in this Investigation are used by anthropologists, paleontologists, and archaeologists.

## OBJECTIVES

- Hypothesize which skulls share the most characteristics.
- Examine skull diagrams of a gorilla, *Australopithecus*, and modern human.
- Measure or observe and record specific skull structures and features.
- Draw pictures of how the facial features of the three primates may have looked.

## MATERIALS

metric ruler  
protractor  
paper

colored pencils (2)  
pencil with eraser

## PROCEDURE

1. Examine Figure 1. Make a **hypothesis** that suggests which skulls share the most characteristics. Write your hypothesis in the space provided.

### Brain Area Compared with Face Area

The rectangles over the skulls in Figure 1 represent the area of the brain (upper rectangle) and face (lower rectangle) of each skull.

2. Determine the area of each rectangle by measuring the length and width in centimeters and multiplying the two measurements together.
3. Record on lines 1 and 2 of Table 1 the face and brain areas for the gorilla, *Australopithecus*, and modern human skulls.
4. Compare the brain and face areas and complete lines 3, 4, and 5 of Table 1.

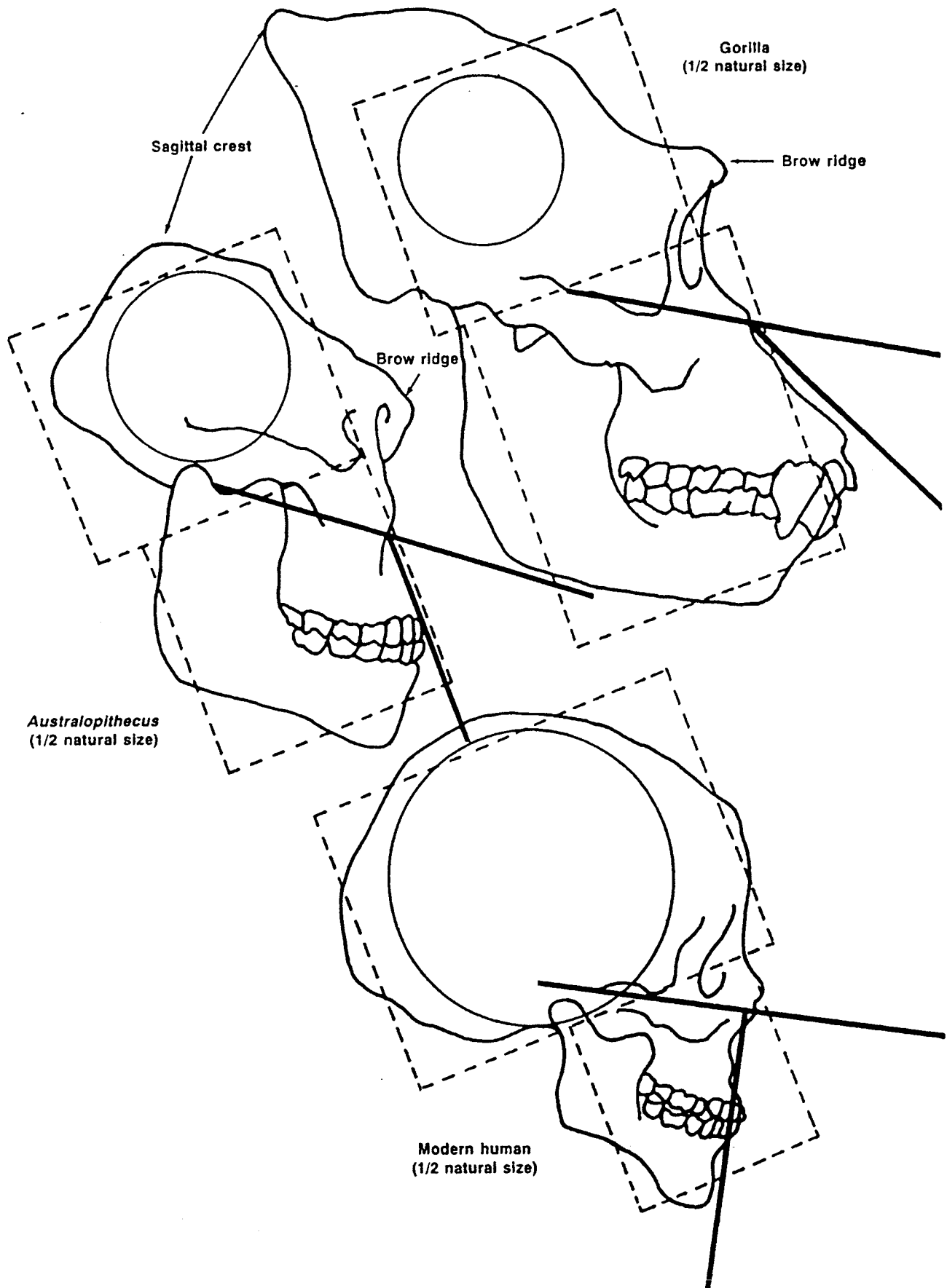
### Cranial Capacity

5. Measure the diameter in centimeters of the circle in each skull. The diameter is the distance across the exact center of each circle.
6. Multiply the cranial diameters by 200 cm<sup>2</sup>. The result is the cranial capacity (brain volume) in cubic centimeters.
7. Record the cranial capacity for each skull on line 6 of Table 1.

### Jaw Angle (Prognathism)

In front of each skull are two heavy lines, one running parallel to the slope of the upper jaw and one running through the nose. These two lines are to be used for measuring how far forward the jaw protrudes.

Figure 1.





8. With a protractor, measure the outside angle formed by the two lines in each skull (the angle toward the right).
9. Place the protractor on each skull as shown in Figure 2. Read the angle by using the scale on the protractor. The angle is read where the lower skull line crosses the protractor.
10. Record the angles on line 7 of Table 1. An angle of less than 90° means that the lower jaw sticks out in front of the nose. Complete line 8 of Table 1.

### Sagittal Crest

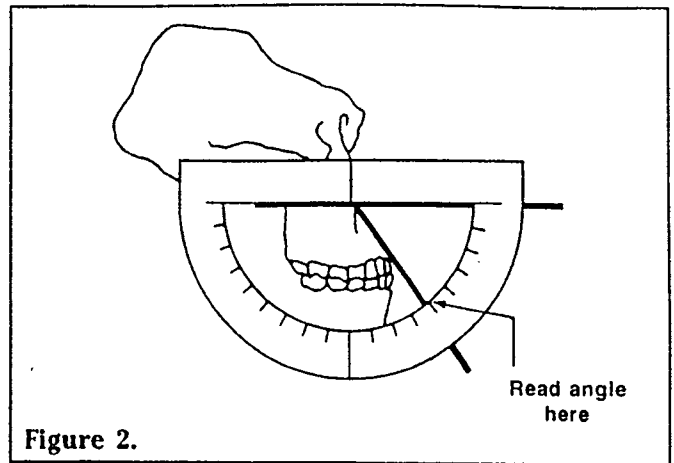
A bony ridge running across the top of a skull for muscle attachment is called a sagittal crest. This bony ridge is associated with heavy temporal muscles used to move the lower jaw.

11. Indicate on line 9 of Table 1 whether a sagittal crest is present or absent in each skull. Refer to Figure 1.

### Brow Ridge (Supraorbital Ridge)

Directly above the eye sockets is a thick bony ridge. This ridge may be present or absent on the skull.

12. Indicate on line 10 of Table 1 whether or not a brow ridge is present.



### Facial Features

13. Place a blank piece of paper over the drawing of the three skulls. With your pencil and colored pencils, try to recreate what the individuals may have looked like when alive. Use bone-shape clues as you make your drawings.

### HYPOTHESIS

## DATA AND OBSERVATIONS

Table 1.

Comparison of Gorilla, <i>Australopithecus</i> , and Modern Human Skulls			
	Gorilla	<i>Australopithecus</i>	Modern human
1. Face area			
2. Brain area			
3. Is brain area smaller than face area?			
4. Is brain area larger than face area?			
5. Is brain area 3 times larger than face area?			
6. Cranial capacity in cm <sup>3</sup>			
7. Jaw angle			
8. Does lower jaw stick out in front of nose?			
9. Sagittal crest present?			
10. Brow ridge present?			

## ANALYSIS

1. Using items 1–5 of your data in Table 1, describe the general differences in face to brain area seen in the three primates. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. Using item 6 of your data, describe the general differences in cranial capacity seen in the three primates. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. Using items 7 and 8 of your data, describe the general differences in jaw angle and prognathism (how far the jaw protrudes forward) in the three primates. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. Using items 9 and 10 of your data, describe the general differences in brow ridge and sagittal crest in the three primates. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
5. How many traits are similar when comparing
  - a. gorilla with *Australopithecus*? \_\_\_\_\_
  - b. *Australopithecus* with modern human? \_\_\_\_\_
  - c. gorilla with modern human? \_\_\_\_\_
6. Based on your answer to question 5, does modern human seem to be closer in evolutionary development to gorilla or *Australopithecus*? \_\_\_\_\_

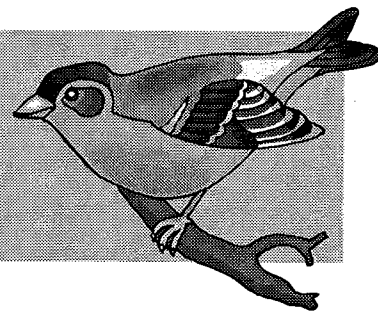
## CHECKING YOUR HYPOTHESIS

Was your hypothesis supported by your data? Why or why not? \_\_\_\_\_  
\_\_\_\_\_

## FURTHER INVESTIGATIONS

1. Obtain drawings of fossil primate skulls, such as Cro-magnon, Neanderthal, *Homo erectus*, and *Homo habilis*. Try to recreate their facial features by drawing over the bone structure.
2. Further investigate human evolution by measuring various features of model and actual human skulls. You may examine the number and type of teeth in the lower jaw, the size of the lower jaw, or the shape of the jaw.

## 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.



"The Beaks of Finches" is a laboratory activity produced by the State Education Department for use in fulfilling part of the laboratory requirement for the Regents Examination in Living Environment. Reproducing any part of this laboratory activity by other than New York State school personnel is illegal.

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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.  


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2. Predict which “beak” will be the *least* successful at picking up small seeds. Give the reasons for your choice.  


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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.”  


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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.

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4. Why did some "beak" types survive on the new island (with large seeds) when they could not survive on the original island?

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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.

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7. Why were there fewer survivors at the end of Round Three?

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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.

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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: \_\_\_\_\_

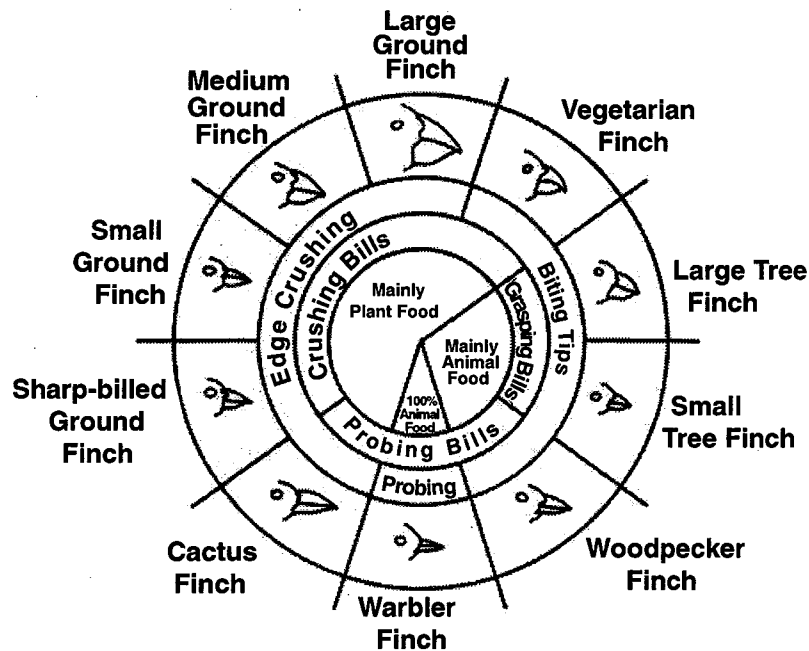
struggle for survival: \_\_\_\_\_

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.

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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.

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- b. Would you expect the two species to compete for food on this island? Support your answer with an explanation.

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- 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.

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12. a. Explain how an island could support large populations of both Large Ground Finches and Small Ground Finches.

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- b. How could you use the materials provided in this lab to test your explanation?

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Data Table for Question #5 of the Analysis Questions

**Class Results**

<b>Beaks That Were</b>	<b>Number of Beak Types</b>	<b>Characteristics of Beaks (Size and Shape)</b>
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		

## Laboratory Activity #1 — Student Laboratory Packet

**Relationships and Biodiversity***A Laboratory Activity for the Living Environment***Introduction**

*Botana curus* is a valuable plant because it produces Curol, a compound used for treating certain kinds of cancer. Curol cannot be produced in the laboratory. *Botana curus* grows very slowly and is on the endangered species list, so its ability to provide Curol in large quantities is limited.

Species that are more closely related to *Botana curus* are more likely to produce the important substance Curol. Three similar plant species that are plentiful (X, Y, and Z) may be related to *Botana curus*. You will work as a researcher to:

- gather structural and molecular evidence to determine which plant species is most closely related to the hypothetical species, *Botana curus*
- use this evidence to decide which plant species is most likely to serve as a source of the important substance Curol

**Safety**

- You will need to wear goggles while conducting Tests 4 and 5.
- Do not eat or drink anything in the laboratory while doing this laboratory activity.

**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 the packet 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.

**Structural Evidence for Relationships**

Perform the following tests and record your observations in Table 1 on page 8 of this packet. Use a hand lens or microscope as needed.

*Test 1—Structural Characteristics of Plants*

- Do not remove the plant samples from the plastic bags/cards.
- Compare the structural characteristics of the plant samples. Record your observations in Table 1 (see page 8).

*Test 2—Structural Characteristics of Seeds*

- Do not remove the seed samples from the plastic bags/cards.
- Compare the structural characteristics of the seed samples. Record your observations in Table 1.



"Relationships and Biodiversity" is a laboratory activity produced by the State Education Department for use in fulfilling part of the laboratory requirement for the Regents Examination in Living Environment. Reproducing any part of this laboratory activity by other than New York State school personnel is illegal.

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### Test 3—Microscopic Internal Structure of Stems

- Use the lowest magnification on your microscope to examine the slides that show cross sections through stems of *Botana curus* and Species X, Y, and Z. Compare the arrangement (circular or scattered) of the bundles of conducting tissue in the specimens. Refer to Figure 1.

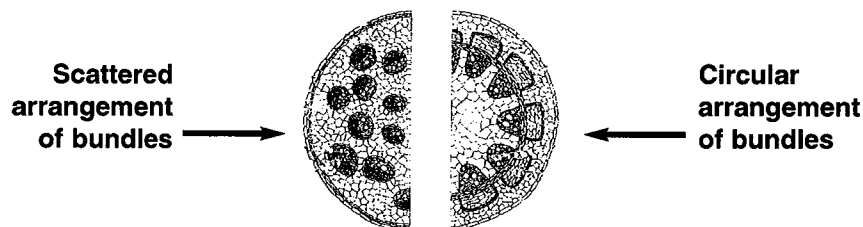


Figure 1

- Record your observations (using words and/or diagrams) of the conducting tissue arrangements in Table 1.

### Hypothesize: Tests 1-3

- Based on your data for structural relationships, which species (X, Y, or Z) would you hypothesize is most likely to produce Curol? \_\_\_\_\_
- 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.

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### Molecular Evidence for Relationships

#### Test 4—Paper Chromatography to Separate Plant Pigments

- You must wear safety goggles when performing this part of the activity.
- Draw a pencil line 2 cm from the bottom of the chromatography paper. Use a pencil to label the top edge of the chromatography paper Bc (*Botana curus*), X, Y, and Z as shown in Figure 1.
- Use a clean microtip dropper to transfer two drops of plant extract from *Botana curus* just above the pencil line as shown in Figure 1.

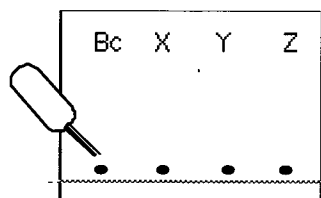


Figure 2

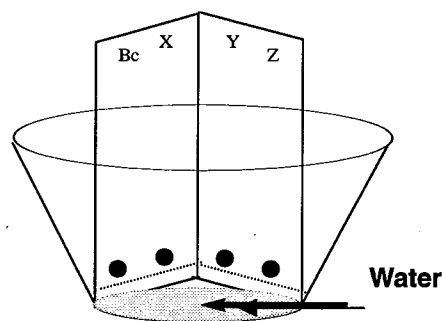


Figure 3

- Using a clean dropper each time, repeat the procedure to place drops of the other plant extracts in the appropriate locations on the paper.



- e. Add just enough water to cover the bottom of the cup approximately 1 cm deep. The water line should NOT be high enough to touch the spots of plant extract on the chromatography paper when the paper is placed in the cup.
- f. Fold the chromatography paper and stand it in the cup as shown in Figure 2.
- g. The chromatography paper must be removed from the cup before the water line reaches the pencil labels at the top of the chromatography paper. While the plant extracts are moving up the chromatography paper, go on to Test 5, but keep checking on the progress of the water moving up the paper so that you can remove it at the proper time.
- h. Once the chromatogram is done, record your observations of the colors and relative amounts of pigments in Table 1.
- i. Clean the microtip droppers thoroughly by rinsing them with water. Carefully pour solutions from the chromatography cup into the waste container. Discard the used chromatography paper.

#### Test 5—Indicator Tests for Enzyme M

- a. You must wear safety goggles when performing this part of the activity.
- b. It is not practical to test a plant directly for Curol. However, if enzyme M is present, a plant may produce Curol.
- c. Test the plant extract from *Botana curus* for the presence of enzyme M. Put one small scoop of indicator powder into one depression of the well tray. Use a clean microtip dropper to add 5 drops of *Botana curus* extract to the indicator powder. A fizzing reaction indicates that enzyme M is present.
- d. Repeat the test for enzyme M using the other plant extracts.
- e. Record the results of your tests for enzyme M in Table 1.
- f. Clean the microtip droppers thoroughly by rinsing them with water. Rinse the well tray and blot it dry using a paper towel.

*Reminder: Complete the chromatography tests and observations before going on.*

#### Test 6—Using Simulated Gel Electrophoresis To Compare DNA

- a. For this test, you will use the plastic bags containing colored paper strips representing portions of DNA molecules. The letters on these strips represent the sequence of bases in DNA molecules isolated from *Botana curus* and Species X, Y, and Z.
- b. To compare DNA molecules, scientists use enzymes that bind to and cut specific base sequences within the DNA. Imagine that you are using an enzyme that binds to the base sequence CCGG and cuts between the C and G. Simulate this cutting process as follows:
  - b1. Remove one of the colored paper strips from the plastic bag labeled *Botana curus*. Locate and lightly shade all CCGG sequences on the DNA from *Botana curus*. The shaded areas represent where the enzyme would bind to cut the DNA.
  - b2. Use scissors to cut off all the “white space” above and below the string of letters representing the DNA bases. Also remove the white paper to the left and right of the string of letters. (This will enable them to fit better in the spaces provided in Table 2 on page 9.)
  - b3. Now cut the strip between the C and G within each of the shaded enzyme recognition sites. This will result in several fragments of DNA.
- c. Scientists use *gel electrophoresis* to separate the DNA fragments resulting from this binding and cutting process. In an electrical field, the negatively charged DNA molecules migrate through a gel-like material toward the positively charged pole. The smaller molecules migrate more rapidly through the gel than the larger ones do.



- d. Simulate the electrophoresis process by placing the DNA fragments from *Botana curus* in the appropriate well on the Simulated Electrophoresis Gel (Table 2). Simulate the effect of electrical current on the DNA fragments by counting the number of letters (bases) in each of the fragments and moving them to the appropriate location on the electrophoresis gel. Refer to the number of DNA letters indicated along the left side of the gel to determine the final position for each fragment.
- e. Call your teacher over to check your work for *Botana curus* before you continue with the DNA from the other species.
- f. Mark a horizontal line to indicate the final position of each fragment of *Botana curus* DNA on the simulated electrophoresis gel (Table 2), then record the size on the fragments (number of bases in each) in Table 1.
- g. Repeat this process for each of the other species (X, Y, and Z): lightly shade the CCGG sequences, cut the DNA, and separate the resulting fragments.
- h. Mark the final position of the DNA bands for each species on the gel (Table 2), then record the size of the fragments (number of bases in each) in Table 1.
- i. Discard the used paper DNA fragments and return all other materials to their original location.

#### Test 7—Translating the DNA Code To Make a Protein

- a. The sequences of DNA bases below represent parts of the genes responsible for the production of one type of protein, an enzyme, produced by *Botana curus* and Species X, Y, and Z.
- 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 messenger 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 \_\_\_\_\_

Sequence of amino acids in the protein \_\_\_\_\_

#### Species X

CAC GTG GAC AGA GGA CAC CTC

Sequence of bases in mRNA produced \_\_\_\_\_

Sequence of amino acids in the protein \_\_\_\_\_

#### Species Y

CAC GTG GAC AGA GGA CAC CTC

Sequence of bases in mRNA produced \_\_\_\_\_

Sequence of amino acids in the protein \_\_\_\_\_

#### Species Z

CAC GTA GAC TGA GGA CTT CTC

Sequence of bases in mRNA produced \_\_\_\_\_

Sequence of amino acids in the protein \_\_\_\_\_



- State how the amino acid sequence you obtained from the gene fragment for *Botana curus* compares with the sequences for the other three species.

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- Summarize your observations of the number of differences in Table 1.

### 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. \_\_\_\_\_ Explain your choice by citing specific evidence from your research.

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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.

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3. Which kind of evidence—structural or molecular—is most helpful in making decisions about relationships between species? \_\_\_\_\_ Explain why.

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4. Based on your observations, list three characteristics (structural or molecular) that all four species have in common.

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5. Provide a biological explanation for the common characteristics that these species share.

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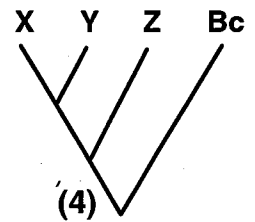
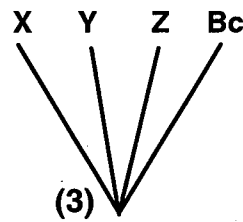
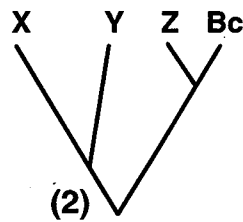
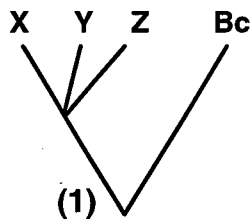


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6. Scientists frequently use branching tree diagrams to represent graphically the relationships between species. Which branching tree, shown below, best represents the relationships among the four species? \_\_\_\_\_



Explain how you used the information on the data table to select this tree.

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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.

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Base your answers to questions 8 through 10 on the reading passage below and on your understanding of biology.

### The Biodiversity Crisis

Plant and animal species are being lost at a rate that is unprecedented in the history of life. Human activities are responsible for much of this biodiversity crisis. Some biologists estimate that within the next century, half of Earth's current species may become extinct.

Extinction and the loss of biodiversity occurs when species do not have adaptations that enable them to survive environmental changes. Human activities such as destruction of natural habitats and pollution are thought to be the major environmental factors causing the decline of species, but others are also important. Overhunting, introduction of foreign species that compete with native species, and removal of predators have also played a significant role in endangering some species.

Why should we worry about the loss of biodiversity? We depend on many species for food, clothing, shelter, oxygen, soil fertility—the list goes on and on. Large-scale extinctions of other species may be a warning to us that we are altering the biosphere so rapidly that our species is threatened too.

Biodiversity ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries having significant value to humankind. Some species have been used as sources for medicines and other useful products. Scientists now use genetic engineering to transfer desirable genes from one species to another. As diversity is lost, potential sources of these genetic materials may be lost with it.

Biodiversity also increases the stability of the ecosystem. Every population is linked, directly or indirectly, with many others in an ecosystem. Disruptions in the numbers and types of one species can upset ecosystem stability. This means that extinction of one species can accelerate the rate of extinction for other species.

Endangered species hold medicinal, agricultural, ecological, commercial, and aesthetic value. They must be protected so that future generations can experience their presence and value.

Assume that the plant you identified as being closely related to *Botana curus* grows rapidly, survives in many environments, and produces Curol. News reports indicate that *Botana curus* plants may become extinct unless expensive efforts are made to preserve the species. Members of your research team disagree as to whether or not *Botana curus* should be saved.

8. State three examples of human activities that could endanger *Botana curus*.

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9. State three reasons why it might be important to preserve *Botana curus*.

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10. State two arguments people might make for NOT preserving *Botana curus*.

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## Universal Genetic Code Chart

Messenger RNA codons and the amino acids they code for.

