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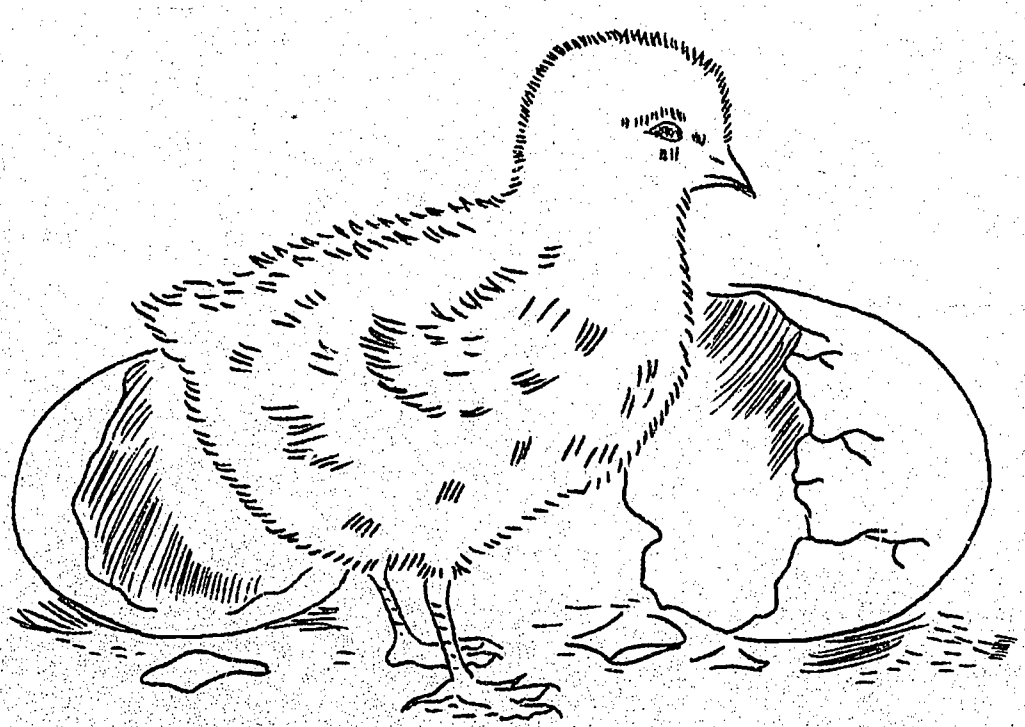
ABSTRACT

Included are instructional materials designed for use with disadvantaged students who have a limited reading ability and poor command of English. The guide is the second volume of a two volume, one year program in life science and contains these two units and activities: Reproduction and Development, 21 activities; and Genetics, 10 activities. A formal textbook is not used in this program, and the learning process relies on class discussion supported by audiovisual materials and small group laboratory activities. Each lesson has a suggested format for teachers to follow in directing activities, with suggested teacher comments. Following each teacher section is the printed material for student use, which generally includes a list of required equipment for small group activities, a short background reading and procedure, and fill-in questions relating to the completed activity. Included is an addendum which lists major concepts and suggested review and test questions for each unit in the two volumes. (PR)

DISCUS SEVENTH GRADE LIFE SCIENCES



PART TWO

D I S C U S

1011 Gilmore Street

Jacksonville, Florida 32204

THE MATERIAL CONTAINED IN THIS MANUAL IS EXPERIMENTAL AND NOT IN FINISHED FORM.

IT HAS BEEN PREPARED FOR USE BY THE DISCUS PROJECT AND ANY OTHER USE REQUIRES THE WRITTEN CONSENT OF THE PROJECT DIRECTOR.

The DISCUS project has developed a course of study in science for the junior high grades (7-9). The material for each grade level has been bound into two manuals.

GRADE 7	BIOLOGICAL SCIENCE
GRADE 8	PHYSICAL SCIENCE
GRADE 9	EARTH SCIENCE

Your comments concerning these materials will be appreciated. For further information, write the project director.