		SECOND BASE				
		U	C	A	G	
FIRST BASE	U	UUU } UUC } <b>PHE</b> UUA } UUG } <b>LEU</b>	UCU } UCC } <b>SER</b> UCA } UCG }	UAU } UAC } <b>TYR</b> UAA } UAG } <b>STOP</b>	UGU } UGC } <b>CYS</b> UGA } <b>STOP</b> UGG } <b>TRP</b>	U C A G
	C	CUU } CUC } <b>LEU</b> CUA } CUG }	CCU } CCC } <b>PRO</b> CCA } CCG }	CAU } CAC } <b>HIS</b> CAA } CAG } <b>GLN</b>	CGU } CGC } <b>ARG</b> CGA } CGG }	U C A G
	A	AUU } AUC } <b>ILE</b> AUA } AUG } <b>MET</b> or <b>START</b>	ACU } ACC } <b>THR</b> ACA } ACG }	AAU } AAC } <b>ASN</b> AAA } AAG } <b>LYS</b>	AGU } AGC } <b>SER</b> AGA } AGG } <b>ARG</b>	U C A G
	G	GUU } GUC } <b>VAL</b> GUA } GUG }	GCU } GCC } <b>ALA</b> GCA } GCG }	GAU } GAC } <b>ASP</b> GAA } GAG } <b>GLU</b>	GGU } GGC } <b>GLY</b> GGA } GGG }	U C A G
						THIRD BASE

*Note:* Amino acid abbreviations are in bold type (e.g., PHE, LEU, SER, etc.)



Table 1: Comparison of *Botana curus* with Species X, Y, and Z

Species	Structural Evidence			Molecular Evidence			
	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							
Species X							
Species Y							
Species Z							



Table 2: Simulated Electrophoresis Gel

- Negative Pole -

Wells → # of DNA bases	Botana curus	Species X	Species Y	Species Z
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 +

### Introduction

A tissue is a group of cells that have a similar shape and function. Different types of tissues can be found in different organs. In humans, there are four basic types of tissue: epithelial, connective, muscular, and nervous tissue.

- 1) **Epithelial tissue** covers the body surface and forms the lining for most internal cavities. The major function of epithelial tissue includes protection, secretion, absorption, and filtration. The skin is an organ made up of epithelial tissue which protects the body from dirt, dust, bacteria and other microbes that may be harmful. Cells are typically flat and thin and an epithelial layer is usually no more than a few cells thick. Epithelial tissue is constantly being replaced as cells die.
- 2) **Connective tissue** is the most abundant and the most widely distributed of the tissues. Connective tissues perform a variety of functions including support and protection. The following connective tissues are found in the human body: fat tissue, cartilage, ligaments, tendons, bone and blood.

Bones contain hollow channels called Haversian canals, which contain blood vessels that enter the bone through the periosteum (tough membrane that covers the bone). Some bones contain red marrow, which is the site of blood cell and platelet formation.

- 3) **Muscle tissue**: There are 3 types of muscle tissue: **skeletal**, **smooth**, and **cardiac**. Skeletal, or striated, muscle is a voluntary type of muscle tissue that is used in the contraction of skeletal parts. Smooth muscle is found in the walls of internal organs and blood vessels. It is an involuntary type. The cardiac muscle is found only in the walls of the heart and is involuntary in nature.
- 4) **Nerve tissue** is composed of specialized cells which not only receive stimuli but also conduct impulses to and from all parts of the body. Nerve cells or neurons are long and string-like.

In tissues, the simplest combination is called a membrane, or a sheet of tissues which cover or line the body surface or divide organs into parts. Examples include the mucous membrane which lines body cavities.

Tissues combine to form organs. An organ is a part of the body which performs a definite function.

The final units of organization in the body are called systems. A system is a group of organs each of which contributes its share to the function of the body as a whole.

## Procedure

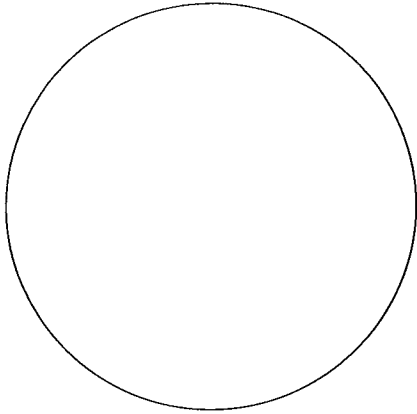
1. View prepared slides of the following tissues:
  - a) Nerve tissue
  - b) Epithelial tissue: label the **nucleus** and the **cell membrane**
  - c) Muscle tissue
    - 1) smooth
    - 2) cardiac
    - 3) skeletal
  - d) Bone: label the **Haversian canals**
  - e) Cartilage or ligament tissue
  - f) Adipose (fat) tissue
  - g) **BLOOD**
2. Draw a picture of each tissue type in your notebook.
  - a) Use colored pencils
  - b) Indicate magnification (use **HIGH** powered objective for your drawings)
  - c) Label what tissue sample you are drawing.
3. Be sure to return your slides to the front table in the correct trays!

## Analysis

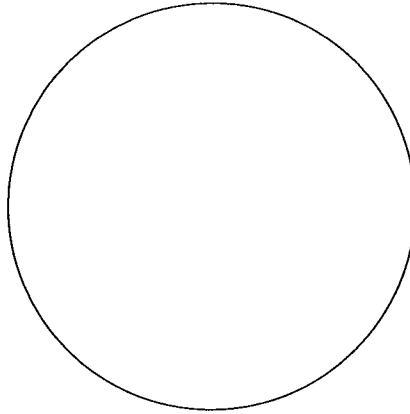
1. Define: a) cell      b) tissue      c) organ.
2. Using complete sentences, describe the 4 types of body tissues. Indicate:
  - a) The function of each tissue type
  - b) Where in the body each type can be found
3. Contrast the appearance, location and function of the three types of muscles. Be sure to state which are “striated”.
4. Using **one** example from the human body, explain how the levels of organization (body systems, cells, organs and tissues) are arranged, starting with the smallest and ending with the largest.

## Conclusion

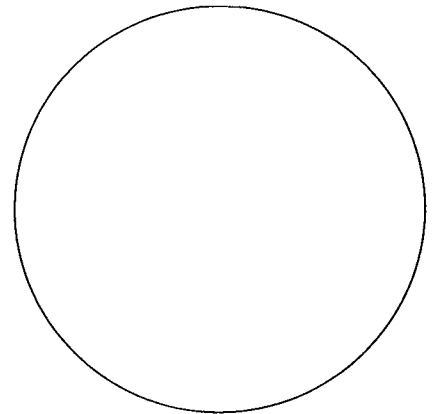
Nerve tissue



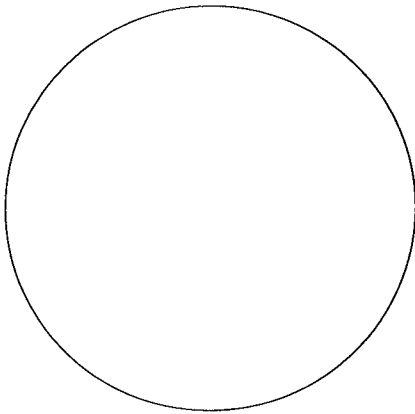
Epithelial tissue



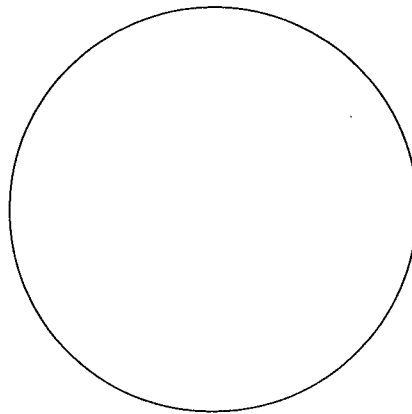
Smooth muscle



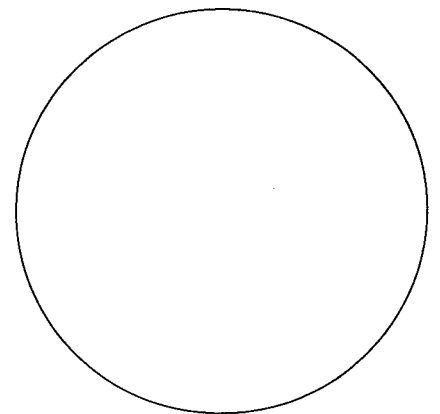
Cardiac muscle



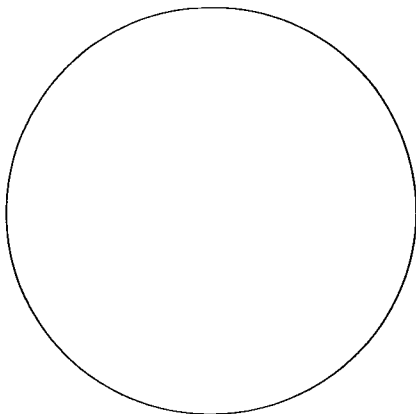
Skeletal muscle



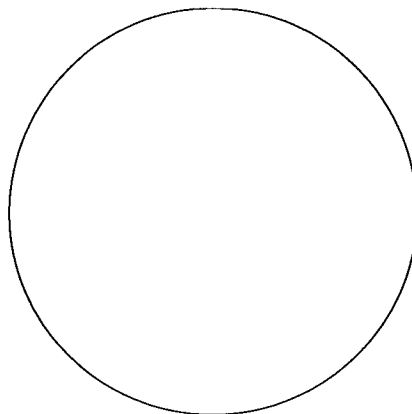
Bone tissue



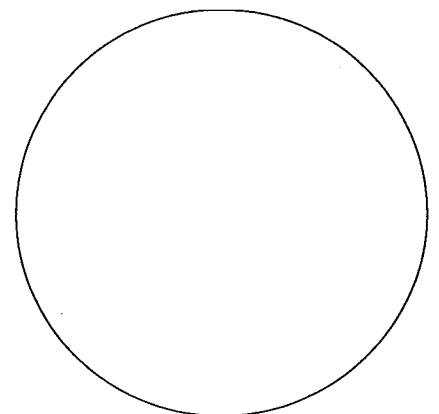
Cartilage or ligament



Adipose tissue



Blood







## Laboratory Investigation

The Human Body

**1**

# Investigating Tissues

### Background Information

There are four types of tissues in the human body: muscle, connective, nerve, and epithelial. Muscle tissue moves body parts. Connective tissue supports the body and unites some of its parts. Nerve tissue carries messages back and forth between the brain and spinal cord and every part of the body. Epithelial tissue forms a protective surface on the outside of the body and lines many cavities within the body.

In this investigation you will observe the four types of tissues in a chicken wing.

### Problem

What are the four types of tissues?

### Materials (per group)

chicken wing  
paper towels  
scissors  
dissecting tray  
dissecting needle

### Procedure - PART A

1. Obtain the chicken wing from your teacher.
2. Rinse the chicken wing under running water and thoroughly dry it with paper towels. Place the chicken wing in a dissection tray.
3. Examine the skin covering the chicken wing.
4. Remove the skin from the wing using the scissors. **CAUTION:** Be careful when using scissors. Carefully cut the skin along the entire length of the chicken wing as shown in Figure 1. Try not to cut through the muscles located below the skin.

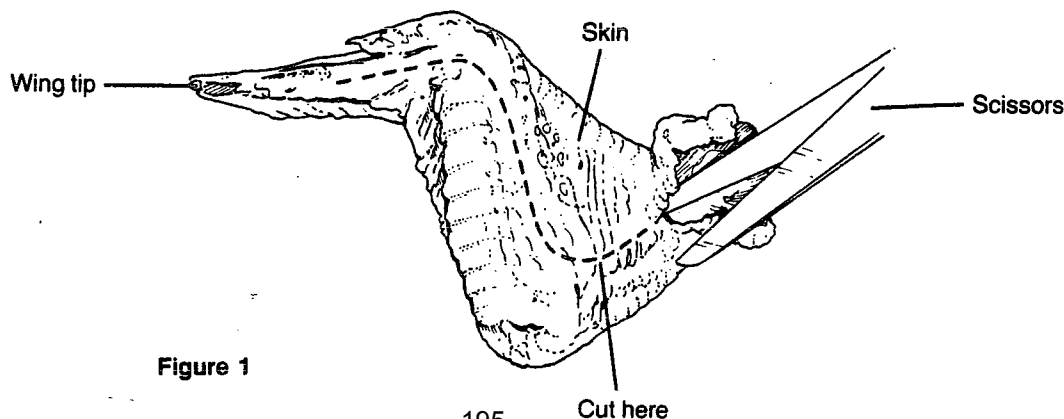


Figure 1

5. Notice the yellowish tissue found in small clumps on the inside of the skin. This tissue is a type of connective tissue called fat.
6. Observe the muscles on the chicken wing. The muscles are bundles of pale pink tissue that surround the bone.
7. Observe the shiny white tissue, or tendons, at the ends of the muscles. Tendons attach muscle to bone.
8. Notice the whitish tissue, or ligaments, between the bones. Ligaments hold bones together.
9. Locate a thin, white strand of material with the dissecting needle. Carefully pull the strand aside with the dissecting needle. This strand is a nerve.
10. Notice a thin reddish-brown strand of tissue. Pull it aside with the dissecting needle. This strand is a blood vessel.
11. In Figure 2, label a tendon, a muscle, and a bone.
12. Thoroughly wash your hands with soap and water.
13. Return all equipment to the storage area. Return the chicken wing to your teacher.

### Observations

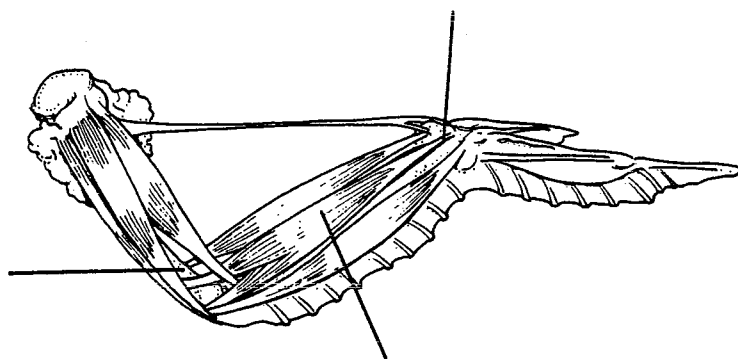


Figure 2

### Analysis and Conclusions

1. Identify the following types of tissues as connective, muscle, nerve, or epithelial.

- a. Tendon \_\_\_\_\_
- b. Nerve \_\_\_\_\_
- c. Fat \_\_\_\_\_
- d. Blood vessel \_\_\_\_\_
- e. Skin \_\_\_\_\_
- f. Ligament \_\_\_\_\_
- g. Bone \_\_\_\_\_
- h. Muscle \_\_\_\_\_

Lab # \_\_\_\_\_ The Chicken Wing - How Muscles and Bones Interact

*Answer the following Prelab Questions:*

(1) How does a muscle move a bone? \_\_\_\_\_  
\_\_\_\_\_

(2) How are muscles attached to bones? \_\_\_\_\_

(3) What is the difference between a tendon and a ligament? \_\_\_\_\_  
\_\_\_\_\_

(4) Why is cartilage found between bones? \_\_\_\_\_  
\_\_\_\_\_

Observations and Data:

(a) Is your wing, the left wing or the right wing? \_\_\_\_\_

(b) Describe the appearance of the skin and state how it is attached to the lower layers: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(c) Describe the appearance of the connective tissue wrapped around the muscle groups: \_\_\_\_\_  
\_\_\_\_\_

(d) Match the following human joints to homologous structures (joints) in the chicken wing:

**ELBOW**

**SHOULDER**

**WRIST**

(a) Upper wing and body \_\_\_\_\_

(b) Lower wing and wing tip \_\_\_\_\_

(c) Upper wing and lower wing \_\_\_\_\_

(e) Explain the difference in function between a tendon and a ligament: \_\_\_\_\_  
\_\_\_\_\_

## The Chicken Wing - How Muscles and Bones Interact

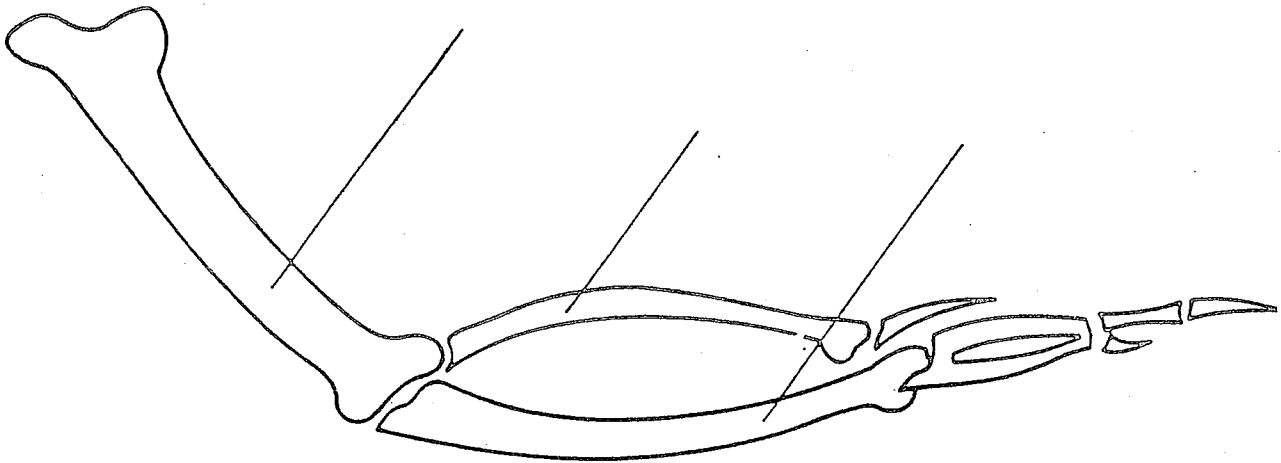
(f) On the sketch of the bones found in the chicken wing,

(1) Label: humerus, radius, ulna

(2) Sketch and color the biceps and triceps muscles on either side of the humerus

Biceps(flexor)bends a joint (**RED**) Triceps(extensor)straightens a joint (**YELLOW**)

(3) Sketch in and label: ligament, tendon, joint, cartilage and any other muscles



g. Describe the appearance of a ligament and explain how it is different from a tendon: \_\_\_\_\_

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-----

h. How did removing the muscles and the tendons from the wing affect the stability of the joint?

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i. What characteristics of the joint enable it to move smoothly? \_\_\_\_\_

-----

j. Sketch and write a description for the bone marrow, compact bone and spongy bone.

Sketch of bone cross section

## The Chicken Wing - How Muscles and Bones Interact

Clean up and answer the following questions:

1. How do tendons differ from muscle tissue in appearance and function? \_\_\_\_\_

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2. Describe how bones, cartilage and ligaments form joints: \_\_\_\_\_

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3. Describe how muscles work in opposition to move the chicken wingtip: \_\_\_\_\_

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4. Give one similarity and one difference between the human arm and the chicken wing: \_\_\_\_\_

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5. Write an inference about the evolution of forelimb structures in vertebrates based upon your observations in this lab:

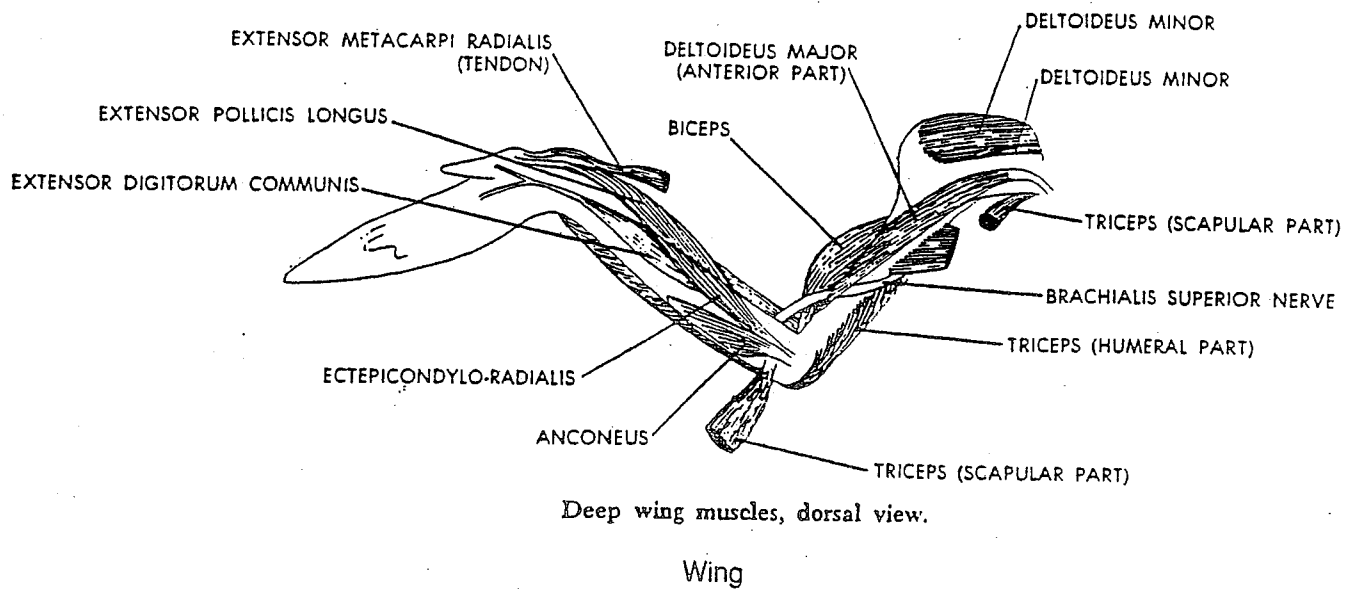
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6. The chicken is not capable of sustained flight. How do you think the structure of the chicken wing differs from the structure of the wing of a bird that flies long distances? (hint: refer to pigeon wing diagram in lab directions). \_\_\_\_\_

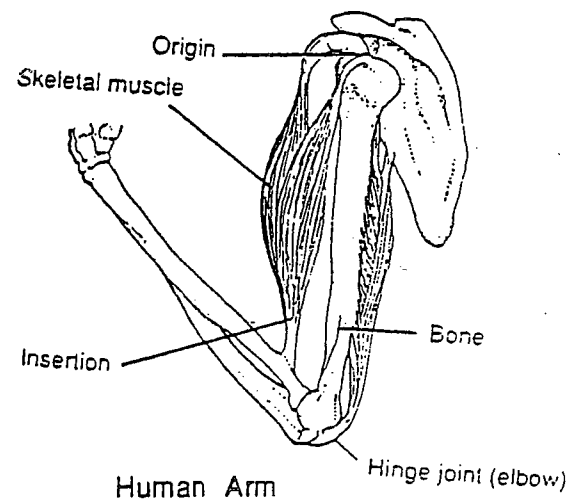
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Prepare a Lab report to include:

- Purpose
- Hypothesis
- Materials
- Procedure
- Data Sheets completed with: observations, diagrams, and questions completed
- Conclusion



# Measuring Lung Capacity

## Introduction

The amount of air that you move in and out of your lungs depends on how quickly you are breathing. The amount of air that is moved in and out of the lungs when a person is breathing normally is called the tidal volume. This amount of air provides enough oxygen for the body when the person is resting. It is possible to inhale more deeply and exhale more forcefully than usual. The maximum amount of air moved in and out of the lungs when the deepest possible inspiration is followed by the strongest possible expiration is called the vital capacity.

In this investigation, you will determine the tidal volume and vital capacity of your lungs. You will also determine if physical characteristics impact physiological qualities.

## Problem

How are the tidal volume and the vital capacity of humans related?

Do physical characteristics (height, weight...) impact physiological qualities (vital capacity, blood pressure...)?

## Hypothesis

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## Materials

- metric ruler
- bathroom scale
- spirometer
- replacement straws
- sphygmomanometer
- stop watch

## Procedure

### A. Measuring tidal volume

1. Place a new straw on the end of the spirometer and zero the spirometer.
2. Place spirometer in your mouth, inhale normally through your nose and exhale normally through your mouth five times. Divide spirometer number by five and place this value in Table 1.
3. Repeat two more times and average.
4. Complete Part B before sharing your spirometer.

### B. Measuring vital capacity (Table 1)

1. After inhaling normally, inhale as much air into your lungs as possible. Exhale as much air as possible from you lungs into the spirometer.
2. Repeat two more times and average.

C. Measuring Pulse and Blood Pressure (Table 2)

1. Place blood pressure cuff around arm and tighten Velcro cuff loosely with the air tube going down the center of the arm.
2. Increase pressure in the cuff by squeezing the bulb. DO NOT over inflate! Stop increasing pressure either at 160 mgHg or when the cuff beeps.
3. Release bulb and the cuff will slowly release the pressure. When the cuff gives a series of beeps release the remaining pressure by pressing in on the release valve attached to the valve.

D. Class Comparison

1. Measure your height in centimeters \_\_\_\_\_.
2. Input all data into class computer in front.
3. Create a line graph which correlates to your hypothesis.
4. Data Retrieval:
  - a. Log in and go to HS shared on bcsd on the S drive
  - b. Go to the Student Community folder
  - c. Go to Class folders
  - d. Go to your teacher and class folder
    - i. SAVE into your account. DO NOT manipulate data until saved
    - ii. Manipulate data using the sort button to help find a correlation.
    - iii. Print a copy of the new data table to include in your report.

Table 1 Lung Volume		
Trial	Tidal volume (cm3)	Vital cap. (cm3)
1		
2		
3		
Average		

Table 2. Blood pressure and pulse

	Systolic Pressure (mgHg)	Diastolic Pressure (mgHg)	Pulse (bpm)
Standing			
Sitting			
Lying down			



## ANALYZE

- Figure 4 shows measurements of a jogger's vital capacity. The measurements were taken using a method similar to the one you used in this investigation. The vital capacity was measured at the beginning of the jogger's training period and then every five days after that. Use the data in Figure 4 to construct a line graph on the graph provided.

Day of Training Period	Vital Capacity (cm <sup>3</sup> )
0	4800
5	4830
10	4890
15	4910
20	4960
25	5040
30	5130

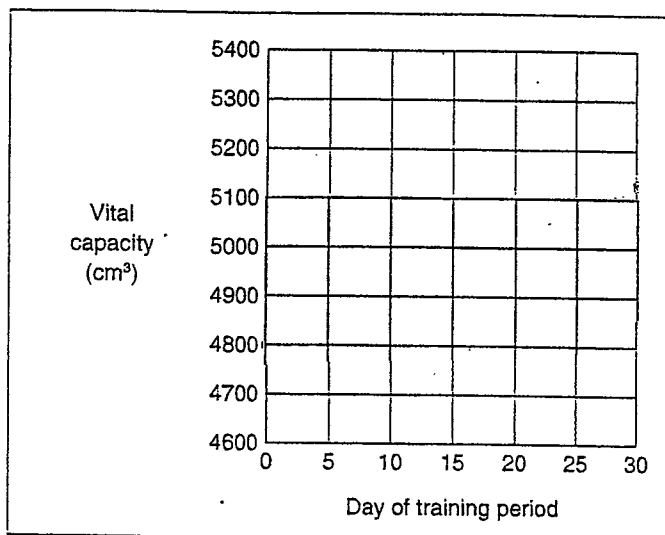


Figure 4

- What happened to the jogger's vital capacity as the training period progressed?

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- What probably caused the change in the jogger's vital capacity?

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- How might vital capacity be important to some musicians?

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- How do you think smoking would affect vital capacity?

---



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Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

**ANALYZE...**

6. Why is it important to measure tidal volume and vital capacity three times and calculate averages for these measurements? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
7. How do your tidal volume and vital capacity compare with those of other class members? Why might there be some variation in the measurements of different people? (SEE DATA TABLE 4.) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
8. How does your estimated vital capacity compare to your measured vital capacity? \_\_\_\_\_  
\_\_\_\_\_
9. If there is a difference, suggest a reason for this. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
10. Why might it be important to know a person's tidal volume or vital capacity? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
11. Even when you exhale as forcefully as possible, some air remains in the lungs. Why is this an important occurrence? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**CONCLUDE**

CONCLUSION: ... (ALWAYS!)

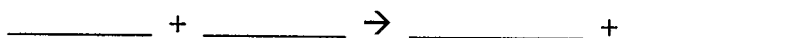
## Measuring Carbon Dioxide Production

### Objectives:

- \*You will learn how to measure CO<sub>2</sub> produced by respiration
- \*You will perform a controlled experiment to observe the effect of exercise on the production of CO<sub>2</sub>

### Background:

Carbon dioxide is a waste product of *internal respiration*. Internal respiration is the chemical reactions within your cells that oxidize your food. This process releases the chemical energy of these organic molecules, like glucose, and transfers this energy to the cell's direct source of energy- ATP! The chemical reactions of internal respiration are also known as *aerobic cellular respiration*. Write the general equation of aerobic cellular respiration below:



The Carbon Dioxide from cellular respiration is excreted from your cells, blood, and body every time you exhale. In this activity, you will observe the change in CO<sub>2</sub> production and excretion when a person goes from resting to exercising.

Make a hypothesis now:

Question- How will exercise affect the production and excretion of CO<sub>2</sub>?

Your Hypothesis-

Your reasoning-

When CO<sub>2</sub> dissolves in water (or blood plasma) it becomes CARBONIC ACID!



Phenol Red is a chemical indicator that is RED when a solution is basic (pH >7), but turns clear when a solution becomes acidic (pH <7). Phenol Red can be used as an indicator of CO<sub>2</sub> production by measuring the amount of exhaled air required to turn the solution from red → clear.

Procedure:

NOTE: Wear safety goggles during this experiment and be careful when blowing into any chemical so you don't splash into your eyes!!

1. Use a pipette to force air bubbles into the phenol red for 60 sec. Record your observations.
2. Measure 100 mL of Phenol Red and pour this into a 200mL flask.
3. Use a straw to blow bubbles into the liquid at a constant rate until it turns completely clear. Make sure your partner times how many seconds required to turn the liquid clear. Record your data.
4. Now, the person who exhaled into the solution must exercise lightly for 2 minutes while the timer prepares another flask containing 100mL of new Phenol Red (be sure to rinse the flask!)
5. After exercise, repeat step 3, and record the time required to turn the liquid clear. Record your data.
6. Compile class data to calculate an average.

Data

TIME REQUIRED TO TURN PHENOL RED CLEAR (SECONDS)

	RESTING	AFTER EXERCISE
YOUR DATA		
CLASS AVERAGE		

Analysis:

1. Does the data support/or not support you hypothesis? Explain.
2. Explain the results of this experiment.
3. What are the independent and dependent variables in this activity? Explain.
4. Describe two important control measures you used in this experiment. Why?

## Blood Typing Whodunit

Adapted from Ward's Simulated Blood Typing

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

### Introduction

Around 1900, Karl Landersteiner discovered that there are at least four different kinds of human blood based on the presence or absence of specific antigens (proteins) on the surface of red blood cells. These antigens have been designated as A and B. Instructions for making these A and B antigen proteins are encoded in DNA.

Landersteiner along with his colleague Wiener later discovered another group of antigens called Rh factors. Most people have the Rh antigen on their red blood cells and are therefore known as Rh positive. Those that lack the Rh factor are Rh negative. Blood types are made up of two parts, the first part indicates which A and/or B antigens are present and the second part indicates if the Rh antigen is present.

Antigens on the surface of cells may trigger an immune response if an antibody that “recognizes” the antigen is present in the blood. In the case of blood cells, this response will cause agglutination, or clumping, if the antigen on the red blood cells combines with an antibody. This is why it is so important to “type” a person’s blood if they need a transfusion. Even a small amount of the wrong type of blood can cause a serious, sometimes fatal, reaction.

### Prelab Activity

Complete the chart below before you begin. The first one is done for you.

<u>Blood Type</u>	<u>RBC Antigen</u>	<u>Antibody Present</u>	<u>Can Receive from...</u>	<u>Can Donate to...</u>
<b>A</b>	A antigen	Anti – B antibody	A & O	A & AB
<b>B</b>				
<b>AB</b>				
<b>O</b>				

Blood type \_\_\_\_\_ is considered the “universal donor”, because it can give blood to any other type.

Blood type \_\_\_\_\_ is considered the “universal receiver”, because it can be given blood from any other type.

### Crime Scene Scenario

Mr. Smith had come home, only to find robbers in his apartment. As the criminal rushes to leave the scene, he runs through a glass door cutting his arm. The crime scene investigators at the scene were able to obtain a sample of the criminal’s blood. Your job will be to analyze this blood, along with blood samples of several suspects, to determine who may be eliminated as a suspect.

### Materials

“Blood” samples from: crime scene, victim, suspect #1, suspect #2, suspect #3 and suspect #4  
6 Blood Typing Trays  
Stirring Sticks

## Procedure

- 1) Label each of your blood typing trays using either a wax pencil or masking tape and a pen.
- 2) Add 3-4 drops of each blood sample into the 3 wells on the designated blood typing tray.
- 3) Add 3-4 drops of the anti-A antibody serum into the **A** well of each tray.
- 4) Add 3-4 drops of the anti-B antibody serum into the **B** well of each tray.
- 5) Add 3-4 drops of the anti-Rh antibody serum into the **Rh** well of each tray.
- 6) Using **SEPARATE** stirring sticks to avoid contamination, gently stir each well. Be sure to thoroughly clean a stirring stick before inserting it into any other well, including a well on the same tray!!
- 7) Record your observations below. Indicate where **agglutination** or **no agglutination** occurs.

**Table 1:** Data

<u>Blood Source</u>	<u>Anti-A</u>	<u>Anti-B</u>	<u>Anti-Rh</u>	<u>Blood Type</u>
<b>Crime Scene</b>				
<b>Victim</b>				
<b>Suspect #1</b>				
<b>Suspect #2</b>				
<b>Suspect #3</b>				
<b>Suspect #4</b>				

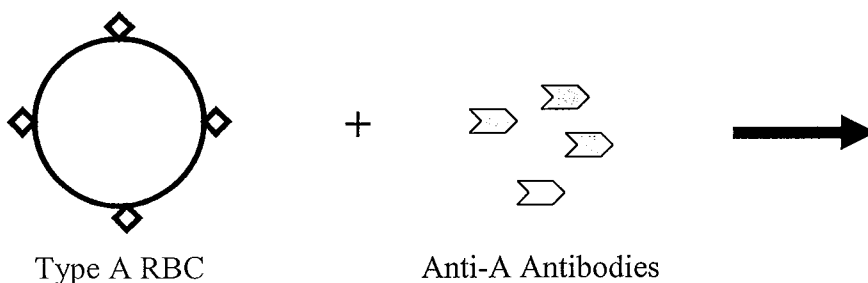
**Table 2:** Agglutination Reactions

<u>Anti-A</u>	<u>Anti-B</u>	<u>Blood Type</u>
Agglutination	No Agglutination	Type A
No Agglutination	Agglutination	Type B
Agglutination	Agglutination	Type AB
No Agglutination	No Agglutination	Type O

- 8) Using Table 2 and your observations, determine the blood type of each individual. Remember to include Rh factor in addition to the ABO type

### Analysis

- 1) Based on your observations, which suspect would you say committed the robbery?
- 2) Do your observations “prove” that the suspect actually committed the robbery? EXPLAIN!
- 3) What further test(s) could be carried out on the blood samples to affirm who committed the crime?
- 4) Why is it necessary to type the victim’s blood?
- 5) What antigen(s) is (are) present are present on the red blood cells of the robber?
- 6) What antibodies are present in the plasma of the robber?
- 7) The suspected robber checked into a local hospital, needing a blood transfusion from the loss of blood he had after cutting his arm. Which blood type(s) could he safely receive?
- 8) Draw what would happen during the antigen-antibody reaction below:







# Capillary Circulation in Goldfish – “Goldfish Lab”

Lab # \_\_\_\_

Modified 6/09 from “Biology Investigations” Investigation #29

## Introduction:



In a closed circulatory system, blood travels from the heart to all parts of the body by way of arteries, and returns to the heart by way of veins. The blood vessels that connect the arteries and veins are called capillaries, the most numerous of all the blood vessels. Various substances, such as digested nutrients, water, oxygen, and dissolved mineral salts, leave the capillaries and eventually enter the tissue cells. At the same time, dissolved metabolic wastes such as urea leave the cells and enter the blood. Eventually the wastes are excreted by certain organs in the body.

The exchange of materials between the blood and the tissue cells occurs only through the walls of the capillaries. As you would expect, capillaries are adapted to this function.

## Objectives:

- ◆ Examine the webbed part of the tail of a living goldfish under the microscope to locate and identify blood moving through capillaries, small arteries, and small veins.
- ◆ Estimate diameters of capillaries, small arteries, and small veins.

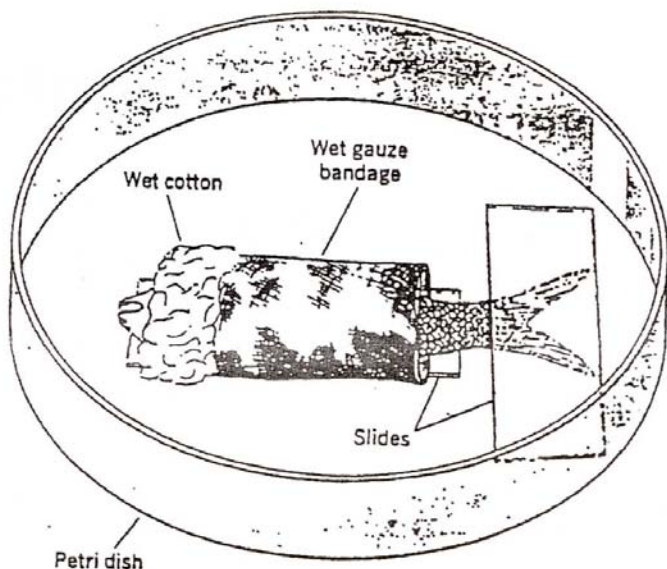
## Materials:

- |                  |              |                    |
|------------------|--------------|--------------------|
| ◆ small goldfish | ◆ petri dish | ◆ absorbent cotton |
| ◆ microscope     | ◆ pipette    | ◆ gauze bandage    |
| ◆ glass slides   | ◆ glass jar  | ◆ fish net         |

## Procedure:

### Part A

1. Soak a strip of bandage in water, catch the goldfish with the net, and lay the fish lengthwise on a slide.
2. Wrap the bandage around the middle section of the fish and slide, leaving the head and tail fin exposed.
3. Place the preparation in the petri dish and then cover the head region of the fish with soaked cotton.
4. Gently spread the tail fin of the fish and cover the fin with another slide (or part of a slide) to keep the fin flat and prevent its movement.
5. Remove the clips from the stage of the microscope and adjust the diaphragm to obtain the best light.
6. Place the petri dish on the stage so that the thinnest part of the tail fin is directly over the opening in the stage.
7. Focus under low power only. Constantly turn the fine adjustment to focus on different levels in the thickness of the fin.
8. Every two minutes drop some water on the cotton and near the side covering the tail of the fish.



## Question:

1. What is the reason for step 3 in the procedure?

## Part B:

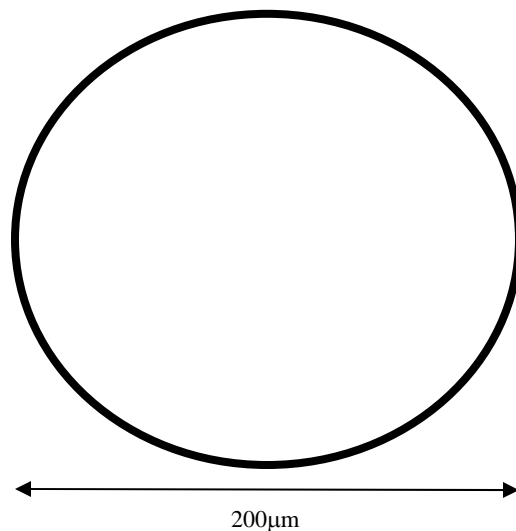
As you focus, you will see blocks of white material. Disregard these. They are blocks of tissue that support the webbing of the fin. Look for the movement of blood within tiny blood vessels. Recall that the image seen in a microscope is reversed and that the heart of a fish is just behind the head. By studying the direction of the blood flow, you can determine whether you are viewing an artery or a vein. Look for a blood vessel in which the blood cells are moving slowly and in single file. Such a blood vessel is a capillary. Study the blood vessels that lead to the capillary and the vessels that lead away from it. Determine which vessels are arteries and which are veins.

In the space provided to the right, draw, color and label what you see in your field of vision on the microscope.

### Label the following:

- ◆ Arteries
- ◆ Veins
- ◆ Capillaries

Using arrows ( → ) indicate the direction the blood is moving in each of the blood vessels you have identified.



Return the fish to the aquarium and clean up your work area.

## Questions:

2. When you see the blood of the fish moving toward the head, in which direction is it really moving?

3. In which type of blood vessel is the rate of blood flow fastest? \_\_\_\_\_

4. In which type of blood vessel is the rate of flow slowest? \_\_\_\_\_

5. In which type of blood vessel does blood flow in spurts? \_\_\_\_\_

6. In which type of blood vessel does blood flow evenly? \_\_\_\_\_

7. Using the diagram you have drawn above, and given the diameter of your field of vision is 200µm, estimate the diameter of ...

An artery \_\_\_\_\_

A vein \_\_\_\_\_

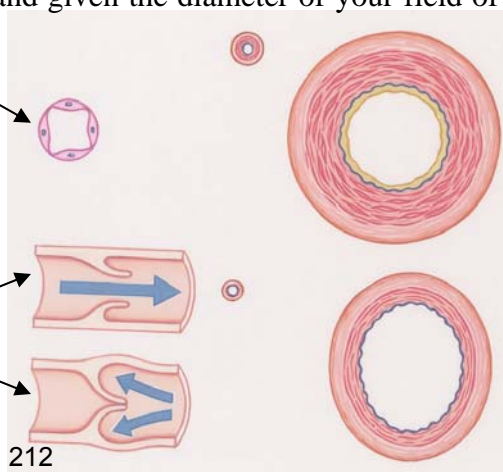
A capillary \_\_\_\_\_

*Notice the one-way valves in veins*

*Capillary*

*Artery*

*Vein*



## Conclusion and Related Questions:

1. What are the functions of capillaries?

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2. How are capillaries adapted to carry out these functions?

---

3. What is the advantage of having red blood cells pass through capillaries in single file?

---

4. Most tissues have a more abundant supply of capillaries than arteries or veins. Explain why this is the case.

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5. What is the relationship between vitamin C and normal capillary function?

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6. a. Which type of blood vessel is the most narrow?

---

- b. How many cells thick is this blood vessel?

---

7. a. What type of blood vessel has the thickest wall?

---

- b. How does the structure of this blood vessel help circulate blood?

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8. Which major tissue is present in arteries and veins but is absent in capillaries?

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9. Can diffusion occur through the walls of arteries and veins? Explain why or why not

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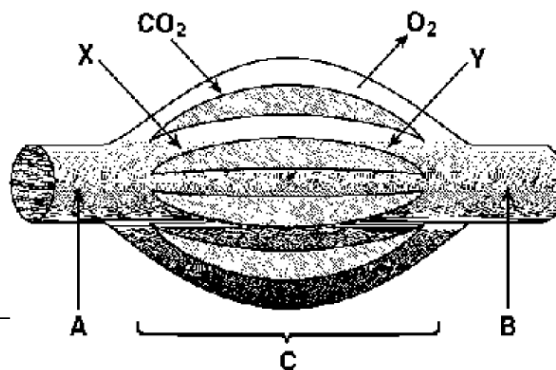
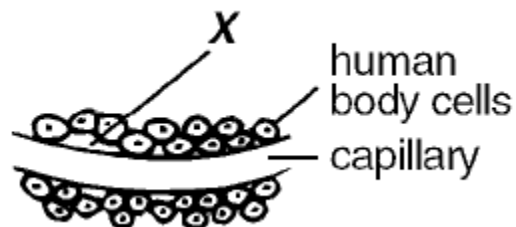
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10. In the diagram to the right, the pressure in vessel B is greater than the pressure in vessel A. Draw an arrow that shows the direction of the blood flow.

11. Is this capillary bed part of pulmonary or systemic circulation? Explain your reasoning.

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# How Does Exercise Affect Heartbeat Rate?

30-2

LAB

## INVESTIGATION

► The heart pumps blood to all the cells of the body. As you exercise, the muscle cells use more oxygen and food, which must be replenished. The cells also produce more wastes, which must be removed. The heart responds to the changing needs of body cells by pumping harder.

## OBJECTIVES

- Determine your heartbeat rate by taking your pulse.
- Hypothesize the effect of exercise on heartbeat rate.
- Compare your heartbeat rate during rest and during exercise.

## MATERIALS

stopwatch or clock with second hand

## PROCEDURE

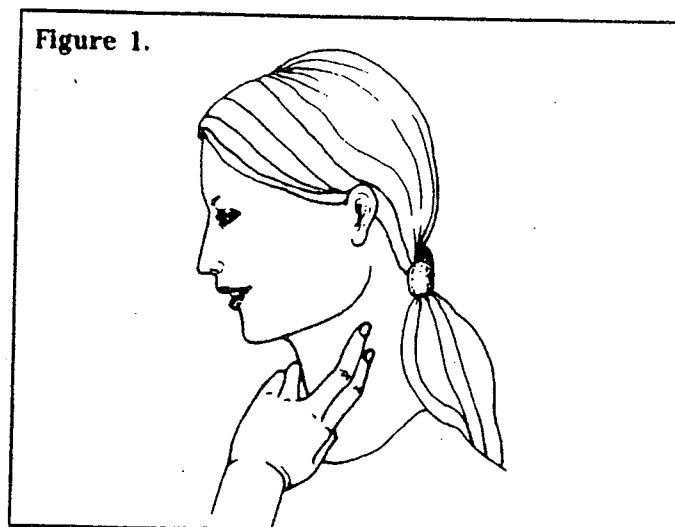
### Part A. Resting Pulse

1. Locate your pulse by placing your index and middle fingers on the carotid artery. This artery is located in your neck, under the corner of your jaw. Figure 1 shows the position your fingers should be in.
2. Press your fingers lightly against your neck to feel the pulse. Each pulse of blood is caused by one beat of the heart.
3. Work in pairs. Your partner will be the timekeeper. You will be the experimental subject.
4. Sit quietly for 2 minutes.
5. Count your pulse for 15 seconds, and record this number in Table 1.
6. Repeat step 5 twice more.
7. Calculate your heartbeat rate per minute by multiplying each of the 15-second counts by 4.
8. Calculate your average resting heartbeat rate per minute.
9. Make a **hypothesis** to explain how exercise will affect heartbeat rate. Write your hypothesis in the space provided.

### Part B. Exercise

1. Follow your teacher's instructions for exercising. Remember that whatever exercise

Figure 1.



you do should be done at a steady rate throughout all exercise periods.

2. You will exercise for 30 seconds of each minute for 10 minutes. In between exercise periods, you will count your pulse for 15 seconds and record this count in Table 2. Figure 2 shows that each minute should be divided as follows.
  - a. 30 seconds—exercise
  - b. 5 seconds—locate the pulse
  - c. 15 seconds—count the pulse
  - d. 10 seconds—record the count and prepare to exercise again

Figure 2.

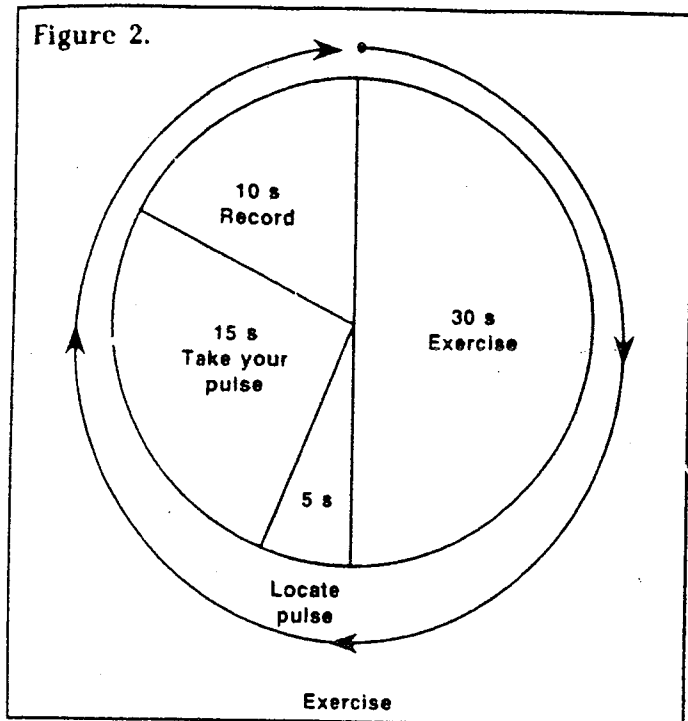
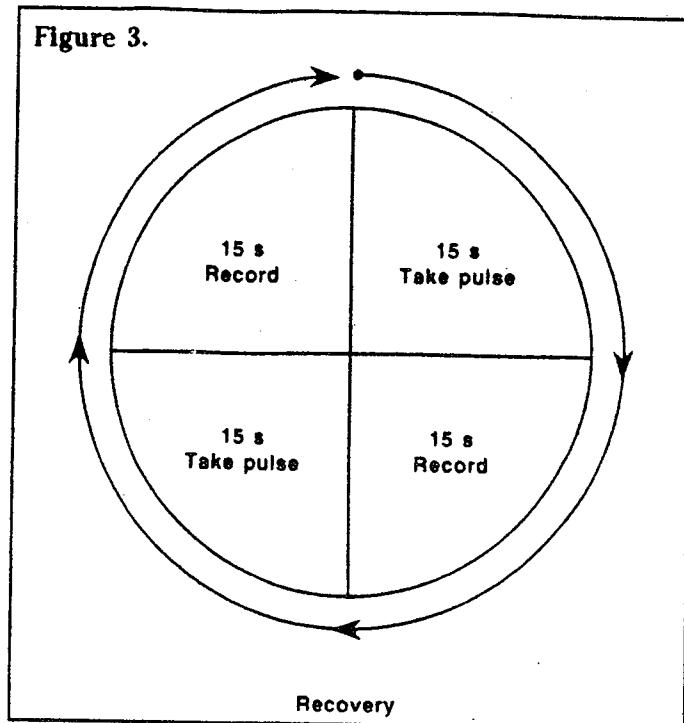


Figure 3.