3-19-70

SECOND SEMESTER

DISCUS SEVENTH GRADE BIOLOGICAL

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Seventh Grade Experimental Classes

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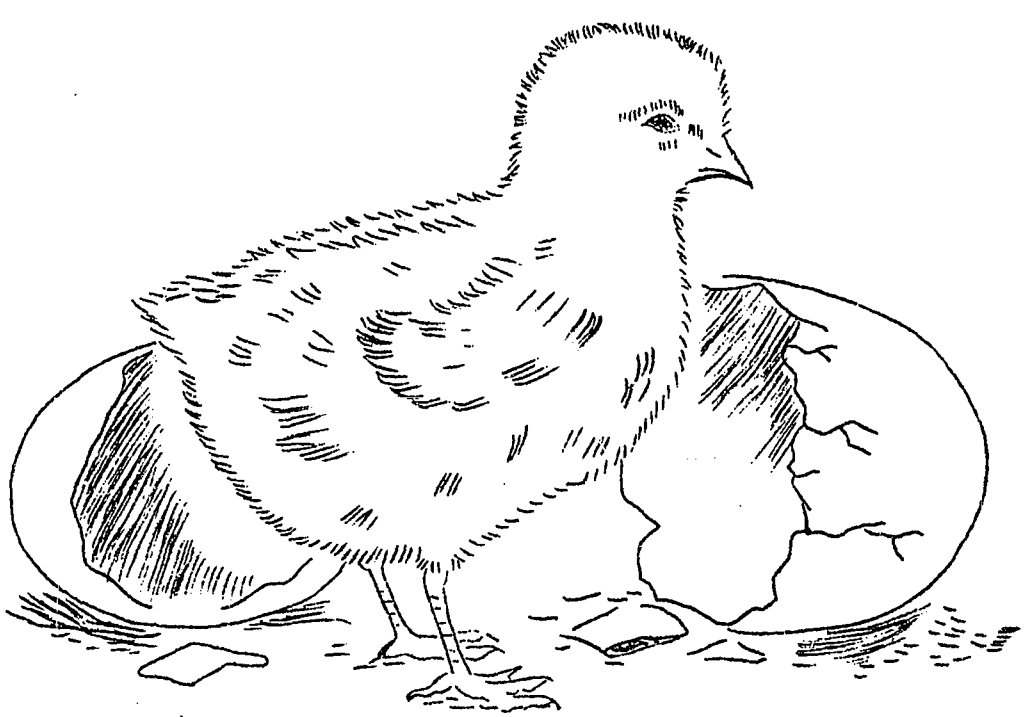
UNIT 4

REPRODUCTION



UNIT IV

TEACHER RESOURCE

REPRODUCTION AND DEVELOPMENT

Reproduction is the process by which plants and animals produce offspring which are similar to their parents. Development is the formation of the organs or parts of the animal or plant after fertilization has taken place. In this unit we shall concern ourselves with the basic process of reproduction in plants and animals and then follow the development of the chick embryo through to hatching. In order to allow sufficient time for development between successive stages related activities have been interjected between observations of the embryo.

The activities included in Unit IV are:

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TEACHER RESOURCE

UNIT IV

REPRODUCTION AND DEVELOPMENT

PEOPLE HAVE SPENT MILLIONS OF DOLLARS ON HEATERS AND AIR CONDITIONERS TO KEEP WARM OR COOL. THEY DO THIS FOR ONE REASON: TO REMAIN AT THE SAME TEMPERATURE. WHAT TEMPERATURE DO YOU THINK IS THE BEST TEMPERATURE FOR A CLASSROOM TO BE? (Write all answers on a transparency.) WHY DO YOU WANT A PARTICULAR TEMPERATURE? Few, if any, correct answers will result. WHAT IS SWEAT? It is mostly water. HOW DOES SWEATING AFFECT THE BODY? It cools the body. WHAT HAPPENS TO THE SWEAT? It evaporates. IF THE EVAPORATION OF SWEAT, (WATER) COOLS THE BODY, THEN THE EVAPORATION OF WATER SHOULD COOL A THERMOMETER. LET'S TRY IT. To demonstrate this cooling effect, wrap some cotton on the bulb of a thermometer, dip it in water, and have a student fan it to hasten the rate of evaporation. The temperature of this thermometer may then be compared to a dry thermometer at room temperature. How many degrees does evaporation cool the thermometer? Have one student serve as time keeper and another record the temperature at one minute intervals on the overhead projector.