### Part C. Recovery

1. Immediately after you finish the exercise period, sit down and begin the procedure for counting your pulse as you recover from exercising.
2. You will count your pulse twice each minute for 10 minutes. Each count lasts 15 seconds. Figure 3 shows that each minute should be divided as follows.
  - a. 15 seconds—count the pulse
  - b. 15 seconds—record the count and prepare for the next count
  - c. 15 seconds—count the pulse
  - d. 15 seconds—record the count and prepare for the next count
 All counts should be recorded in Table 2.
3. Calculate the number of beats per minute for all counts recorded in Table 2.

### Part D. Graphing

1. Look at the grid provided in Data and Observations. The minutes are on the horizontal axis. The heartbeat rates are on the vertical axis. Plot your average resting heartbeat rate on the first vertical line.
2. Plot your heartbeat rates during exercise for minutes 1 through 10.
3. Plot your recovery pulse rates for minutes 11 to 20. **NOTE:** There are data for every thirty seconds in this time period. Be sure to plot the heartbeat rate data against the correct times.

### HYPOTHESIS

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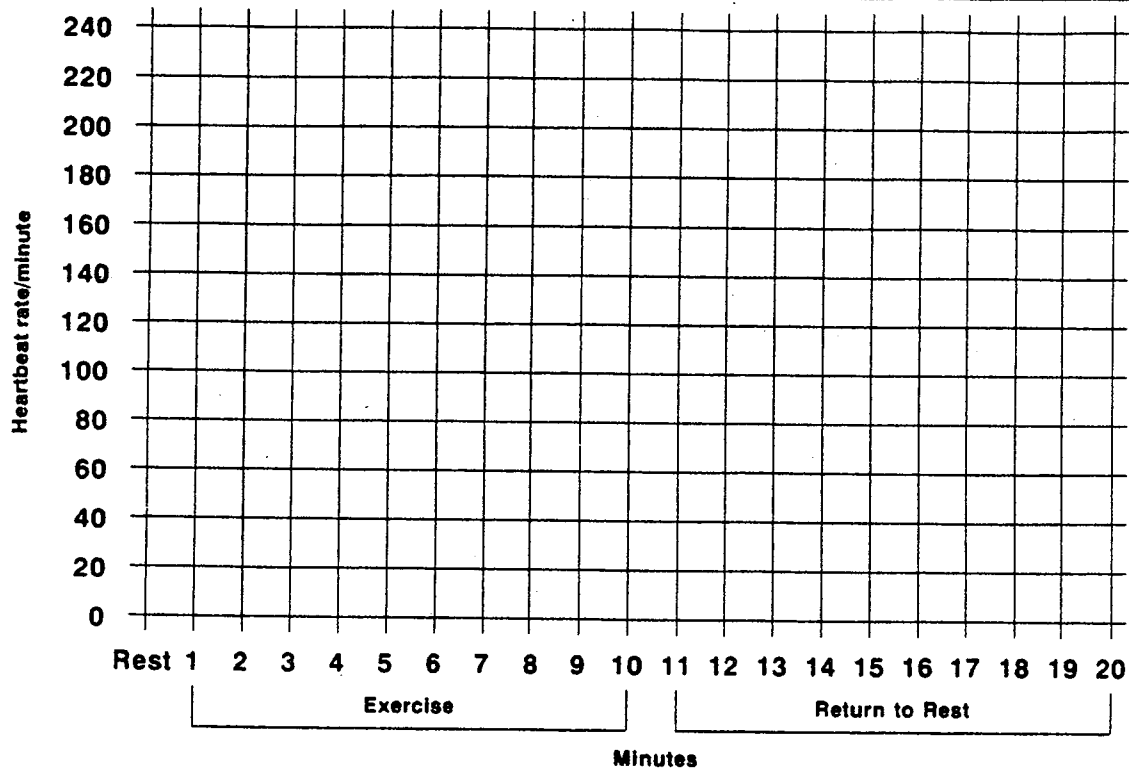
## DATA AND OBSERVATIONS

Table 1.

Condition	Trial	Pulse	
		Beats/15 seconds	Beats/minute
Rest	1		
	2		
	3		
	Average		

Table 2.

Condition	Minutes	Pulse	
		Beats/15 seconds	Beats/minute
Exercise	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
Recovery	11:00		
	11:30		
	12:00		
	12:30		
	13:00		
	13:30		
	14:00		
	14:30		
	15:00		
	15:30		
	16:00		
	16:30		
	17:00		
	17:30		
	18:00		
	18:30		
	19:00		
	19:30		
	20:00		



## ANALYSIS

1. What was your average resting heartbeat rate? \_\_\_\_\_
2. What was your highest heartbeat rate? \_\_\_\_\_ When did this rate occur? \_\_\_\_\_
3. Did you return to your resting rate during Part C? \_\_\_\_\_ If so, how many minutes did it take? \_\_\_\_\_
4. Why do some classmates return to their resting rates more rapidly than others? \_\_\_\_\_  
\_\_\_\_\_
5. Describe the shape of your graph. \_\_\_\_\_  
\_\_\_\_\_
6. What factors, other than exercise, would increase heartbeat rate? \_\_\_\_\_  
\_\_\_\_\_

## CHECKING YOUR HYPOTHESIS

Was your **hypothesis** supported by your data? Why or why not? \_\_\_\_\_  
\_\_\_\_\_

## FURTHER INVESTIGATIONS

1. Compare the average heartbeat rate of the males with that of the females in your class.
2. Test the effect of lying down, standing up, and sitting on your resting heartbeat rate.



Answer the following questions after completing the cardiovascular fitness lab.  
Be sure you have a title page, data chart, and graph completed.

**Complete the following work on a separate piece of paper to be included as part of your written lab report.**

**Lab Analysis**

**1. Comparison to average**

- (a) Create a chart on the blackboard to record all heart rates for each patient in your class at the following times: 4, 6, 12, 16 minutes. Include these data in your lab report.
- (b) Calculate the class average heart rate at each of the above time points. Include these data in your chart. Mark these points on your graph.
- (c) How do your numbers compare to the class average at each time? Why do you think your values are different?

**2. My heart at work**

Account for the major changes in slope of your graph.

What were you doing that caused changes in your heart rate?

Why does your heart rate change in each case?

**3. Aerobic benefit**

Perform the following calculation:  $220 - (\text{your age}) = \underline{\hspace{2cm}}$ . This is your maximum safe heart rate. It should never exceed this.

Specialists claim that maximum aerobic benefit of exercise is achieved only when our heart rates work at 60-80% maximum capacity.

Calculate this range =  $\underline{\hspace{2cm}}$

How close did you get to this? If not, explain why.

4.

Specialists also claim that to receive maximum aerobic benefit that you need to work at 60-80% of maximum heart rate for at least 20 minutes.

Describe the last time that your heart rate was this high for 20 minutes.

**5. Cardiac Output = stroke volume (mL/beat) x heart rate (bpm)**

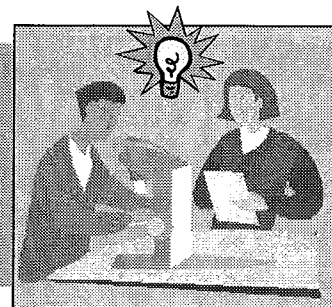
The units of cardiac output are milliliters of blood per minute. This is the amount of blood your heart can pump in one minute.

Explain how an increase of heart rate can increase cardiac output.

Why does our cardiac output increase when we exercise?

Why does an athlete's heart not increase its rate of contraction as much as a nonathlete's heart during exercise?



**Laboratory Activity #2 — Student Laboratory Packet****Making Connections***A Laboratory Activity for the Living Environment***Discovering Connections**

As they make observations, scientists are always looking for patterns in the natural world. For instance, researchers have observed that pregnant women who smoke cigarettes have a higher incidence of low-birthweight babies and that people with high-fat diets have a greater risk of developing heart disease. Many similar medical discoveries are a result of the patterns that can be observed when studying people and their lifestyles.

Discovering and explaining connections is one of the basic methods by which our knowledge of the world advances. It is what science is all about! Sometimes the connections are not what we expect or would predict, and sometimes we may have a hard time explaining the connections. Nevertheless, that is how science makes progress.

In this part of the laboratory activity, you will make a few observations about yourself and your classmates; then you will look for patterns or connections.

**Safety**

Safety is important during any laboratory activity. Although no dangerous chemicals or heat sources are used in this investigation, be sure you are careful and behave responsibly.

Another concern is health. If you have health reasons for not performing the exercises called for in this activity, tell your teacher so that other arrangements can be made for you to successfully complete the investigation. If you are excused from gym class for medical reasons, for example, or if you have asthma, tell your teacher about it before beginning the laboratory activity.

***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 that packet 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.



"Making Connections" is a laboratory activity produced by the State Education Department for use in fulfilling part of the laboratory requirement for the Regents Examination in Living Environment. Reproducing any part of this laboratory activity by other than New York State school personnel is illegal.  
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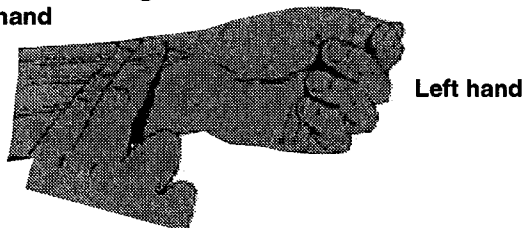
## Part A. Looking for Patterns

### A1. What Is Your Pulse Rate?

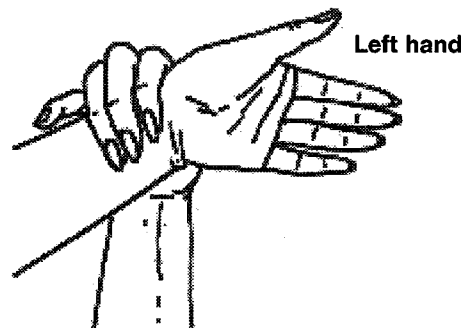
Your pulse is a result of the expansion of blood vessels that occurs each time your heart beats to send a surge of blood through your body. You can feel certain blood vessels “pulse” as this happens. Two different ways to take your own pulse are illustrated below. Choose the one that works best for you. As you press lightly, you should feel the pulsing of the blood. If you cannot locate your pulse after a short time, ask your teacher for help.

#### Two Methods of Taking Your Own Pulse

Index and middle fingers  
of right hand



Left hand



Left hand

Your pulse rate is a measure of how many times a minute your heart beats. Count the number of pulses you can feel in 20 seconds. Record the number below and then multiply it by 3 to determine how many times your heart beats in 60 seconds. Wait a minute and measure your pulse again. Wait another minute and measure your pulse a third time.

- Record your pulse rates for three trials below:

Trial 1 (20-second count) \_\_\_\_\_ X 3 = \_\_\_\_\_ per minute

Trial 2 (20-second count) \_\_\_\_\_ X 3 = \_\_\_\_\_ per minute

Trial 3 (20-second count) \_\_\_\_\_ X 3 = \_\_\_\_\_ per minute

Your pulse rate should be about the same each time. For accuracy, it is often better to take two or three readings, about a minute apart, and average them.

- Calculate and record your average pulse rate per minute: \_\_\_\_\_
- Record your average pulse rate on the board or on a transparency provided by your teacher so that everyone can see the pulse-rate data for the entire class.



### Complete a Data Table

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

**Class Results: Average Pulse Rates**

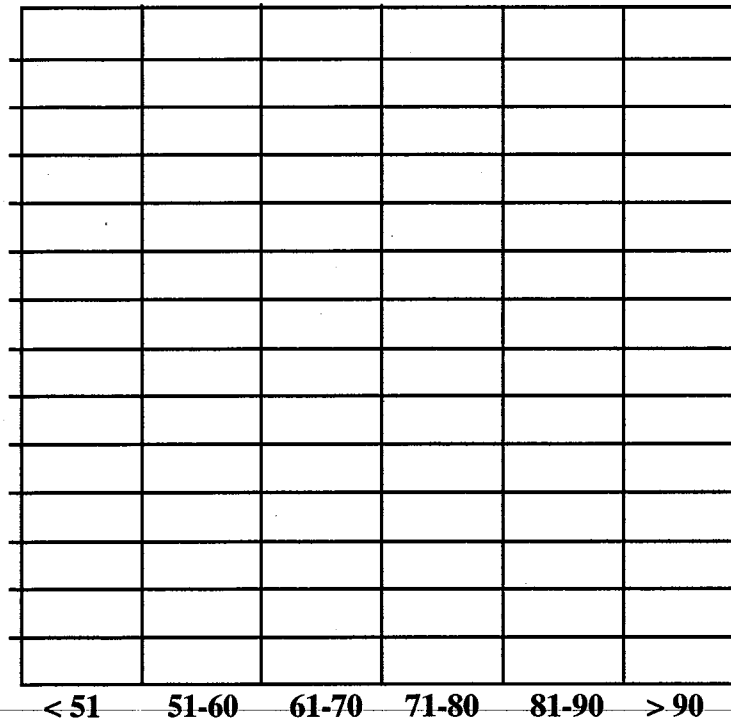
Pulse rate per minute (range of averages)	< 51	51-60	61-70	71-80	81-90	> 90
Number of students in this range						

### Prepare a Histogram

Use the information in the data table to prepare a histogram of the class results. Use the grid below.

- Provide a title for the histogram.
- Label the vertical axis and mark an appropriate scale on the vertical axis.
- When you have determined the height of each column, shade in the vertical bars.

**Histogram Title:** \_\_\_\_\_



< 51      51-60      61-70      71-80      81-90      > 90

**Average Pulse Rate Range**



## Answer the Following Questions

Do you see a pattern to the class data? \_\_\_\_\_ If so, what is it? If not, explain why you think a pattern does not exist.

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A question that someone might ask about pulse rate is, "Is there a connection between height and pulse rate?" Based on the information obtained from this activity, can you tell if there is a connection between a person's height and the person's average pulse rate? \_\_\_\_\_ If so, explain the relationship and how you can tell it exists. If not, what additional data would you need to collect to find out if there is a connection?

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State another question that someone might ask about pulse rate that could be answered by doing an experiment.

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Some people have suggested that someone's pulse rate will increase if he or she becomes more active. Try this: Once you have found your resting pulse rate, run in place for one minute. As an alternative, you can dance or do knee bends, jumping jacks, or push-ups.

Did your pulse rate increase? \_\_\_\_\_ Ask four classmates if they got similar results. Did their pulse rates increase after exercise? \_\_\_\_\_

Pulse rates increase for most people after exercise. Explain why this connection between pulse rate and activity makes sense.

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## A2. How Does Fatigue Affect Muscle Performance?

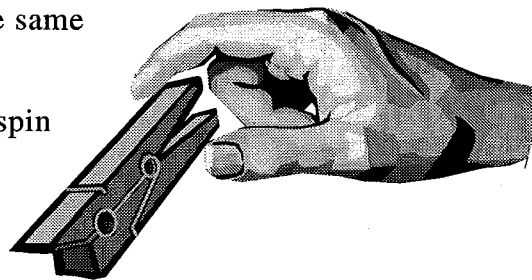
A condition known as *muscle fatigue* occurs when certain waste products of muscle cell activity build up in the cells. Until these waste chemicals are removed, the fatigue will continue.

### Do the Following Activity

Hold a spring-type clothespin between your thumb and index finger. Pinch the ends together completely (until the two ends touch) and release them. Do this as rapidly as possible for one minute. Record the number of times you could squeeze the clothespin in one minute: \_\_\_\_\_

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: \_\_\_\_\_



### 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.

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Could you do as many in a minute the second time as you could do the first time? \_\_\_\_\_

Provide a biological explanation for these results.

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**Part A. Questions** (Answer each of the following questions in the spaces provided. You will need to turn in your final answers in a separate answer packet.)

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

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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.)

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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?

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

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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 choice is the correct one.

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## Part B. Investigating Claims

You hear many claims made every day. Advertisers make claims about the usefulness or effectiveness of their products. Your friend may claim to be able to do something that you do not think he or she can really do. Do you believe all the claims that people make? Have you ever bought a product based on a claim made in an advertisement, only to find that the product did not work as you expected it to?

When does a *claim* become a *fact*? Scientists look for evidence to support or refute a claim. Evidence can help you determine which claims are facts and which are opinions or even misrepresentations. For example, if one of your classmates claims to be the fastest runner in the class, you could gather evidence by holding a series of races. If your classmate's claim is true, that person should win all of the races. If another individual wins the races, your classmate's claim was simply an opinion not supported by the evidence.

In this part of the laboratory activity, you will conduct an investigation to determine which of two opposing claims can be supported with evidence. First read the section below. It describes two opposing claims. Then investigate to see which claim (if either) is supported.

### Conflicting Claims About the Effect of Exercise on the Rate of Clothespin Squeezing

**Student A** claims that a person will be able to squeeze a clothespin more times in a minute if the person exercises first. Student A suggests that exercising produces a faster pulse rate, which indicates that the blood is getting to the muscles faster.

**Student B** claims that a person will be able to squeeze the clothespin more times in a minute if the person does *not* exercise first. Student B suggests that exercise takes energy away from the muscles, and a person who has been resting will have more energy.

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

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### Design an Experiment

You must now design and conduct a controlled experiment to gather evidence that will determine which of the two claims is correct. Use the information on the next page to help you design your controlled experiment. Be sure your experimental methods will provide enough data upon which to base a valid conclusion. You will have to conduct several trials.



### Guidelines for Designing a Controlled Experiment

Scientists follow certain guidelines when they conduct and report on a controlled experiment. These are provided below. As you work through this section to design your experiment, make notes as you go along. Your notes will become the outline for your investigation, and you can use them to prepare a final version at the end.

- 1. Determine the question you are trying to answer.** The question should be directly related to what you want to find out. For example, if you want to know whether or not light intensity affects tomato seed germination (the emergence of a plant from the seed), you might ask, "Does light intensity affect tomato seed germination?"

*Write in your notes the question you will be attempting to answer.*

- 2. Formulate the hypothesis you will be testing with your experiment.** The *hypothesis* is a tentative statement about the expected relationship between the variables. This statement must be written in a way that allows the relationship to be tested. It often suggests that there is a connection between two factors. For example, "Light intensity will influence the germination of tomato seeds."

*Write in your notes the hypothesis you will be testing.*

- 3. Formulate a title for your investigation.** A title addresses specifically what is being investigated. The title should be a statement in the form of "The effect of....on...." You should specify the organism(s) you are using as well. For example, "The effect of light intensity on seed germination in tomato plants."

*Write the title of your experiment in your notes.*

- 4. Plan the design of your experiment.** In the planning of your experiment, consider each of the following. Make notes of your ideas to use later.

- a. You need to decide what data you will collect. The *dependent variable* is the one you measure. In this investigation, the number of times the clothespin can be squeezed in a minute is the dependent variable.
- b. What is to be your *independent variable*—the one you will vary to see how it may affect the dependent variable? In this investigation, you might make the independent variable the subject's level of activity just before each of the trials during which you measure that subject's clothespin-squeezing rate.
- c. To do a fair test (controlled experiment) and obtain a valid conclusion, you must keep all but the independent variable constant. What other variables will it be important to keep constant to obtain meaningful data?
- d. Decide how many individuals you will test, how many trials you will conduct with each, and the conditions to which they will be subjected. In this case, you need to determine how many people you will test and what you will have them do.
- e. Make note of safety precautions that will be necessary.

*Write out the steps of your experimental design in your notes.*

- 5. Design one or more data tables that you will use to record the data as it is collected.**

Your data table(s) should also have sections for summarizing or averaging the data, as appropriate. Your data table(s) must be designed and finalized before you begin the experiment.

*Sketch in your notes the data table(s) you plan to use. Be sure to include appropriate headings and units.*

- 6. Write out the steps you will follow to conduct your experiment.**

- 7. Have your experimental design plan approved by your teacher.**

- 8. Conduct your experiment.** Gather the materials you will need, arrange for your "test subjects," and do the experiment.



## Organization of the Final Report

When you are finished, organize your data and determine what the data “tells you.” Also, review what you did and think about whether or not some procedures should have been done differently to give you more reliable results. Your final report should have the following sections:

- **Title** — Use your notes from the previous section. (Refer to Guideline 3.)
- **Hypothesis** — Use your notes from the previous section. (Refer to Guideline 2.)
- **Methods and Materials** — Describe the materials (what you used) and procedures (what you did) in your experiment. This may be done in the form of a list, a paragraph, or a combination of both. Use your notes from the previous section to guide you in this. (Refer to Guidelines 4 and 6.) Be sure to identify the dependent and independent variables.
- **Data Collected** — Include your completed data table(s) and, if appropriate, a graph or graphs to summarize the data for easier understanding of what you found.
- **Discussion and Conclusions** — These will relate back to the title and hypothesis for the investigation. Be sure to note whether your data supports or does not support your hypothesis. You also need to include an explanation of how or why this conclusion follows from the data you collected.
- **Suggestions for Improvement** — Discuss any possible sources of error that may make your data less reliable. Include a discussion of controlling the variables when investigations involve human subjects. State three additional variables that may have influenced the outcome of your experiment.
- **Suggestions for Further Research** — Nearly any experiment that is done produces new questions that could be answered with new investigations. Include two suggestions for other investigations that could be done or additional data that needs to be collected to further support your findings or to answer any new questions that came up during the experiment.

*Note: You will need to make two copies of the report—one to hand in and one for exam review.*

## Prepare To Present Your Research to the Class

Just as scientists must always defend their claims and conclusions to their peers, you should be prepared to report on and defend your findings before the class. If you are chosen to do a presentation to the class, you should be able to address each of the sections of the final report and to answer questions about your data and conclusions. You should prepare some visual aids to make the presentation clear and understandable.





## Introduction

Earthworms are classified under the phylum *Annelida*, which also includes leeches and bristleworms. Earthworms are the only species of segmented worms that live on land. Their skin must be kept moist so that oxygen can diffuse through the body wall into the bloodstream. The basic body design of an earthworm is a “tube within a tube”, consisting of a digestive tract (“tube”) surrounded by the outer skin (the other “tube”). Earthworms are herbivores, obtaining nutrients by eating through the soil they live in. By doing this, they help aerate the soil and fertilize with the nitrogenous wastes they leave behind. Earthworms are hermaphrodites, meaning they possess both female and male reproductive organs. However, they do not fertilize their own eggs! They must find a mate in order to reproduce. Adapted from [http://www.mhhe.com/biosci/genbio/virtual\\_labs/BL\\_14/BL\\_14.html](http://www.mhhe.com/biosci/genbio/virtual_labs/BL_14/BL_14.html)

## Purpose

- To examine the internal and external features of the earthworm
- To compare and contrast the earthworm’s anatomy to that of a humans’

## Safety

- The chemical preservative may cause skin and eye irritation, therefore, avoid contact.
- Should contact occur between the preservative and skin/eyes, rinse thoroughly with water.
- Be careful when using sharp equipment. Report any cuts, no matter how small, to your teacher.

## Materials

- |                  |   |              |           |            |
|------------------|---|--------------|-----------|------------|
| * hand lens      | * dissecting pins                                     | * probe      | * Forceps | * scissors |
| * dissecting pan | * Preserved earthworm ( <i>Lumbricus terrestris</i> ) | * Razorblade | * ruler   |            |

## Prelab Activity

Label ventral (belly), dorsal (back), anterior (head) and posterior (rear) sides of the worm below



RECORD all data for this lab on the separate data sheet provided.

Label all drawings as indicated.

## Procedure

1. RINSE the earthworm thoroughly under running tap water.

### **External Features:**

2.
  - a. Count the number of segments your earthworm has. Record the number on your data sheet.
  - b. Measure the length of your earthworm. Record the length on your data sheet.
3. Place the worm in your dissecting tray, ventral side up. The ventral side is flatter and lighter in color than the dorsal side.
4. Look at the **ventral side** of the earthworm with the magnifying lens.
  - \* Locate the **seminal receptacle** openings, located between the ninth and tenth segments and tenth and eleventh segments. This is where sperm from another earthworm enters the worm during mating.
  - \* Locate the **oviduct openings**, where the eggs leave the worm, on the fourteenth segment.
  - \* Locate the **sperm ducts** on the fifteenth.  
This is where sperm will leave this earthworm to go to another worm.
5. Locate the clitellum, the smooth, thickened and non-segmented part of the worm, toward the anterior end of the worm.
6. Run your fingers along the ventral side of the worm. You will feel bristles called setae.
7. Most segments have small excretory openings toward their anterior edges. Locate these openings.
8. Make a **sketch** of your earthworm, ventral side up, on your data sheet. Be sure to sketch the ENTIRE worm, from the mouth to the anus. **Label** the following pieces:
  - \* seminal receptacle openings      \* oviduct openings      \* sperm ducts      \* clitellum
  - \* excretory openings      \* mouth      \* anus      \* setae
  - \* anterior end      \* posterior end      \* dorsal side      \* ventral side

### **Internal Features**

9. Place your worm, **ventral side down**, in your tray. Pin it to the dissecting tray by putting one pin through the worm just behind the mouth and another pin about three centimeters from the hind end of the worm.

**During this section, be careful not to poke or cut too deeply, or you will damage the internal organs!!!!**

10. Using the point of the scissors, pierce the skin of the worm about five centimeters behind the clitellum.
11. Angling the scissors toward the ceiling, cut toward the front end of the worm, in a straight line along the midline of the worm. Continue through the clitellum and STOP when you reach the pin you placed in the anterior end of the worm. Cut carefully and gently so as not to destroy the tissue underneath.

12. Tear away the connecting tissue from the skin using scissors or a razorblade. Peel away the skin a little at a time and pin both halves of the skin flaps to the dissecting pan as you go. This should make visible the organs inside. Continue until you have reached the pin at the anterior end of the worm.
13. Starting at the anterior (front) end of your worm, find an enlarged oval structure that lies just behind the mouth. This structure is the **pharynx**. The **esophagus** is the long tube that continues down the worm just after the pharynx.
14. Begin moving toward the posterior (back) end of the worm. At the end of the esophagus is a circular organ, the **crop**, followed immediately by another organ, called the **gizzard**. Using your probe, gently press down on the crop and then the gizzard. **Record** your observations on your data sheet. Both of these organs function during digestion.
15. The **intestine** continues from the gizzard down the entire length of the worm, ending at the **anus**.
16. Look at the esophagus again. Wrapped around this structure are some narrow, dark red tubes. These are hearts, referred to as the **aortic arches**. Count the number of these and record it. Find the **dorsal blood vessel**, projecting off of the aortic arches.
17. Locate the intestine again. Gently move the intestine aside to find the **ventral nerve cord**. The cord looks like a piece of white thread. This nerve cord extends through the entire worm. You may also see the **ventral blood vessel**, which looks like the dorsal blood vessel, but in on the ventral (belly) side of the worm, on the underside of the intestine.
18. To locate the earthworm's reproductive organs, look at the larger, lobed structure to the side of the aortic arches. These are the **seminal vesicles**, which house the **testes**. Also to the side of the aortic arches are the smaller **seminal receptacles**, which hold the sperm from another worm.
19. The **ovaries** are small, white, conical shaped organs attached between segments twelve and thirteen. The **oviduct** comes out of the **egg sack** (attached to the ovary) and empties out of the opening you saw on the outside of the worm.
20. On many segments, just to the left and right of the intestine, you will see white looped channels. These are the **nephridia**. These structures collect and transport the worm's metabolic waste out of its body.
21. Label the internal structures diagram on your data page. Be sure to include the following...
 

* mouth	* esophagus	* crop	* gizzard	* intestine	* aortic arches
* dorsal blood vessel	* ventral nerve cord	* ventral blood vessel		* seminal vesicles	
* seminal receptacles	* ovaries	* nephridia	* clitellum	* brain	* pharynx

### Clean Up

- Carefully remove all of the pins from your worm
- Wrap the earthworm in paper towel and dispose of it in the trash
- Rinse all of the equipment and the tray with water
- Return all equipment to where you picked it up
- Wipe down your table
- Wash your hands with soap and water





1. Number of segments in your earthworm: \_\_\_\_\_ Length of Earthworm: \_\_\_\_\_
2. **Sketch and LABEL!!!!**

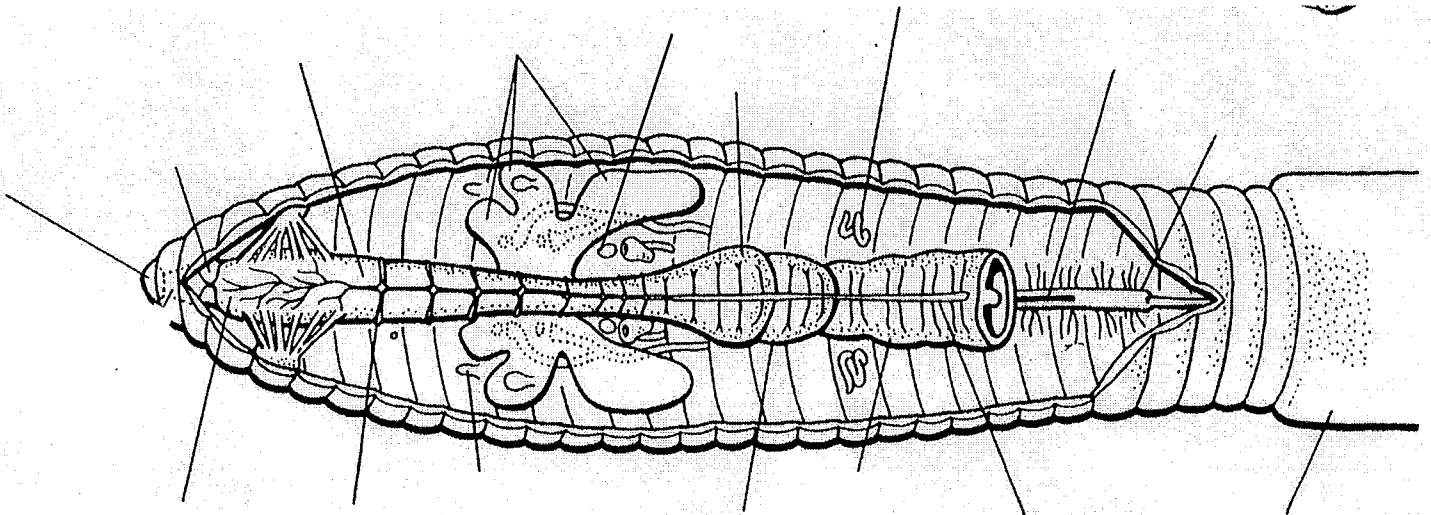
[illegible]

3. Describe the crop: \_\_\_\_\_

Describe the gizzard: \_\_\_\_\_

4. Number of Aortic Arches: \_\_\_\_\_

5. **Label!!!!!!**



6. Shade the organs in the above diagram using the following key:
- |                      |        |                    |        |                       |      |
|----------------------|--------|--------------------|--------|-----------------------|------|
| Digestive organs =   | orange | Excretory organs = | yellow | Reproductive organs = | blue |
| Circulatory organs = | red    | Nervous organs =   | green  |                       |      |
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## Analysis

1. Suggest a possible function of the external **setae**: \_\_\_\_\_  
\_\_\_\_\_
2. Both the crop and the gizzard belong to the earthworm's digestive system. Given their positions in the worm and using your observations of these two organs, suggest how the crop and gizzard function differently during digestion.  
  
Crop: \_\_\_\_\_  
  
Gizzard: \_\_\_\_\_
3. What type of circulatory system does an earthworm have, open or closed? \_\_\_\_\_  
What did you see inside the earthworm that helped you determine this? \_\_\_\_\_  
\_\_\_\_\_
4. a. By which life process do earthworms release the energy from the food they eat?  
\_\_\_\_\_
- b. Write the equation for this process: \_\_\_\_\_ + \_\_\_\_\_  $\rightarrow$  \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_
- c. What do you think would happen to the pH of the earthworm's environment as this process occurs? More acidic or more basic? (circle one)
- d. Explain your answer: \_\_\_\_\_
5. Why is it beneficial to a worm NOT to fertilize its own eggs? \_\_\_\_\_  
\_\_\_\_\_

## Conclusion

1. Describe two benefits an earthworm gives to the environment it lives in.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
2. State three ways the anatomy of an earthworm is similar to that of a human.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
3. State two ways the anatomy of an earthworm is different to that of a human.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_

**Introduction**

In the United States today we have a variety of different foods available, at less cost than ever before. Each day we choose some foods over others and we often do so without thinking about their nutritional value. In this project, you will take a close look at the types of food and the quantities of foods you eat. You will keep a log of everything you eat and drink for 24 hours. You will also record everything you do for 24 hours to gauge how many calories you are burning a day. This project is a good opportunity for you to take a look at how your diet compares to the USDA guidelines, but it will only work if you keep careful (and honest) records. All websites are linked via my website under Resources.

**Procedure**

- 1) On the data table provided, record ...
  - \* All food and drink consumed for a 24 hour period, including portion sizes where available.
  - \* All activity carried out for a 24 hour period.
- 2) **BEFORE you start**, complete the **Hypothesis** question under the **Analysis** section of your worksheet
- 3) Visit the “My Pyramid” website <http://www.mypyramidtracker.gov/>
  - a) Scroll to the bottom of this page and click on **New User Registration**
  - b) Enter the required information to obtain a user name and password and click **Submit**  
DON'T forget your user name & password!!!!
  - c) Enter your age, gender, height & weight then click on **Proceed to Food Intake**

To enter **FOOD** data:

- 4) Enter foods consumed...
  - a) Enter a food into the Search box and click **Search**
  - b) Find the food that BEST matches the food you ate then click on the red **Add** button on the left
  - c) Continue searching and adding foods until all your foods are added
- 5) Enter amounts of food consumed...
  - a) Click on **Select Quantity** underneath the foods you have added
  - b) Enter the serving size and number of servings of the specific foods you; click **Save & Analyze**

- 6) Analyze your foods...
- Scroll down to the Nutrient Intakes box and click on **Calculate Nutrient Intakes from Foods**
  - PRINT** a complete copy of the Calculate Nutrient Intakes from Foods report
  - Scroll down to the bottom of this page and click on **My Pyramid Recommendations**
  - PRINT** a complete copy of the My Pyramid Recommendations report

To enter **ACTIVITY** data:

- Click on **Energy Calculator** and then **Daily Calculator**
- Enter weight, height, age and gender where appropriate
- Using your activity log, estimate the number of hours you carried out the following activities...  
Be sure the total hours for all activity equals 24!!

**Resting:** Sleeping or reclining

**Inactivity:** Sitting or standing still

**Very light activity:** Seated and standing activities, painting trades, driving, laboratory work, typing, sewing, ironing cooking, playing cards, playing a musical instrument

**Light exercise:** Walking on a level surface at 2.5 to 3mph, garage work, electrical trades, carpentry, restaurant trades, house cleaning, child care, golf, sailing, table tennis

**Moderate exercise:** Walking 3.5 to 4mph, yard work, carrying a load, cycling, skiing, tennis, dancing

**Heavy exercise:** Walking with load uphill, tree felling, heavy manual digging, basketball, climbing, football, soccer

- Click on **Calculate Calories** button;

Most people probably burn between 2000 and 3000 calories a day, depending on age, gender and activity level. This is only a **rough** guide, but if it appears you are burning way more or less calories than this, go back and take a good look at your activity levels and make any necessary adjustments.

- Print** your results (you will hand this in).

- 5) Complete the **Analysis & Conclusion** below.

What will you hand in?? Check the following and staple **in this order**...

_____ Food and Activity Log (pink sheet)	5 pts
_____ Food & activity analyses you printed out	5 pts
_____ "My Pyramid" data (question #2)	3 pts
_____ Answers to Analysis and Conclusion questions	12 pts
_____ Worksheet on vitamin deficiencies (attached)	5 pts

**Total Points: 30 pts**

**Hypothesis** (2-3 complete sentences)

How do you see your nutritional health? Do you eat a balanced diet? Do you exercise regularly?

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---

---

---

**Analysis:**

1) a) According to your nutritional analysis printout (from NATS site), which nutrients are inadequate in your diet (<80%)? What would be the long term health consequences of this malnutrition? You may have to research what the nutrients do for you in order to answer this. **Be specific.**

b) According to your nutritional analysis printout (from NATS site), which nutrients are in excess in your diet (>120%)? Would there be any long term health consequences of this excess? You may have to research what the nutrients do for you in order to answer this **Be specific.**

2) Complete the table below referring to your USDA Food Pyramid.

<b><u>Food Category</u></b>	<b><u>Color on the Pyramid</u></b>	<b><u>Recommended Daily Amount</u></b>
Grains		
Vegetables		
Fruits		
Milk		
Meats & Beans		

Oils: \_\_\_\_\_ teaspoons

Discretionary Calories: \_\_\_\_\_ calories

Define “discretionary calories” in your own words: \_\_\_\_\_

- 3) Compare your actual food analysis with your recommended “My Pyramid” amount. Do you feel that the food choices you make during a typical day provide you with the recommended daily amounts of nutrients? You may need to convert ounces to grams to accurately compare the data. **Explain and be specific!!**
- 4) In 2-3 sentences, compare your daily calorie intake with the amount of calories you burn daily through activity and exercise.

### Conclusion

- 1) How does your original hypothesis compare to the data you collected? **Be specific!!**
- 2) Based on the data you collected and the analysis you did today in lab, do you believe this activity provides an accurate or inaccurate view of your current lifestyle?

ACCURATE / INACURATE (circle one)

**Explain**, being sure to mention anything that was not ordinary for the day you collected your data.

- 3) Do you feel that your current lifestyle warrants change? YES / NO (circle one)

**Explain**, being as specific as possible as to what changes you would like to make or why you feel changes are not necessary.

**Introduction**

Recognizing the presence of a disease is based to some extent on the existence of abnormalities known as symptoms. Urine testing is one very important diagnostic tool. Urinary tract infections, kidney malfunction, diabetes and liver disease are just some of the medical problems that can be diagnosed through urinalysis. In analyzing a urine sample, several factors are examined. These include the appearance and color of the urine, the odor, the pH and specific gravity.

**Color and Appearance**

The normal urine can range from pale yellow to amber, depending on the concentration of the pigment urochrome, which is the end product of hemoglobin breakdown. A pale yellow urine may indicate diabetes, granular kidney or simply drinking large amounts of water. A milky color might indicate a urinary tract infection. Red colors may be due to food pigments (such as beets), certain drugs or blood in the urine.

**Odor**

The odor of urine can vary greatly. An ammonia smell may result from certain foods, while a fishy smell may indicate cystitis. A sweet smell could be due to acetonuria or diabetes.

**pH**

The normal pH range of urine is 4.5 to 8.0, and fluctuates depending on the type of food ingested. Fevers and disorders like emphysema lower urine pH, whereas kidney failure, vomiting and urinary tract infections raise urine pH.

**Specific Gravity**

Specific gravity is a measure of the density of a substance in grams per milliliter. The specific gravity of urine usually ranges between 1.015 to 1.025 g/mL. The more dilute the urine, the lower the specific gravity, while really concentrated urine has a higher specific gravity.

**Drug Screening**

A urine sample can be tested for drug overdose and toxicity, or for the presence of abused drugs, including cannabinoids, cocaine, methadone and opiates. However, these tests only detect the presence of the drug in question, not the amount of drug.

**Pregnancy**

When a woman becomes pregnant, a hormone called human chorionic gonadotropin (HCG) is secreted by the embryo's tissues. Because HCG is excreted in the urine, urinalysis is used to detect this hormone, thereby indicating the presence of an embryo as early as 8 to 10 days after fertilization.

**Microscopic Observations**

Looking at urine under a microscope can detect the presence of crystals, casts, cells and microorganisms that can indicate a disorder.

**Protein (albumin), Glucose and Ketones**

Proteins and sugars, such as glucose, are NOT normally present in urine as they are **reabsorbed** by the body when blood is filtered by the kidneys. When these molecules are abnormally found in urine, it may indicate a disorder. Protein in the urine could indicate kidney damage. Sugars in the urine may indicate a condition called diabetes mellitus, characterized by a lack of the hormone insulin, which triggers sugar storage. Diabetes may also be diagnosed from the presence of ketones in the blood, which appear in urine due to inadequate carbohydrate metabolism.

**Phenylketonuria (PKU)**

PKU is a failure of the body to produce the enzyme necessary to break down the amino acid phenylalanine. It is caused by a recessive genetic trait and causes nerve and brain damage, accompanied by mental retardation if left untreated. However, by reducing phenylalanine from the diet, mental retardation does not occur.

Ideally, newborns are screened via blood test for the chemical phenylpyruvic acid, which shows up a few days after birth. Phenylpyruvic acid is not present in urine until 2- 6 *weeks* after birth. State laws require PKU testing of infants within 28 days or less of birth. In some states, testing is required prior to hospital discharge regardless of age.

### Purpose

- Learn the basis of urinalysis and its application in diagnosis of disorders
- Perform a simulated urinalysis
- Apply the basic principles of urinalysis to diagnose medical disorders

### Materials

- |   |                |                       |
|---|----------------|-----------------------|
| * 10 mL samples of simulated patient urine (#1-5) | * pH paper     | * glucose test strips |
| * ketone test strips                              | * 5 test tubes | * Biuret solution     |
| * Goggles   | * wax pencils  |                       |

### Procedure

#### Test #1: Physical Characteristics

For each urine sample provided, observe and record color, clarity and smell of the urine on data chart.

#### Test #2: Testing pH

- a) Dip a **pH test strip** into the urine of patient #1
- b) Compare the color of the test strip to the color chart within 30 seconds of sampling
- c) Record data on the data chart
- d) Repeat with urine from patients #2-#5

#### Test #3: Glucose Testing

- a) Dip a **glucose testing strip** into the urine of patient #1
- b) Compare the color of the test strip to the color chart after two (2) minutes
- c) Record data on the data chart
- d) Repeat with urine from patients #2-#5

#### Test #4: Ketone Testing

- a) Dip a **ketone testing strip** into the urine of patient #1
- b) Compare the color of the test strip to the color chart after two (2) minutes
- c) Record data on the data chart
- d) Repeat with urine from patients #2-#5

#### Test #5: Protein testing **CAREFUL:** Biuret is caustic!!

- a) Label five test tubes with #1 - #5
- b) Place urine from each patient into the corresponding test tube
- c) Place approximately 1 mL of Biuret solution into each test tube.
- d) Record color change on the data chart
  - \* A **positive** reaction will result in an orange-red color.
  - \* A **negative** reaction will result in a ~~green~~ **blue** color.



Data Table

<u>Patient</u>	<u>Color</u>	<u>Clarity</u>	<u>Smell</u>	<u>pH</u>	<u>Glucose</u>	<u>Ketone</u>	<u>Protein</u>
#1							
#2							
#3							
#4							
#5							

**Questions** (use *Introduction* of lab to help you)

- 1) Diagnose potential disorders for the patients you studied today in lab

<u>Patient</u>	<u>Potential Disorder</u>	<u>Evidence to Support your Diagnosis</u>
#1		
#2		
#3		
#4		
#5		

- 2) Should a doctor rely *solely* on urinalysis to diagnose a disorder, or should other test be done? **Explain.**
- 3) Why is it important to perform tests on a urine sample not containing any abnormalities?
- 4) How would a kidney problem disrupt your homeostasis? **Be specific.**
- 5) As *blood* enters the kidneys to be filtered, it contains proteins, wastes, salts, glucose and phosphate molecules. After the blood is filtered, only wastes, salts and phosphate molecules are contained in the *urine* produced by the kidneys. In other words, glucose and proteins are NOT usually found in urine even though these molecules do enter the kidneys before filtering occurs.
- Given this information, list one function of the kidneys besides filtering the wastes from your blood.
- 6) Describe how a urine test can detect pregnancy.
- 
- 7) a) What damage does PKU cause in a person?
- b) Why is initial diagnosis of PKU made by a *blood* test and not a urine test? **Be specific.**

# Testing Reflexes and Reactions

# Lab 20

## Background

You have probably touched a hot stove or sharp object and pulled your hand away before realizing what had happened. This fast and automatic reaction to a stimulus is a *reflex action*. Some reflexes prevent injury to the body. For example, the withdrawal reflex that allows you to remove your hand from a hot stove before you even feel a sensation of heat helps to prevent a severe burn. Reflexes also control automatic activities in the body, such as the beating of the heart, breathing, gagging, and stomach movements.

In the *reflex arc*, or pathway, of the simple withdrawal reflex described above, a sensory neuron carries impulses from the skin to the spinal cord, where it synapses with an interneuron. The interneuron synapses with a motor neuron. Impulses carried by the motor neuron stimulate the appropriate muscles to withdraw the affected body part. All this happens in a fraction of a second.

In nonreflex responses, impulses must travel to the brain, where they are interpreted and a proper response initiated. The time required for the brain to receive the impulses, interpret them, and initiate a response is much longer than the time required for a reflex arc involving only the spinal cord.

A person's *reaction time* is a measure of how quickly he or she can perceive a stimulus and react to it. Reaction time is important in operating vehicles and machinery, in sports, and in many everyday activities. Reaction time may be increased by fatigue, drugs, and distraction.

## Objectives

In this activity you will:

1. Demonstrate some human reflexes.
2. Measure your reaction time.

## Materials

clear plastic sheet or plexiglass panel  
meter stick  
calculator with square root function or a table of square roots

## Procedures and Observations

### PART 1. REFLEXES

Work in pairs, alternating as subject and experimenter.

1. The subject should sit on a chair with one leg crossed over the other. The top leg must be free to swing. With the side of the hand the experimenter should tap the subject's top knee on the tendon

just below the kneecap. (Not too hard!) It may take several taps before the proper part of the tendon is stimulated.

a. *Describe the response of the leg.*

---

2. Repeat Step 1, but this time the top leg of the subject should be held out straight.

b. *Describe the response of the leg.*

---

c. *In which leg position is the response the greatest?*

---

3. Switch roles and repeat Steps 1 and 2.

4. The subject should close and cover his or her eyes for at least 1 minute. At the end of the minute, the experimenter should watch the subject's pupils as the eyes open.

d. *Describe the response of the iris and its affect on the pupil.*

---

5. Switch roles and repeat Step 4.

6. The subject should remove a shoe and sock. The experimenter should scratch the bottom of the subject's foot with a fingernail, in one continuous motion from toe to heel.

e. *Describe the response of the toes.*

---

7. Switch roles and repeat Step 6.

8. The subject should hold a clear plastic sheet in front of his/her face. The experimenter should toss a crumpled sheet of paper at the subject to try to make him/her blink.

f. *Describe the response of the subject's eyes.*

---

9. Switch roles and repeat Step 8.

## **PART II. REACTION TIME**

---

1. The subject should rest his or her elbow on the table, with the arm extending over the side. The experimenter should hold a meter stick in the air, with the 0-cm line between the subject's index finger and thumb. The experimenter then should drop the meter stick and the subject should catch it between the index finger and thumb as quickly as possible. Note the measurement in cm of the meter stick where it was caught (the distance it fell).

a. *Record the distance the meter stick fell before it was caught.*

Trial 1: \_\_\_\_\_

**Testing Reflexes and Reactions** (continued)**20**

2. Repeat Step 1 four more times.

b. *Record the distance for each trial.*

Trial 2: \_\_\_\_\_

Trial 4: \_\_\_\_\_

Trial 3: \_\_\_\_\_

Trial 5: \_\_\_\_\_

3. Switch roles and repeat Steps 1 and 2.

4. Determine the average distance the meter stick fell by adding the measurements from the five trials and dividing by 5.

c. *Record the average distance the meter stick fell.*

\_\_\_\_\_

The time it takes for an object to fall a certain distance can be found by the formula.

$$t = \sqrt{\frac{2d}{a}}$$

where  $t$  = reaction time (in s) $d$  = distance the meter stick falls (in cm) $a$  = acceleration due to gravity =  $980 \text{ cm/s}^2$ 

5. Determine your reaction time by using the above formula. Use the average distance determined in Step 4.

d. *Use the space below to record your reaction time and show your calculations.***Analysis and Interpretations**

1. How is the iris-pupil response to light a protective reflex?

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2. How is the blinking response a protective reflex?

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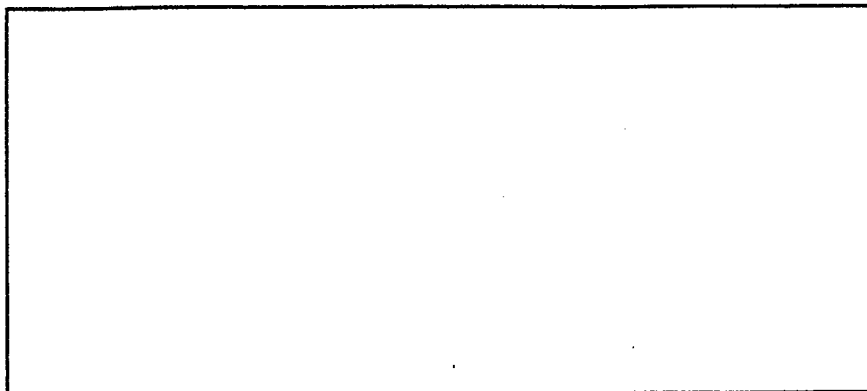


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3. What is the reaction time of a person who catches the meter stick at the 95-cm mark? Show your calculations.



4. Name three sports and three occupations in which reaction time is important.

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5. Give an example of how distraction could slow down reaction time.

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### For Further Investigation

1. Considering your experiments with reaction time, do you think a subject could catch a dollar bill folded lengthwise and dropped through his/her fingers? Test your prediction.
2. Design an experiment to test the effect of distraction on reaction time. Write down your plan and check with your teacher before trying your experiment.
3. How far will an automobile moving 50 mph (80 kph) travel during your average reaction time? Investigate stopping distance as it relates to reaction time and actual mechanical stopping distance. Construct a graph using your data.
4. Certain poisons act on the nervous system. Use library sources to report on three poisons and how they work.

CONCLUSION —

# Reaction Times

How fast can you react to a stimulus?

## Introduction

A dark blur against the ice marks the path of the hockey puck as it sails toward the goal at 80 km per hour. In a fraction of a second, the goalkeeper must plot the puck's course and move to block it.

The time required to sense a stimulus, analyze its meaning, and respond appropriately is called the reaction time. What factors affect reaction time? Do you respond to all stimuli with equal speed? Can your reaction time be improved? How does the use of alcohol, tobacco, or other drugs affect your ability to react?

Every person must be able to respond to stimuli in the environment. In many cases, the speed at which you react is not important. In other instances, reaction time makes the difference between success or failure and even life or death.