WHAT HAPPENS WHEN YOU PUT ALCOHOL ON THE SKIN? WHY ARE PATIENTS WITH A HIGH FEVER SOMETIMES GIVEN AN ALCOHOL BATH? WHICH WOULD LOWER THE TEMPERATURE MORE, ALCOHOL OR WATER? HOW CAN WE FIND OUT? (Involve the class in planning this activity). You will need three thermometers one dry and two with cotton fastened to their mercury tips. One of the cotton tips is dipped in water and the other in alochol. These are then compared to the dry thermometer as the two liquids evaporate. TEMPERATURE IS VERY IMPORTANT TO LIVING ORGANISMS.

WHAT TEMPERATURE DO MOST PEOPLE MAINTAIN? (98.6F average) Discussion. This temperature is best for chemical reactions of the body to take place. If a person gets too hot or too cold, death will result. If you burn your finger, the cells of your skin are killed. If you touch your tongue to a cold ice tray, the skin will not only stick, but will also be destroyed. Other examples may be suggested by the class. Stress that temperature has a direct relation to the chemical reactions causing the death.

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WHAT IS THE DIFFERENCE BETWEEN "LIVING AND NON-LIVING", "DEAD" AND "ALIVE"? LET'S SEE IF WE CAN LIST SOME OF THE THINGS WE WOULD EXPECT LIVING ORGANISMS TO BE DOING. FOR EXAMPLE: MOVING? EATING? NOW YOU TRY TO THINK OF SOME.

(List on a transparency the class suggestions. The term "organisms" will need to be defined).

LET ME SHOW YOU SOMETHING AND YOU DECIDE IF IT IS LIVING OR NON-LIVING?

You may demonstrat many of the characteristics of living things given by the class by using a mercury amoeba. This demonstration is quite spectacular when done on an overhead projector with all the materials in a glass petri dish.

Into the dish pour enough dilute nitric acid (HNO_3) to cover the bottom of the dish. Using an eye dropper, add one or two drops of mercury. Now, we are ready to feed our man-made creature. To produce activity in the dish, add a few grains of Potassium Dichromate on or near the mercury. This will produce bubbling, splitting, and discoloration of the liquid, etc.

To highten the excitement of the demonstration, bring the mercury to class in a brown bottle and do not let the class see the mercury, (since many will recognize mercury).

If the mercury does not react readily, the acid may be two weak and should be strengthened.

From this demonstration the following characteristics may be observed:

MOVEMENTS

UNION - Two drops of mercury forming one.

REPRODUCTION - Splitting of the drops

EATING - On the projector the mercury will appear to engulf the grains of Potassium Dichromate

GIVING OFF WASTE - Bubbles will leave the mercury as if CO_2 or some other gas were being given off. The liquid (acid) will become discolored as if both liquid and solid wastes are being given off.

This activity may last the entire period if the teacher plays along with the discussion and is evasive in answering questions from the class as to whether the "creature" is living or not.

Another interesting demonstration along the same line involves the use of a small piece of copper wire submerged in concentrated silver nitrate ($AgNO_3$) solution in a petri dish and placed on the overhead projector.

The small piece of copper wire on the screen looks very much like a small worm. As the replacement reaction between the copper and the silver takes place, fine, hair-like crystals will form around the wire. This will cause the wire to appear to grow, another characteristic of living things.

The excitement of this demonstration may be increased by showing the students the "creature" at the beginning of the period, removing the dish and showing the class again at the end of the period with a discussion of what has happened.

From the above demonstrations students will begin to see that the answer to the question , "What is a living organism?" is not quite as simple as it may first appear.