## Prelab Preparation

1. Describe at least 3 experiences that have occurred during the last week when your reaction time has been important.
2. A motorist swerves the car to avoid a dog that has run into the road. Which parts of the nervous system are involved in the reaction and what is the function of each part?
3. How might tobacco, alcohol, and other drugs affect reaction time? Read the procedures for Steps A–G. The procedure described in Steps A–C will be used to obtain a measure of your reaction time.
4. Why is it necessary to work with a partner and not perform the experiment by yourself?

*Hypothesis: Will your reaction increase or decrease with practice? How will you compare?*

## Procedure

### Part I

#### Reaction Time to a Visual Stimulus

You must work with a partner to complete the following procedures. One of you will act as the recorder while testing your partner's reaction time. After completing Steps A through D, exchange roles and repeat the procedure.

- A. Place your forearm on the surface of the table with your hand extended over the edge. Have your partner position the zero end of the meter stick between your thumb and forefinger, as shown on the next page.
  - B. Determine your reaction time by catching the meter stick between your fingers after your partner releases it without warning.
5. In your data table, record the distance that the meter stick falls. Use the distance versus time table, to convert the distance of fall to reaction time. Use the distance on the table that is closest to your distance of fall value.

## Learning Objectives

- To compare reaction times to a visual stimulus with those to an auditory stimulus.
- To compare reaction times to a stimulus without distractions with those to a stimulus with distractions.

## Process Objectives

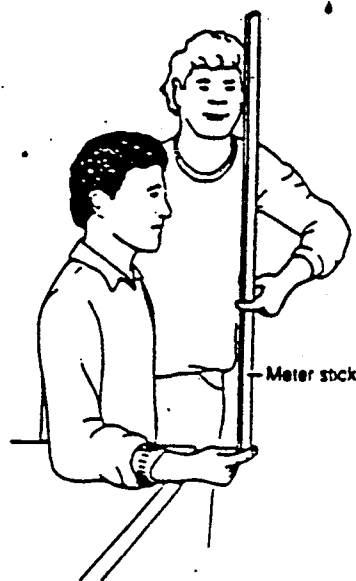
- To organize data using tables and graphs.
- To analyze and interpret team and class data.
- To make inferences about the effect of psychoactive drugs on reaction time based on the results of your experiment.

## Materials

For Group of 2

- Meter stick

Purpose



Distance v. Time Fall	
Distance of Fall (cm)	Time of Fall (sec)
0.2	.02
0.8	.04
1.1	.05
1.7	.06
2.4	.07
3.1	.08
3.9	.09
4.9	.10
7.0	.12
9.6	.14
12.5	.16
15.8	.18
19.5	.20
23.6	.22
28.9	.24
33.0	.26
38.2	.28
43.9	.30
48.8	.32
56.4	.34
63.5	.36
70.8	.38
78.4	.40
86.4	.42
94.8	.44
103.7	.46
112.9	.48
122.5	.50

C. Repeat the procedure for a total of 20 trials.

6. Record your data after each trial in your data chart.

7. Calculate the average distance of fall. Use this number, referring again to the distance versus time table, to determine the average reaction time. Record these figures in your data table.

8. Converting the average distance of fall to the average reaction time gives a better measure than averaging the reaction times for the 20 trials. Why is this true?

#### Reaction Time to an Auditory Stimulus

D. Position the meter stick as described in Step A. Close your eyes. As the meter stick is released, your partner will say, "Go." React to this auditory stimulus as quickly as possible by closing your fingers on the meter stick.

9. Record your data in your data table as in Step B.

10. Repeat the process for a total of 20 trials, recording your results for each trial. Then find your average reaction time to an auditory stimulus as in Question 7.

#### Reaction Time with Distractions

11. How might reaction times be affected when a person is distracted and less prepared to receive a stimulus?

E. Two teams should work together to test the effect of distractions on reaction time. While one person is tested, a second will act as the recorder, and the 2 others will act as distractors. Follow the procedure in Step D for testing reaction time to an auditory stimulus, except for the following changes. The distractors will select a previously studied chapter from your biology textbook. During the testing procedure, the distractors will ask the person being tested questions from the Review section at the end of the chapter. The person being tested is expected to respond to these questions while waiting for the "Go" signal from the recorder.

12. Record your results for 20 trials in your data table and determine your average reaction time, as in Question 7.

F. Exchange roles and repeat the procedure to test all members of your team.



### Strategy for Organizing

Make graphs large enough to be able to see variations in the data easily. When the scale of the graph becomes very small, patterns in the data may no longer be apparent.

### Strategy for Analyzing

Look at your average reaction time for each stimulus and see how it compares with the class average for each stimulus. Are you closer to the class average for one stimulus than for the others?

RE-DRAW  
AT  
LARGER  
SIZE

13. Record the data after each trial.

14. You and your partner should each use separate sheets of graph paper to prepare graphs showing your own data for the 3 types of stimulus. Label the horizontal axis of the graph "Trial Number" and the vertical axis "Reaction Time." Make sure that you and your partner use the same scales on your graphs so that you can compare data. Plot your data for each type of stimulus separately. Use different colored lines or different symbols in your graph to distinguish between the types of stimuli.

15. In what way does this graph tell you more about your reaction time than the number calculated as "Average Reaction Time"?

16. Does your reaction time remain constant over 20 trials or is there any variation? Is there any evidence of a trend toward faster or slower reaction times over the 20 trials? What might account for such trends?

17. How does your reaction time to an auditory stimulus compare to that for a visual stimulus? What might account for this difference?

18. How does your reaction time compare to that of your partner? What might account for this difference?

### Part II

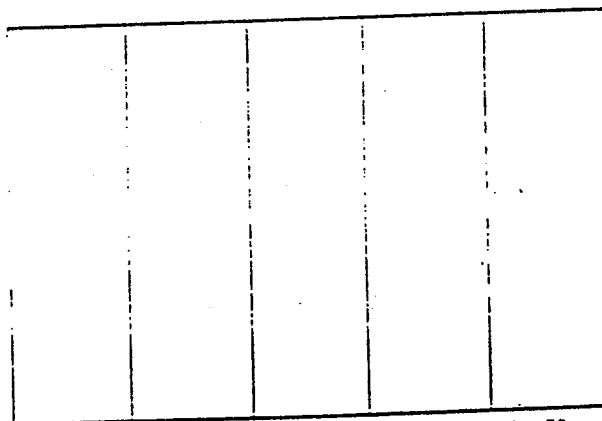
G. Pool the data for the entire class. Your teacher will fill in the figures on an enlarged copy of the table on the chalkboard.

H. Work as a class with your teacher to make a bar graph showing the variation among the average reaction time of all class members to the 3 forms of stimuli.

19. How does your reaction time compare to that of the class? What could account for any differences?

Model Bar Graph

Number of Students

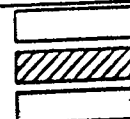


.02 - .10 .12 - .20 .22 - .30 .32 - .40 .42 - .50  
Average Reaction Time

Visual stimulus

Auditory stimulus

Auditory stimulus with distractions



### Postlab Analysis

20. Why might psychoactive drugs affect a person's reaction time? How does the data collected in Step E indirectly relate to the effect of psychoactive drugs on reaction time?
21. Briefly speculate on how each type of psychoactive drugs might affect reaction time.
22. What types of activities would be adversely affected because of the influence of psychoactive drugs on reaction time?

### Student Data - Reaction Times

Visual Stimulus			Auditory Stimulus			With Distractions		
Trial	Distance of Fall (cm)	Reaction Time (sec)	Trial	Distance of Fall (cm)	Reaction Time (sec)	Trial	Distance of Fall (cm)	Reaction Time (sec)
1			1			1		
2			2			2		
3			3			3		
4			4			4		
5			5			5		
6			6			6		
7			7			7		
8			8			8		
9			9			9		
10			10			10		
11			11			11		
12			12			12		
13			13			13		
14			14			14		
15			15			15		
16			16			16		
17			17			17		
18			18			18		
19			19			19		
20			20			20		
Avg.			Avg.			Avg.		

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# Investigating Senses: Sight

# Lab 21

## Background

Your senses provide your brain with information about what is happening both inside and outside your body. When a sense receptor is stimulated, it sends nerve impulses to the brain for interpretation. Various kinds of sense receptors are located throughout the body. They range from tiny nerve endings in the skin to highly specialized organs, such as the eyes and ears. Each type of sense receptor responds only to a certain type of stimulus. Human senses include sight, touch, smell, taste, and hearing.

## Objectives

In this activity you will:

1. Investigate your sense of sight.

## Materials

eye test chart

## Procedures and Observations

The sharpness of your sense of sight can be checked by using an eye test chart.

Work in pairs.

1. Obtain an eye test chart from your teacher. Have your partner hold it and stand exactly 6.1 meters (20 feet) away from you. Cover your left eye and read the rows of letters starting at the top. Read down as far as you can.
  - a. Record the number to the right of the row in which sight becomes uncertain.
2. Cover your right eye and repeat Step 1.
  - b. Record the number to the right of the row in which sight becomes uncertain.

An eye with normal vision can read the bottom row from 20 feet away. This is called 20-20 vision. If, for example, you could read just to the row labeled 30, this means that you would read at 20 feet what a normal eye could read at 30 feet. Your vision would be 20-30.

**3. Estimate your vision for your right and left eye.**

*c. Record your estimated vision for each eye.*

R: \_\_\_\_\_

L: \_\_\_\_\_

Every person has a dominant eye. The dominant eye takes over when focusing on something. In most people, the right eye is dominant.

**4. Make a circle with your right thumb and forefinger. With both eyes open, look at an object across the room through the circle. Have your arm extended fully. First close your left eye and look at the object.**

*d. Does the object appear in the center of the circle?*

---

**5. Next close your right eye and look at the object.**

*e. Does the object appear in the center of the circle?*

---

*f. The dominant eye will be the one for which the object remains in the center of the circle. Which is your dominant eye?*

---

---

The blind spot is the place on the retina where the optic nerve enters the eye. There are no rods or cones in this area, so no vision occurs at the blind spot. Both right and left eyes have a blind spot.

**6. Cover your left eye. Then hold your book about 15 cm away and focus on the star in Figure 1.**



**Figure 1**

**7. Continue to look at the star, and slowly move your book away from you.**

*g. What happens to the dot to the right of the star as you move your book away?*

---

---

*h. At about what distance from your eye does this occur?*

---

## 16-2 How Are Your Senses Sometimes Fooled?

What you see and what you think you see are not always the same. Seeing is done with your eyes. The message your eyes pick up is sent to the brain where it is interpreted. The brain may then "tell" you that you see something that is not present. The mistaken idea that you get is an illusion. If the mistaken idea is because of what you see, or your eyes, it is called an optical illusion.

### INVESTIGATION

#### OBJECTIVES

In this exercise, you will:

- look at several diagrams and record what you see.
- compare your results with what you know is present.

#### KEYWORDS

Define the following keywords:

illusion \_\_\_\_\_

optical illusion \_\_\_\_\_

sense \_\_\_\_\_

#### MATERIALS

ruler                      red marker  
file card                yellow marker  
blank paper

#### PROCEDURE

##### Part A. Triangle Illusion

- Examine Figure 1 for a white triangle. Record in Table 1 on page 127 if you see it.
- Now record in the table if the white triangle is really present. Is there a white triangle drawn

on the diagram? \_\_\_\_\_

##### Part B. Bent Line Illusion

- Examine Figure 2. Record in Table 1 if you think the lines across the diagram could meet without the resulting line being bent.

FIGURE 1.

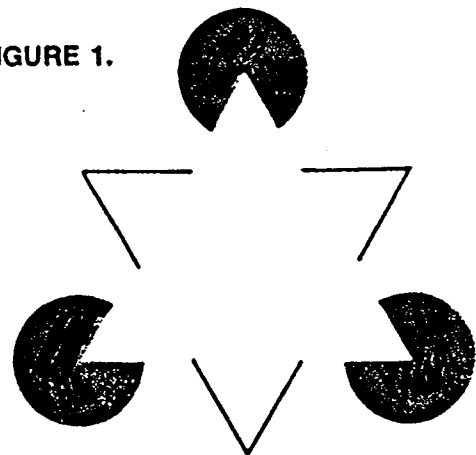
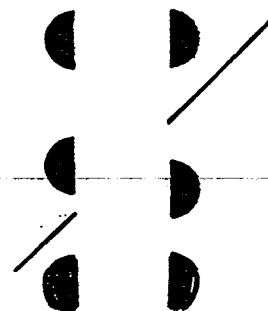


FIGURE 2.



2. Lay a ruler on Figure 2 next to both lines. Does it now appear that the lines would meet in the center without the resulting line

being bent? \_\_\_\_\_

3. Record your results in Table 1.

### Part C. Paper Fold Illusion

1. Fold a file card as shown here in Figure 3. Lay it on your desk about 20 cm from your eyes.
2. Stare at the figure for about 20 seconds with one eye closed. Does the fold appear to always

be in the top of the figure? \_\_\_\_\_

3. Record your answer in Table 1. Also record where you know the fold really is.

### Part D. Flower Illusion

1. Color Figure 4 so that the center is red and the petals are yellow.
2. Stare at the diagram for 30 seconds. Then stare at a blank piece of paper.
3. Record in Table 1 what you see. Also record what you know is on the blank paper.

### Part E. Cylinder Illusion

1. Look at Figure 5.
  2. Which cylinder appears largest?
- \_\_\_\_\_
3. Record your answer in Table 1.
  4. Measure the cylinders with a ruler.

Was your answer correct? \_\_\_\_\_

5. Record your correct answer in Table 1.

### Part F. Cube Illusion

1. Stare at the number 1 in Figure 6 for at least one minute.
2. What appears to happen to corner 1 when you gaze at it steadily?

FIGURE 3.

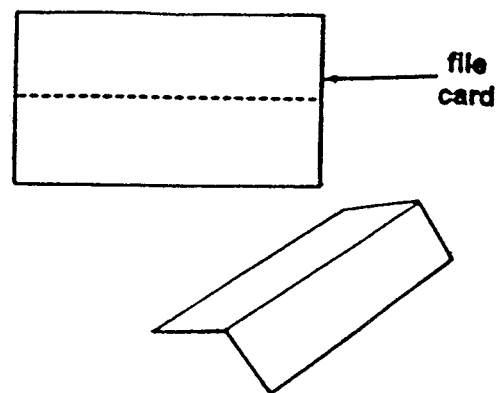


FIGURE 4.

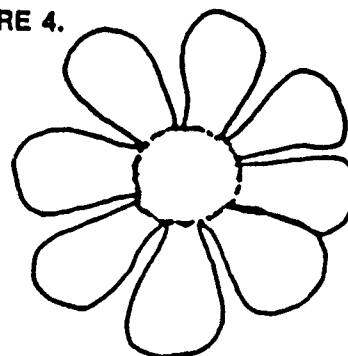


FIGURE 5.

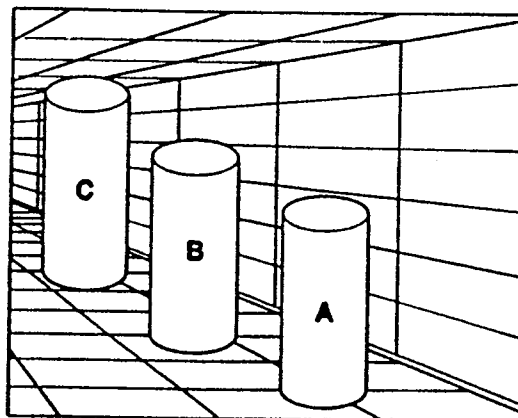
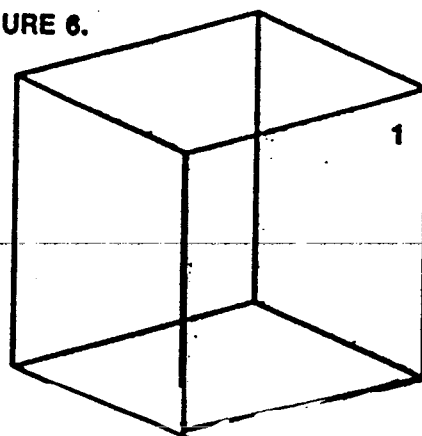


FIGURE 6.



4. Also record in Table 1 what Figure 6 really shows.

**Table 1. Observing Illusions**

Illusion	Appears	Really is
Triangle		
Bent line		
Paper fold		
Flower		
Cylinders		
Cube		

**FIGURE 7.**



**Part G. Figure Reversals**

1. Examine Figure 7. What do you see?

\_\_\_\_\_

2. When you look a second time, do you see anything different?\_\_\_\_\_

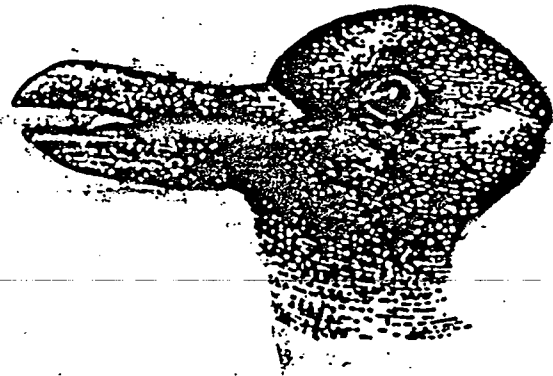
3. Do both figures ever appear at the same time?\_\_\_\_\_

4. Examine Figure 8. This figure was used in 1900 by psychologist Joseph Jastrow. What do you see when the face looks to the left?\_\_\_\_\_

5. What do you see when the face looks to the right?\_\_\_\_\_

Can you see both at the same time?\_\_\_\_\_

**FIGURE 8.**



6. Examine Figure 9. What do you

see? \_\_\_\_\_

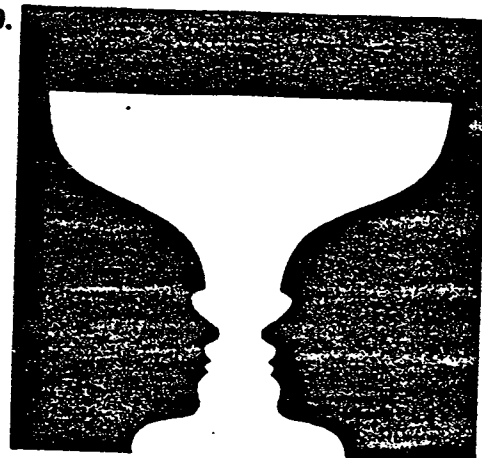
7. Look at the figure again. Do you see anything different? What do

see? \_\_\_\_\_

Can you see both things at the

same time? \_\_\_\_\_

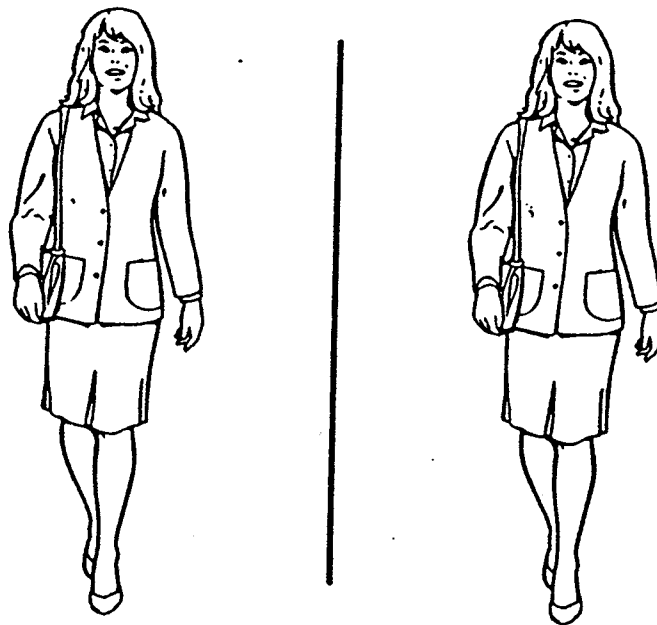
FIGURE 9.



### Part H. Creating Illusions

1. Examine the figure of the two girls below. They are both exactly the same size. Without changing their size, create the illusion that one girl is taller than the other.

FIGURE 10. Make your own illusion



### QUESTIONS

1. Which of the illusions in this activity were optical illusions? \_\_\_\_\_
2. Sometimes a driver sees water on a dry highway. Why is this water an optical illusion? \_\_\_\_\_
3. Name some jobs people have in which they must be aware of optical illusions. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**Introduction**

Pigs are placental mammals and show the distinguishing characteristics of that group. In studying the anatomy of the fetal, or unborn, pig, you will see that its various organ systems are basically the same as those of humans. To see the organs and organ systems discussed in this lab, you will have to do a very careful dissection. It is very easy to crush or remove important structures before you recognize what they are. You should study accompanying diagrams and compare the structures you see with the diagrams so that you can more easily identify the structures you see.

**Purpose**

- Observe the external anatomy of the fetal pig
- Observe the organs and organ systems of the fetal pig
- Relate what you are seeing in the fetal pig to your own anatomy

**Materials**

- \* preserved fetal pig
- \* dissecting tray
- \* razor blade
- \* dissecting scissors
- \* string
- \* forceps
- \* dissecting pins
- \* gloves
- \* probe
- \* metric ruler

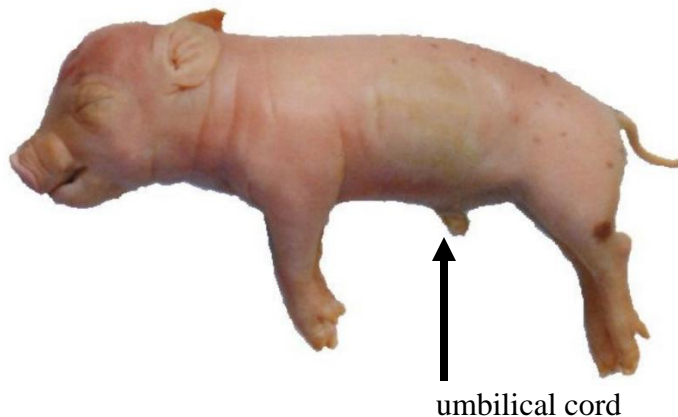
**Safety**

- The chemical preservative may cause skin and eye irritation; therefore, avoid contact.
- Please wear goggles during this activity, aprons are also available.
- Should contact occur between the preservative and skin/eyes, rinse thoroughly with water.
- Be careful when using sharp equipment. Report any cuts, no matter how small, to your teacher.

**Anatomical References**

Label following regions on the picture below AND in your data sheet!!

- \*Anterior
- \*Posterior
- \*Ventral
- \*Dorsal
- \*Cranial
- \*Caudal
- \*Pectoral
- \*Pelvic



**Figure 1**

## External Observations

RINSE your pig well under running water to remove as much preservative as you can!! Line your tray with a couple layers of brown paper toweling to absorb any wetness.

Put on your gloves and wear them throughout this lab activity. The **Figure 1** on the first page shows the external anatomy of the fetal pig. Note that the back is the **dorsal** side of the pig and the belly is the **ventral** side. The head of the animal is the **anterior**, while the tail end of the pig is **posterior**.

The pig has four regions. **Cranial** refers to the head region, **pectoral** refers to the shoulder/chest region, pelvic refers to the hip region and **caudal** region refers to the end region.

Pick up your pig and examine it. You can estimate the age of the pig from its length. Measure the pig from the tip of its snout to the base of its tail in **millimeters**. Estimate the age of your pig using the measurements below. Record this on your data sheet.

7 weeks = 28 mm

8 weeks = 40 mm

15 weeks = 220 mm

17 weeks = 300 mm (length at birth)

### Sexing Your Pig

The sex of a pig can be determined from the external structures. Both male and female pigs have nipples on the ventral surface, so the presence of nipples cannot be used to determine the sex of the pig. In both males and females, the anus is located just beneath the tail.

In **male** pigs, the scrotal sac, which contains the testes, is located beneath the anus. The urogenital opening of the male is just posterior to the umbilical cord on the ventral surface.

In **female** pigs, the urogenital opening is beneath the anus, in a “spike-like” genital papilla.

Once you record the sex of your pig on your data sheet, examine a pig of the opposite sex.

### Umbilical Cord

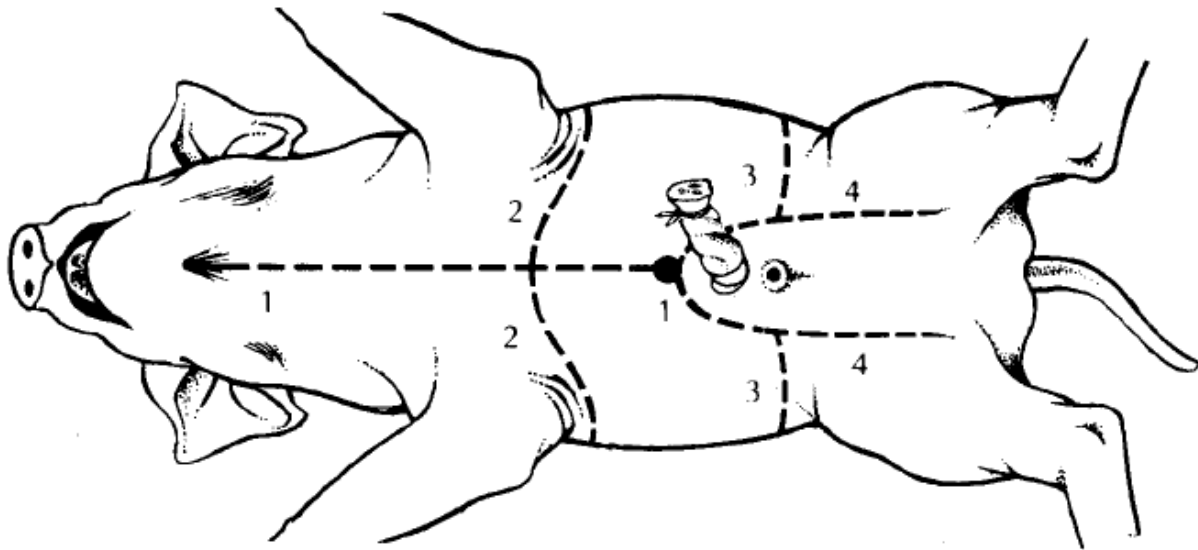
The umbilical cord contains blood vessels that connect the fetus to the placenta. This serves as a “supply line” that carries nutrients and oxygen to the fetus and carries wastes away from the fetus. In the pig, the umbilical cord extends from the midline of the ventral surface. Make a fresh cut through the umbilical cord by cutting a small portion about 1 cm off the end of the cord. Examine the blood vessels of the umbilical cord. The two red vessels are arteries and the one blue vessel is a vein. Draw a cross section of the umbilical cord and label the blood vessels you see on your data sheet.

## Internal Observations

Place the pig on its back in a dissecting tray. Tie a piece of string around the “wrist” of one of the front legs. Run the string under the bottom of the dissecting tray and tie it around the “wrist” of the other front leg. The string should be fairly tight, with lots of tension to it, and not loose. Do the same with the “ankles” of the hind legs, making sure to pull the string under the tray and to pull it tight. The legs should be spread apart so that you are able to dissect efficiently.

**Figure 2** below shows where your incisions should be made. In making incisions use only the **TIP** of your razor blade or your scissors, whichever works better for you. Do **NOT** press down hard. Your goal is to preserve the internal organs and leave them intact, not to mush them up or damage them! Be particularly careful in the incision over the chest area.

Begin the incision at the spot marked by the dot on line 1. Then make the incision shown by line 2 and so on.



**Figure 2**

The ends of the diaphragm, the muscle that separates the abdominal and chest cavities, are attached to the body wall. Gently pull apart the flaps of the body wall along the long cut between the front and hind legs. Do **NOT** lift the flap with the umbilical cord. As you separate the flaps under the front legs, use the scissors or razor blade to carefully cut the ends of the diaphragm at the body wall so that the flap can be pinned down (use several pins).

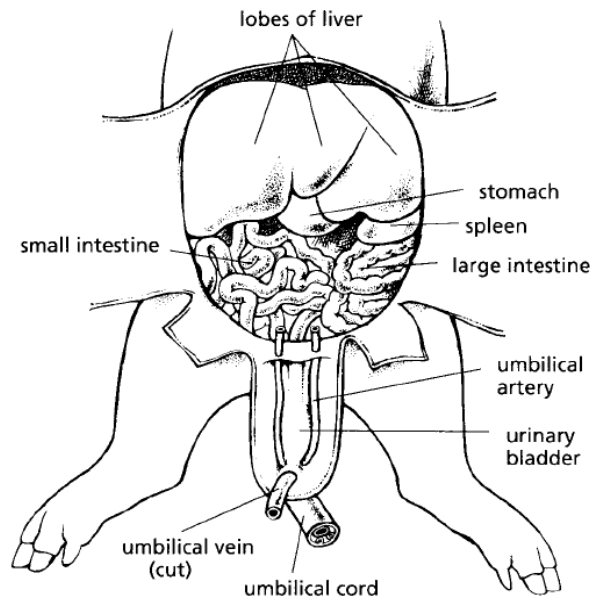
Carefully pull up the flap with the umbilical cord a slight way. You will see the umbilical vein extending from the inside of the umbilical cord up through the liver, toward the head. In order to pull up this flap, use your scissors to cut the umbilical vein. Do **NOT** cut off the flap! After cutting the vein, just leave the flap extending backward between the hind legs of the pig.

### **Digestive System**

The organs of the abdominal cavity are covered by a membrane called the **peritoneum**. If the membrane is still covering the internal organs, carefully slit the peritoneum and then use the forceps to pull it off the organs of the abdomen.

**RINSE** the abdominal cavity really well with running tap water! Drain your pig over the sink and use brown paper towels to soak up any excess liquid as needed.

Much of the upper abdomen of the pig is filled by the red-brown **liver**, while the lower part is filled by **intestines**. The other organs of the abdomen can be seen by gently moving aside the liver and intestines. See **Figure 3** to help you identify the pieces of the abdomen.



**Figure 3**

Examine the liver, both upper and lower surfaces. Locate the **gall bladder**, located underneath the liver. You may need to look hard and use your probe to dislodge the gall bladder from underneath the liver. It looks like a green, deflated balloon. Trace the duct that carries bile away from the gall bladder. Follow it until it enters the digestive tract. The gall bladder stores bile, which emulsifies fats into smaller droplets. Answer the questions on your data sheet.

When you have finished examining the liver, remove it with your scissors. Find the **stomach**. The long, flattened, reddish organ that lies along the outer curve of the stomach is the **spleen**.

Find the part where the stomach and the **esophagus** meet. Also find where the stomach joins the small intestine. Make a cut that will open the stomach from where it meets the esophagus to where it meets the small intestine. Squeeze out a portion of the stomach contents with your probe. Answer the questions on your data sheet.

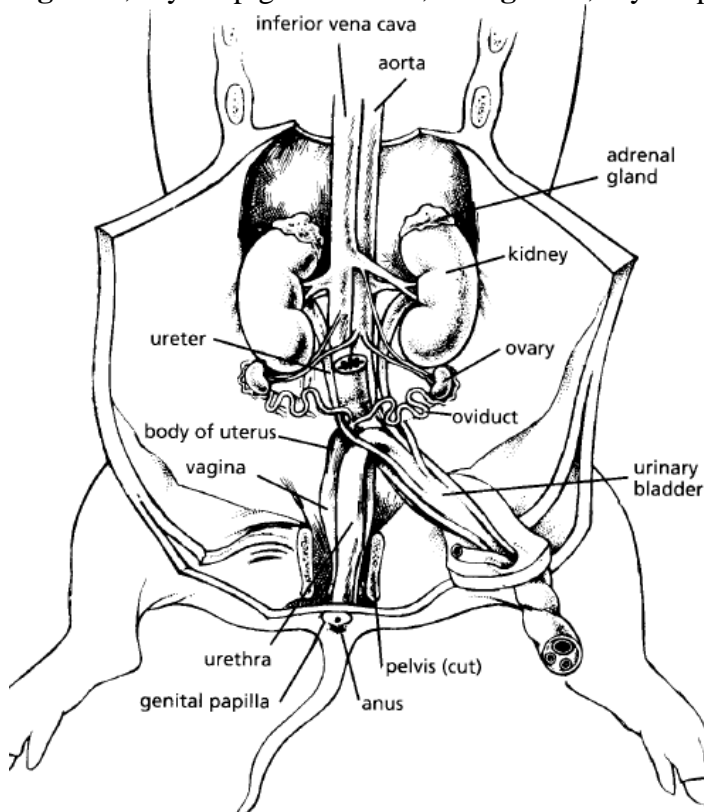
Lift up the stomach and locate the **pancreas**, cutting through its covering membrane as needed. It is a whitish organ that looks like a sponge. The pancreas makes many digestive enzymes that allow the hydrolysis of many complex molecules into smaller ones. Follow the pancreatic duct (tube) that attaches to the pancreas (the side closest to the small intestine) and follow it through to the **small intestine**. Answer the questions on your data sheet.

Examine the small intestine. Spread apart some of the coils of the intestine and note the mesentery, a membrane that holds the intestine in place. Blood vessels and nerves also run through the mesentery. Find the junction of the small and large intestines. Find the **caecum**, a small pouch located at the beginning of the **large intestine**, similar to a human appendix. The lower part of the large intestine is known as the **rectum**. Answer the questions on your data sheet.

### **Excretory System**

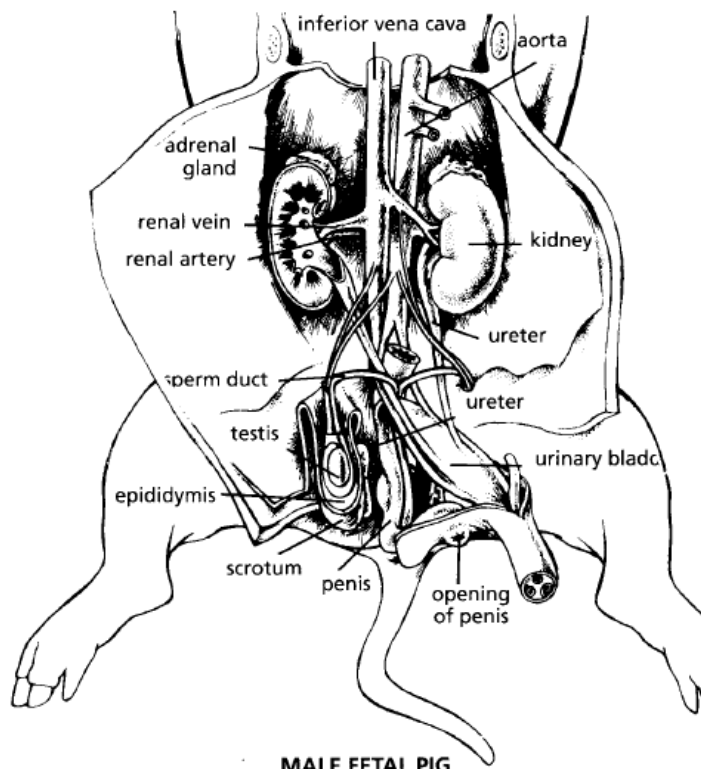
When you have finished with your study of the digestive system, carefully remove the stomach by using your scissors to cut it where it joins the esophagus. Then pull up the intestines and cut out the small intestines and the large intestine, leaving a short section of the large intestine showing. Cut any attached blood vessels close to the intestinal walls. **Note:** Be careful not to destroy the large blood vessels that lie beneath these organs!

The large artery and vein that run along the midline of the **dorsal** surface of the abdomen are the **aorta** and the **inferior vena cava**. Branches from these vessels, the **renal** arteries and veins, serve the **kidneys**. Look at **Figure 4**, if your pig is a female, or **Figure 5**, if your pig is a male, to help you identify the excretory features.



**FEMALE FETAL PIG**

**Figure 4**



**MALE FETAL PIG**

**Figure 5**

Identify the aorta and the inferior vena cava. Locate the **kidneys**, the large, bean-shaped organs found against the dorsal body wall on either side of the abdomen. The kidneys are outside the peritoneum, so they will probably be covered by a membrane. Using your forceps, gently pull the membrane away from one kidney. Be particularly careful if your pig is a female, as her ovary will be just below the kidney. Leave the kidney on the other side of the body intact.

On the side where the kidney is exposed, identify the renal artery and vein and the **ureter**, a large white tube that carries urine to the **urinary bladder**. Follow the ureter and trace it through to the urinary bladder. Examine the top (head end) of the kidney. Answer the questions on your data sheet.

With your razor blade, cut through the kidney **lengthwise** down the kidney, as if you were cutting it open like you cut open a bagel. Remove the front half of the kidney. Draw the cut section and label it in the box provided on your data sheet.

Before starting your study of the reproductive system, you will have to open the pelvic region of the pig. Use your razor blade to make a cut slightly to one side of the midline, through the flap containing the umbilical cord, toward the anus. Referring to **Figure 4** above, pull back the skin, and then carefully cut through the muscle and cartilage of the pelvis.

## **Reproductive System**

In the female pig, the small, kidney-shaped ovaries are found just below the kidneys. However, unlike the kidneys, the ovaries are inside the peritoneum, and are held in place by mesenteries. Eggs released from the ovaries enter the oviducts, which are twisting tubes that carry the eggs to the uterus. The ovary also produces

several hormones that regulate the pig's reproductive cycle. The uterus, which is small in the fetal pig, is found along the midline of the body. Extending from the uterus is the vagina. The vagina and urethra share a single opening (the urogenital opening) to the outside of the body, anterior to the anus.

For a **female** pig, refer to **Figure 4** to locate the **ovary**. If you cannot find it on the side where you have studied and dissected the kidney, look on the other side. Remove any fat tissue that may be in the way, but be careful not to damage the oviduct and supporting membrane. From the ovary, follow the **oviduct** to the body of the **uterus**. Then trace the **vagina** toward the **urogenital** opening, and finally to the genital papilla on the body surface. Answer the questions on your data sheet.

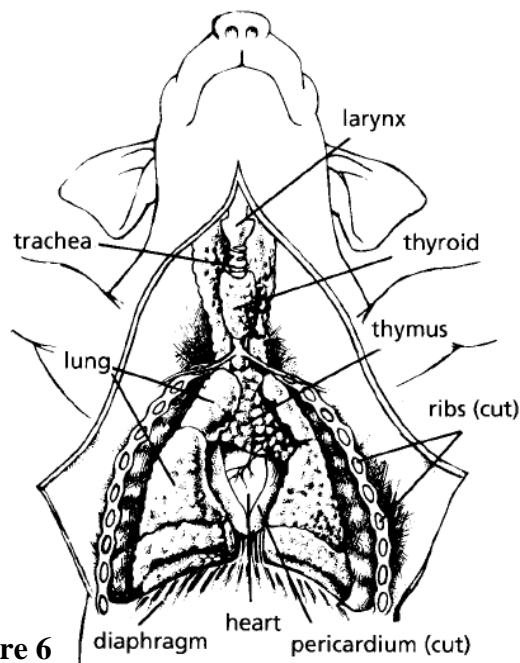
In the fully developed male pig, the testes are located in the scrotum, a pouch found outside the body wall anterior to the anus. The testes grow originally within the abdomen and go down into the scrotum as the fetus develops. The openings in the abdominal wall through which the testes pass are the inguinal canals. Sperm produced in the testes are stored in the epididymis, a small coiled tube that lies next to each testis. The testes are also where testosterone, the male sex hormone, is produced. The epididymis is continuous with the sperm duct. The sperm duct from each testis passes upward through the penis to the outside of the body.

For a **male** pig, refer to **Figure 5** to help you identify the reproductive structures. Carefully cut open one of the scrotal sacs and find one of the **testes**. If the pig is too young, and the testes have not yet descended, you may have to follow the **inguinal canals** up from the **scrotum** to find the testes. Identify the **epididymis**, which begins at the top or head end of the testis. Follow the epididymis around the testis where it joins the **sperm duct**. Follow the sperm duct upward to where it enters the **urethra**. Locate the **penis**, which is found in the strip of body wall that contains the urinary bladder. Both urine from the kidneys and sperm from the testes are released from the body through the penis. Answer the questions on your data sheet.

### Circulatory & Respiratory Systems

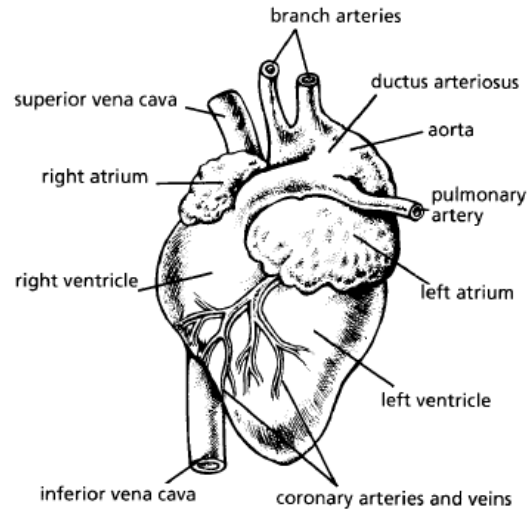
The thoracic, or chest, cavity holds the heart and lungs and is lined by membranes. The chest wall and the surface of the lungs are covered by the **pleural membranes**, while the heart is covered by the **pericardium**.

Gently pull apart the body wall of the chest along the cut you made previously. Pin down the two flaps to the tray. Carefully remove any of the pleural membrane that has not been pulled away with the body wall. Note how the **diaphragm** forms a muscular floor for the chest cavity. See **Figure 6** below. Answer the questions on your data sheet.



**Figure 6**

Lift the lungs out of the way and examine the heart, which is enclosed by the pericardium. The upper, or head, end of the heart is partly covered by the thymus gland. See **Figure 7** to help you identify these pieces.



**Figure 7**

Remove the thymus and then cut away the pericardium around the heart. Lift the bottom of the heart and identify the inferior and superior **vena cava**, which enter the **right atrium**. Identify the **pulmonary artery** leaving the **right ventricle**. This large artery divides to form the two pulmonary arteries to the lungs a short distance after leaving the heart. Try to trace these vessels. Put the heart back in place and identify the **aorta**, which comes from the **left ventricle**. Draw the picture and answer the questions on your data sheet.

In pigs (and humans, too) there is a vessel called the *ductus arteriosus*. This vessel serves as a shunt, or passageway, between the pulmonary artery and the aorta prior to birth. In the fetus, where the lungs are not functioning in respiration, much of the blood bypasses the lungs. It passes from the right ventricle into the pulmonary artery and then through the ductus arteriosus to the aorta. At birth, the ductus arteriosus normally closes up and all the blood from the right ventricle goes to the lungs.

Using scissors carefully cut the blood vessels around the heart at a little distance away from the heart so you can still study their relative positions. Examine the back, or dorsal, side of the heart. Try to identify the ductus arteriosus using **Figure 7** above.

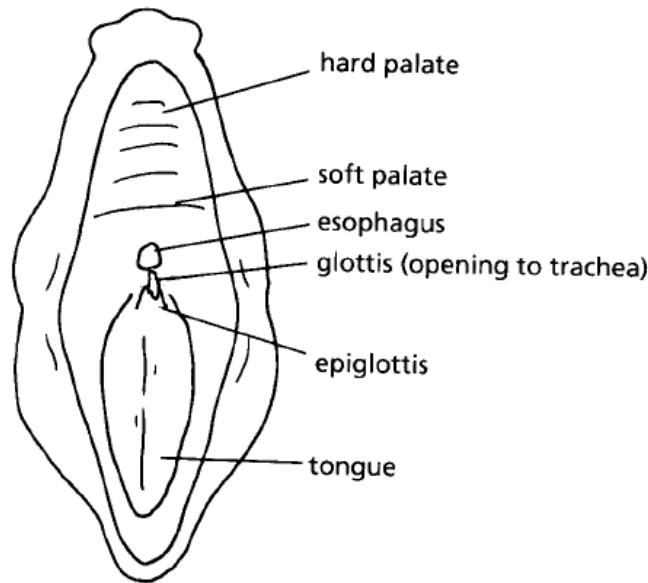
With a razor blade, cut through the heart lengthwise, parallel to the front and back of the heart, as if you were cutting it open like a bagel. You may not be able to see much detail of the internal structure of the heart. Try to identify the fragile **valves**, which separate each atrium from its corresponding ventricle. With the heart removed, identify the **trachea** by its cartilage-ring structure. Find where it divides into the two **bronchi**, which enter the **lungs**. Identify the esophagus, which lies under (dorsal to) the trachea. Touch both the trachea and the esophagus with your probe. Describe your observations on your data sheet.

The **carotid arteries** and **jugular veins**, which carry blood to and from the head, are found on either side of the trachea. Beneath them is the **vagus nerve**. Nerves look like white cotton threads you sew with.

Follow the trachea upwards toward the head. Locate the **thyroid gland**, which lies over the trachea. It is reddish brown and has two lobes, or parts. The thyroid gland is a ductless **endocrine gland**, which means it makes chemicals called **hormones**, which are secreted directly into the bloodstream without the use of a duct, or tube. These hormones then circulate throughout the body via the bloodstream looking for their **target cells** they need to “work on”. Find the larynx, which is at the top of the trachea. Answer the questions on your data sheet.

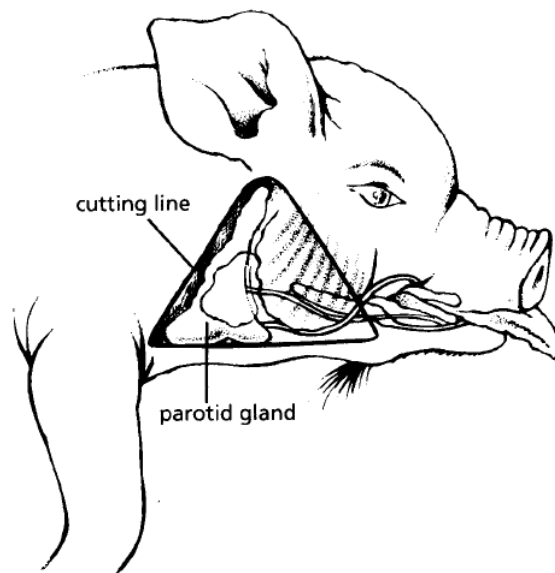
## The Head (BONUS only)

Examine the head of the pig. Open the mouth and examine the tongue, any teeth that are visible, and the back of the throat. If the teeth are not visible, you will probably be able to feel them in the gums. To view the epiglottis, glottis, and opening to the esophagus, use your razor blade to slit the corners of the mouth on both sides. See **Figure 8** below. Also, note the hard and soft palates.



**Figure 8**

The pig has four pairs of salivary glands whose secretions are carried into the mouth by ducts. The largest of these is the **parotid gland**, which extends from the base of the ear to the shoulder and the jaw. Using your razor blade, make an incision through the skin and facial muscles beginning at the base of the ear. See **Figure 9** to help you know where to cut. Remove the skin and muscle layer and examine the parotid gland.

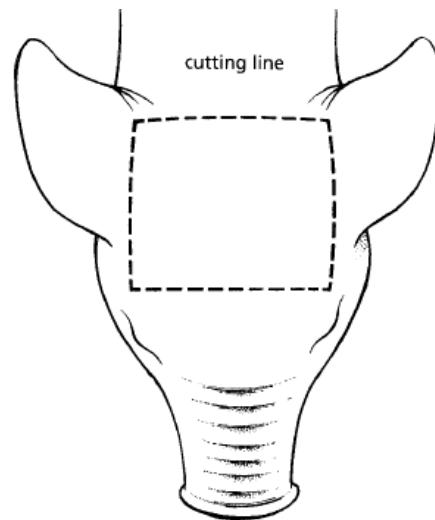


**Figure 9**

The **brain** is the “control center” of any animal. It is part of the pig’s nervous system, which is very similar to that of a human. There is a central nervous system, consisting of the brain and spinal cord, and a peripheral nervous system, consisting of cranial and spinal nerves and their branches.

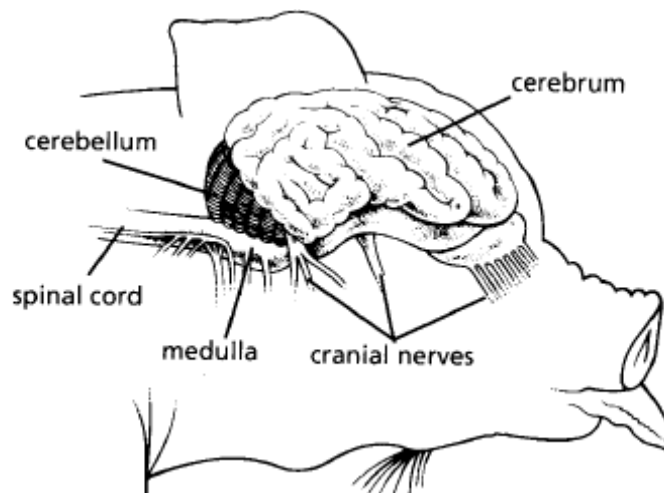


Using your razor blade, make the cuts as instructed in **Figure 10** below. Peel off the skin. Carefully insert the pointed end of your scissors between the joints in the skull bones. Then use the tips of your forceps to pull or break off pieces of the skull until you have opened up most of the skinned area.



**Figure 10**

The brain and spinal cord are protected by three membranes known collectively as the **meninges**. In living animals, cerebrospinal fluid fills the space between the two inner membranes. In preserved specimens, the two inner membranes both adhere to the surface of the brain. Cut through the meninges to expose the brain, using **Figure 11** as a guide. Note the right and left cerebral hemisphere (or halves), which make up the **cerebrum**, which in humans is in charge of learning, memory and thinking. Identify the **cerebellum**, which is behind and beneath the cerebrum and coordinates motor function and helps with balance. The **medulla** is beneath the cerebellum and is in charge of more primitive functions, such as heartbeat and breathing rate.

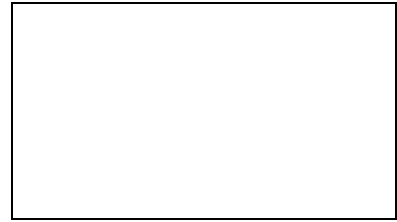


**Figure 11**



**External Features Observations**

1. a. My pig is a GIRL / BOY because \_\_\_\_\_  
\_\_\_\_\_
- b. Can you use the presence of nipples to determine the sex of a fetal pig? YES / NO  
Why not? \_\_\_\_\_
2. My pig is \_\_\_\_\_ mm long.
3. My pig is approximately \_\_\_\_\_ weeks old.
4. Draw your “cut” umbilical cord here. **LABEL** arteries and vein. →
5. What is the function of the umbilical cord in the fetal pig?  
\_\_\_\_\_

**Anatomical References**

6. Label following regions on the picture below:

\*Anterior

\*Posterior

\*Ventral

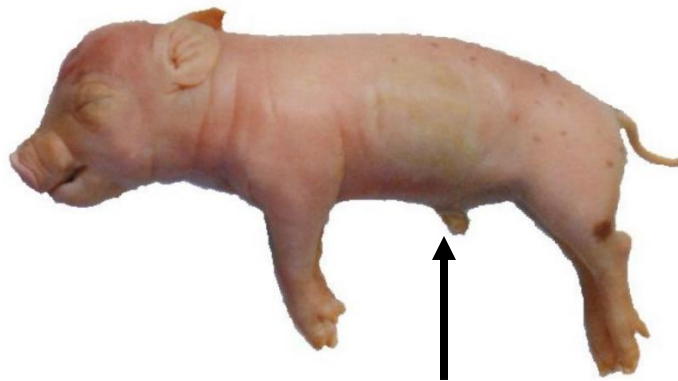
\*Dorsal

\*Cranial

\*Caudal

\*Pectoral

\*Pelvic

**Figure 1**

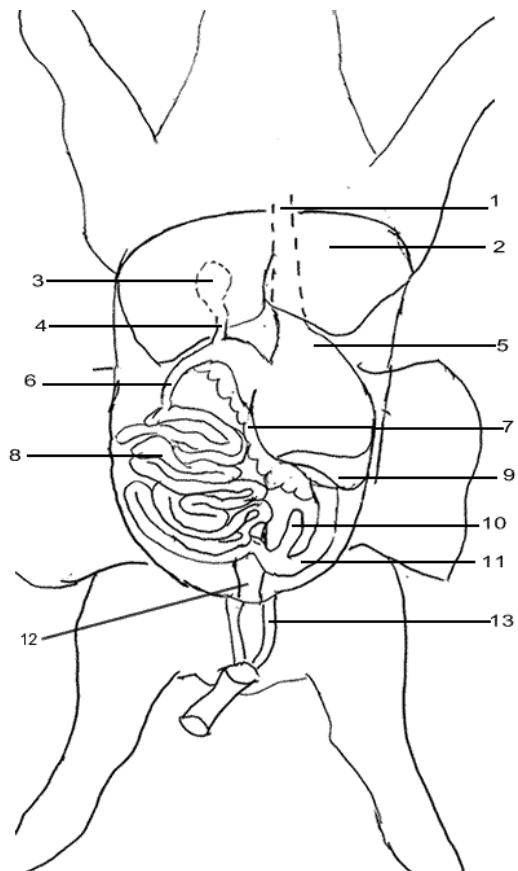
umbilical cord

## Internal Features Observations

### Digestive System

7. How many lobes (parts) does the liver have? \_\_\_\_\_
8. Describe the location and appearance of the gall bladder. \_\_\_\_\_  
\_\_\_\_\_
9. a) What is the function of bile? \_\_\_\_\_  
b) What organ is at the end of the bile duct? \_\_\_\_\_  
c) Why does it make sense that the bile would be poured into this organ? \_\_\_\_\_  
\_\_\_\_\_
10. Describe the contents of the stomach: \_\_\_\_\_  
\_\_\_\_\_
11. Could the contents of the stomach possibly be food? YES / NO  
Explain: \_\_\_\_\_  
\_\_\_\_\_
12. There are 2 sphincters, or rings of muscle, in the abdominal cavity; one where the stomach meets the esophagus and another one where the stomach joins the small intestine.  
  
Suggest a possible function of these muscle rings.  
\_\_\_\_\_
13. a) What substances does the pancreas produce that aid in digestion? \_\_\_\_\_  
b) Why does it make sense that the pancreas would pour these substances into the small intestine?  
\_\_\_\_\_
14. What is the name of the membrane that covers the organs in the abdomen? \_\_\_\_\_
15. What is another word for “duct”? \_\_\_\_\_
16. Describe the differences you observe between the small and large intestine.  
  
Small intestine: \_\_\_\_\_  
  
Large intestine: \_\_\_\_\_

17. Label the digestive organs in the diagram below:



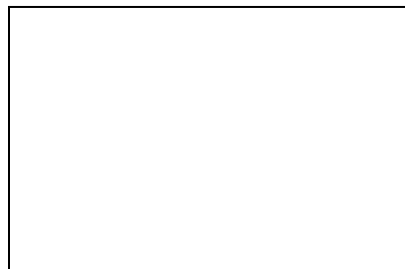
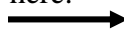
- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_
- 5) \_\_\_\_\_
- 6) \_\_\_\_\_
- 7) \_\_\_\_\_
- 8) \_\_\_\_\_
- 9) \_\_\_\_\_
- 10) \_\_\_\_\_
- 11) \_\_\_\_\_
- 12) \_\_\_\_\_

### Excretory System

18. What structure lies on top of each kidney? \_\_\_\_\_ gland
19. What blood vessels run on either side of the urinary bladder in the fetal pig? \_\_\_\_\_
20. Describe the appearance of the urinary bladder: \_\_\_\_\_

21. Draw and label a cross-section of the pig's kidney here.

Label the renal cortex, medulla & pelvis.



22. The kidneys have a large supply of blood, as you can tell from the large blood vessels that are attached to it. Why do the kidneys require so much blood? (What is their job?)

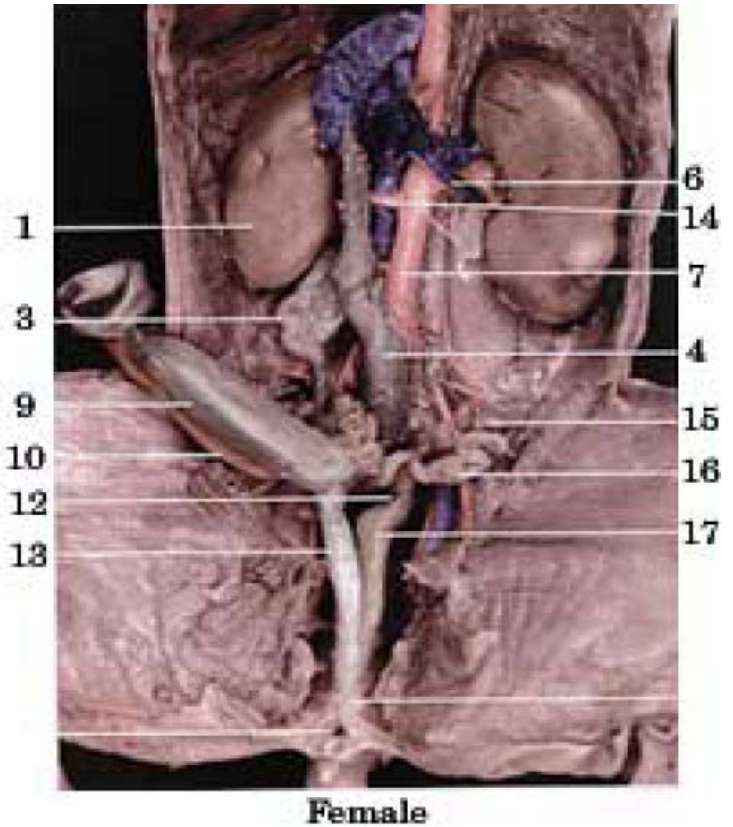
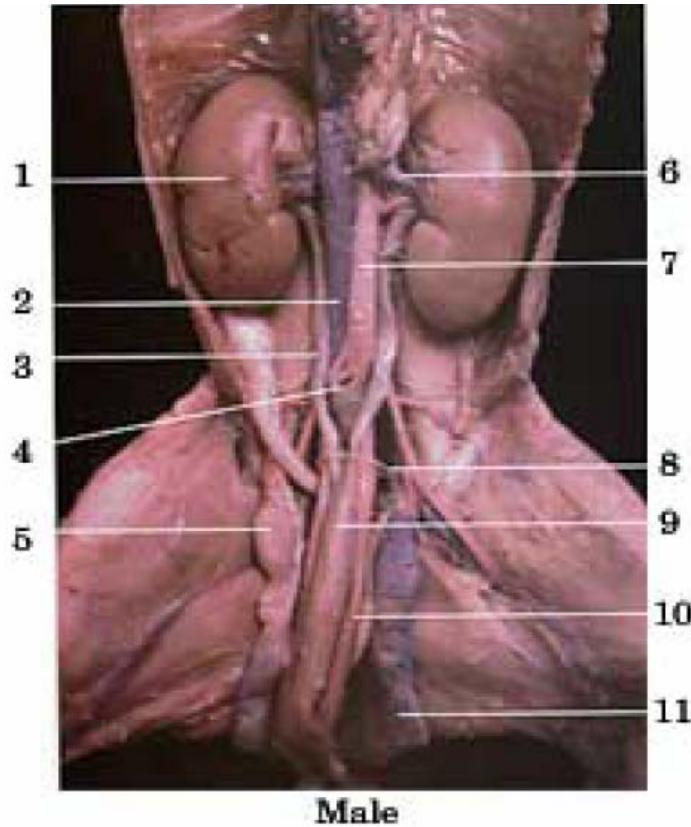
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## Reproductive System

23. Label the reproductive organs in the diagrams below



1. _____	5. _____	9. _____
2. _____	6. _____	10. _____
3. _____	7. _____	11. _____
4. _____	8. _____	12. _____
		13. _____

24. Describe the path an egg takes from the ovary through to the female pig's reproductive tract.

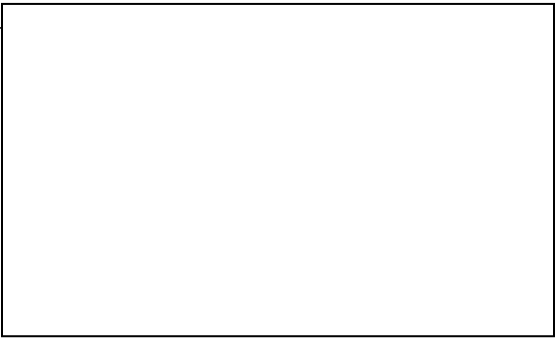
\_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

25. Describe the path a sperm cell takes from the testis through the male pig's reproductive tract.

\_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

26. Besides sperm or egg, what type of substance is made by the gonads? \_\_\_\_\_

## Circulatory & Respiratory Systems

27. What is the name of the membrane that covers the heart? \_\_\_\_\_
28. What muscle separates the abdominal and thoracic (chest) cavities? \_\_\_\_\_
29. How many lobes (pieces) does the left lung have? \_\_\_\_\_ the right lung? \_\_\_\_\_
30. Are the lungs of the fetal pig functional? YES / NO
31. What is the name of the gland located just above the heart? \_\_\_\_\_
32. How many chambers does the heart contain? \_\_\_\_\_
33. What role do the coronary arteries play in maintaining a healthy heart? \_\_\_\_\_  
\_\_\_\_\_
34. Draw an external view of the heart here →   
Label Left Atrium, Left Ventricle, Right Atrium,  
Right Ventricle, Valves, Aorta, Vena Cava  
DRAW arrow to show the path of blood through the heart
35. What is the function of the ductus arteriosus in fetal mammals? \_\_\_\_\_  
\_\_\_\_\_
36. Describe the appearance and texture of ...  
Trachea: \_\_\_\_\_  
Esophagus: \_\_\_\_\_
37. Explain the rich blood supply of the thyroid gland. \_\_\_\_\_  
\_\_\_\_\_

## **BONUS**

In order to receive the bonus, you must correctly demonstrate to your instructor that you have completed the entire bonus section through a verbal “quiz” regarding your dissection, which will be administered by your instructor when you are ready.

Teacher Check: \_\_\_\_\_

## Conclusion

- 1) Describe 5 similarities between the **internal** anatomy of a pig and the internal anatomy of a human.

\* \_\_\_\_\_

\* \_\_\_\_\_

\* \_\_\_\_\_

\* \_\_\_\_\_

\* \_\_\_\_\_

- 2) Describe 2 advantages and 2 disadvantages of dissection in the study of animal tissues and organs.

Advantages	Disadvantages
1)	1)
2)	2)

- 3) Discuss 3 interesting things that you learned about biology, anatomy or the pig from this lab.

1) \_\_\_\_\_

\_\_\_\_\_

2) \_\_\_\_\_

\_\_\_\_\_

3) \_\_\_\_\_

\_\_\_\_\_



**Introduction**

When a human female is born, her ovaries contain the immature cells that will produce eggs during her lifetime. Production of mature eggs through the process of **meiosis** usually begins between the ages of 12 to 14.

One egg will mature every 28 days or so inside a **follicle**, near the surface of the ovary. When the egg is fully mature, it will be released from the ovary in a process known as **ovulation**. If the egg meets a sperm, **fertilization** occurs and the fertilized egg (zygote) implants itself into the thick lining of the uterus. If the egg does not meet a sperm, the egg disintegrates and is discarded along with the thick uterine lining. This process is called **menstruation**.

Hormones carried in the bloodstream bring about the changes in the ovary and uterus, as well as other target tissues involved in the female reproductive system. The cycle of hormones that causes these changes is known as the **menstrual cycle**. The pituitary gland secretes the hormones that signal growth and secretions of the ovary (FSH & LH) and the ovaries secrete hormones that signal growth and change in the uterus (estrogen & progesterone). The levels of these four hormones are controlled by means of **feedback**.

**Procedure**

On the graph provided, plot the hormone levels from the following data. Answer **ALL** the analysis questions.

**Data**

DAY	FSH Units/mL	LH Units/mL	Estrogen Units/mL	Progesterone Units/mL
1	9	9	30	0.60
2	11	12	40	0.80
3	13	16	50	1.00
4	14	18	70	1.00
5	15	19	80	1.00
6	14	16	100	1.00
7	14	12	130	1.20
8	15	19	140	1.20
9	13	15	180	1.30
10	11	16	220	1.50
11	9	20	215	1.50
12	18	30	200	1.60
13	13	75	190	1.80
14	9	58	180	2.00
15	9	30	160	2.30
16	8	14	150	3.70
17	8	10	150	5.80
18	8	9	160	8.30
19	8	7	170	10.40
20	7	5	170	12.00
21	7	3	170	12.00
22	6	3	160	11.80
23	5	2	160	10.30
24	5	3	140	7.20
25	6	3	130	4.00
26	7	4	110	3.00
27	7	5	80	1.50
28	8	7	60	0.80

FOLLICULAR PHASE

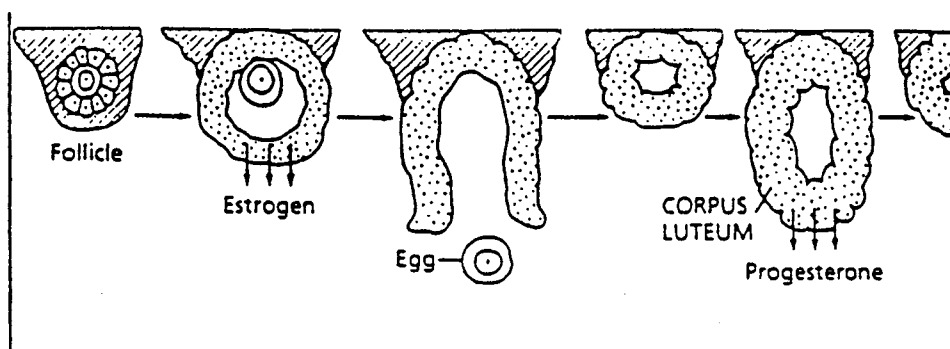
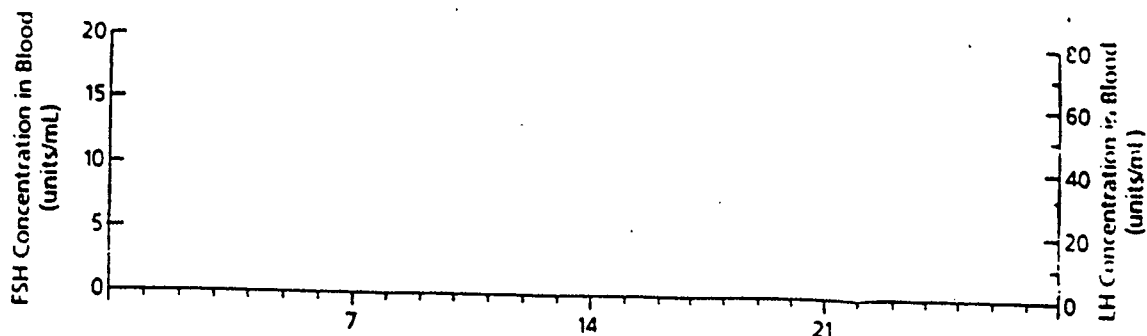
LUTEAL

PHASE

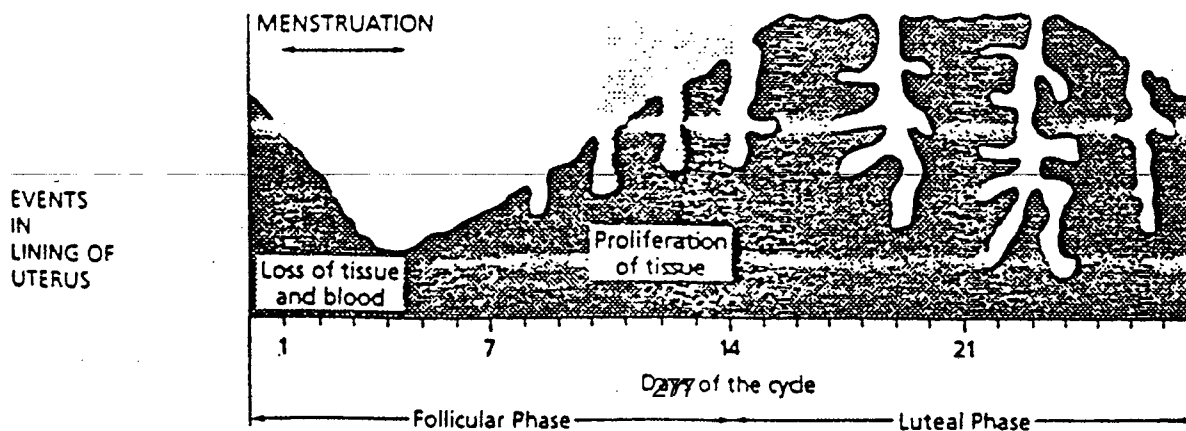
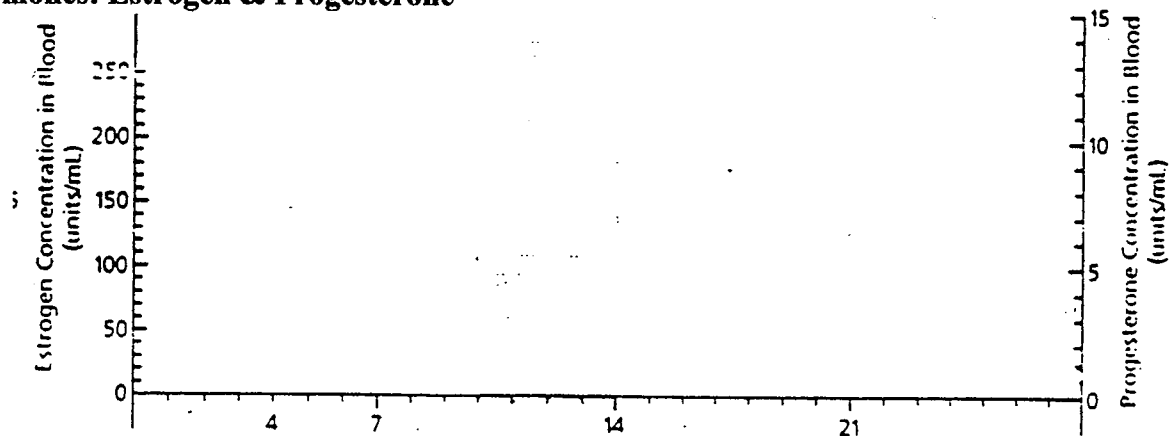


## Graphs

### Pituitary Hormones: FSH & LH



### Ovary Hormones: Estrogen & Progesterone



**Analysis** Use your graphs, notes and lab introduction to answer the following questions.

- 1) **Four** major hormones regulate the human menstrual cycle. Please fill in the chart below:

<u>Hormone Name</u>	<u>Produced by...</u>
1.	Pituitary OR Ovary
2.	Pituitary OR Ovary
3.	Pituitary OR Ovary
4.	Pituitary OR Ovary

- 2) **Negative feedback:**

Increase in hormone levels cause a(n) \_\_\_\_\_ in hormone

Decrease in hormone levels cause a(n) \_\_\_\_\_ in hormone

**Positive feedback:**

Increase of a hormone causes a(n) \_\_\_\_\_ in hormone

- 3) Which hormone most directly leads to the build up of the uterine lining between days 5 & 15?
- 4) Look at your graphs for days 11 through 14. What happens to the levels of the following hormones:

**FSH** \_\_\_\_\_

**LH** \_\_\_\_\_

Is this an example of negative or positive feedback? Explain

- 5) Look at your graphs for days 12 through 14. What happens to the levels of the following hormones:

**Estrogen** \_\_\_\_\_

**LH** \_\_\_\_\_

Is this an example of negative or positive feedback? Explain

- 6) a) Estrogen and progesterone levels are **increasing or decreasing** (circle) around day 21.  
At the same time, FSH and LH levels are **increasing or decreasing** (circle) around day 21.
- b) Many birth control pills contain synthetic estrogen and/or progesterone to maintain higher levels of these hormones in the female body. Hypothesize a reason why these pills prevent pregnancy.

- 8) Describe 2 other feedback mechanisms in human beings. Be sure to include the hormones involved!

a)

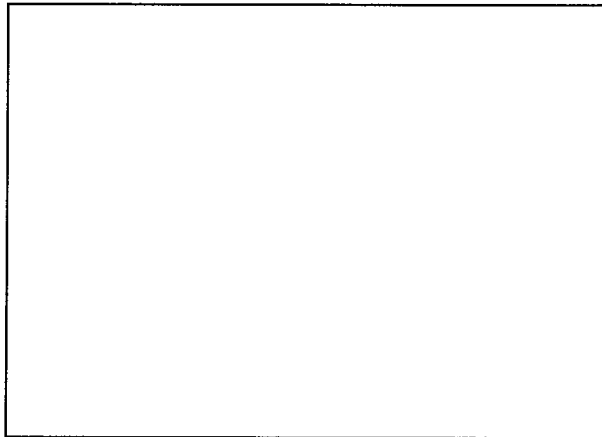
b)

ProcedureEXTERNAL

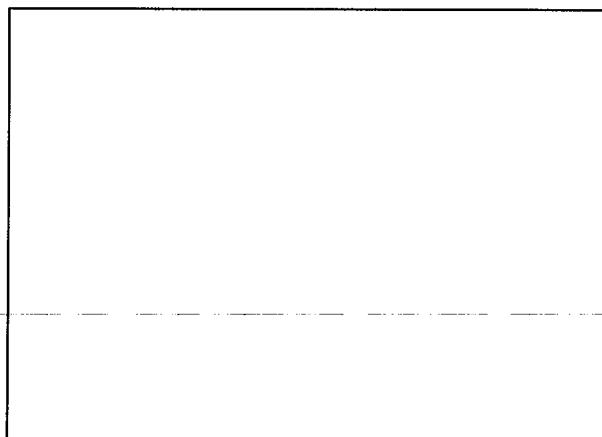
- 1) In pairs, examine the bovine (cow) ovary. Examine the outside of the ovary.
- 2) You may see small round purple dots. These are **follicles**, which produces eggs.
- 3) You may see a raised, yellow bump. This is the **corpus luteum** (“yellow body”).

The corpus luteum (CL) forms after the egg has been released (ovulation). It produces the hormone **progesterone**, which helps maintain the uterine lining during pregnancy.

- 4) The last thing you might see is large, deep purple fluid-filled structures. These are abnormal structures called **follicular cysts**. (WATCH OUT – they squirt!!)
- 5) DRAW what you are looking at and **LABEL** any structures that you see.

INTERNAL

- 6) Using a scalpel, slice each ovary in half, lengthwise, as if you were slicing a bagel.
- 7) DRAW what you are looking at and **LABEL** any structures that you see.



## ANALYSIS

- 1) The corpus luteum is formed after an egg has been released. What would it suggest if you found more than one corpus luteum in your cow ovary?
- 2) Contrast the follicle and the corpus luteum

	<u>Color</u>	<u>Size</u>	<u>Function</u>
Follicle			
Corpus luteum			

- 3) What is the function of each of the following hormones? (use notes & lab introduction)
  - a) FSH \_\_\_\_\_
  - b) LH \_\_\_\_\_
  - c) Estrogen \_\_\_\_\_
  - d) Progesterone \_\_\_\_\_
- 4) Test kits are available that predict (one day in advance) when a woman will ovulate. What hormone does this kit test for?
- 5) What hormones are produced by the ovaries? \_\_\_\_\_  
What hormones are produced by the pituitary gland? \_\_\_\_\_
- 6) As levels of estrogen (and progesterone) rise in a human female, LH and FSH are suppressed.
  - a) What type of feedback (negative or positive) does this change in levels demonstrate?
  - b) Hypothesize a reason why birth control pills, which contain synthetic versions of estrogen and progesterone, prevent pregnancy.