LET'S CONSIDER SOME CHEMICAL REACTIONS IN A REAL LIFE SITUATION. HOW MANY OF YOU HAVE SEEN A CHICKEN EGG? HOW MANY OF YOU KNOW WHERE LITTLE CHICKS COME FROM? WHICH CAME FIRST THE CHICKEN OR THE EGG? WHY? Discussion. LET'S GROW SOME LITTLE CHICKS, AND DURING THIS TIME FIND OUT AS MUCH AS WE CAN ABOUT HOW THEY DEVELOP. WHAT DO YOU THINK WE WILL NEED BEFORE WE START? Discussion. LET ME TELL YOU SOMETHING ABOUT EGGS THAT YOU WILL NEED TO KNOW. PERHAPS YOU ALREADY KNOW MOST OF THESE THINGS, BUT LET'S MAKE SURE.

Place transparency B-45 on the overhead. Have students copy the drawing. After they complete the drawing, write the name of each part on the transparency. Ask the students to tell you what they think the purpose of each part is. If they do not know write the correct purpose on the transparency for them, and discuss each item. Use transparency B-45.

Teacher Resource
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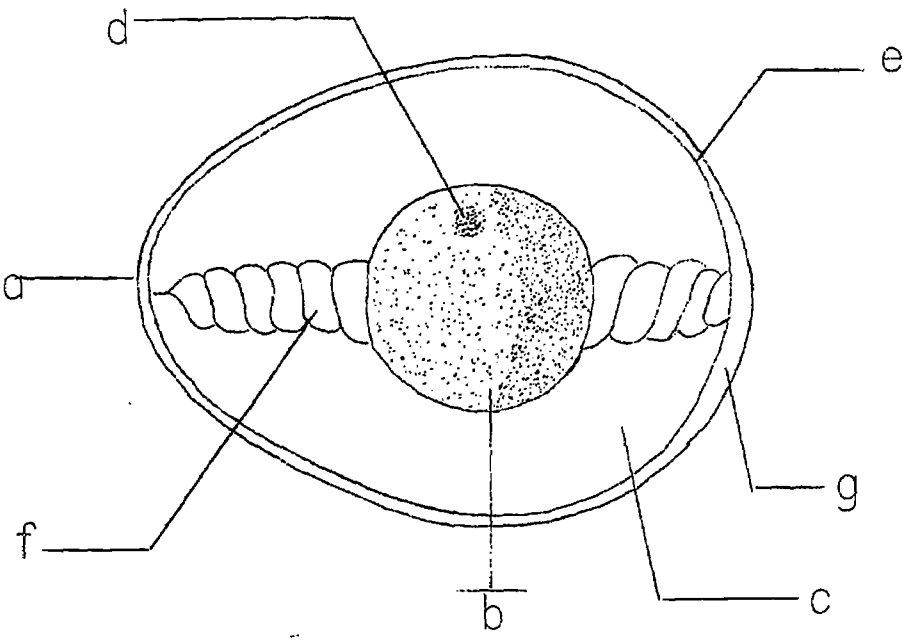
Parts	Purposes
a. Shell	a. Protection and Insulation
b. Yolk	b. Food for the embryo
c. Albumin or white	c. Food for the embryo
d. Growth disc (a white dot on the yolk)	d. The fertilized egg develops into the chick
e. Membrane	e. Regulation of materials entering and leaving the egg.
f. Chalaza	
g. Air space	



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Incubation requirements

a. HOW MANY DAYS DO YOU THINK ARE REQUIRED FOR CHICK EGGS TO HATCH? (21 days at 99°F, longer at lower temperature)

b. Turning the eggs in the incubator every 4 to 8 hours - WOULD SOMEONE LIKE TO VOLUNTEER TO DO THIS?

c. Adequate air and moisture. HOW DO WE KEEP MOISTURE IN THE INCUBATOR? - Place a small pan or dish of water in the incubator.

After discussing these points, have each group of students write their names on three eggs with a pencil and place the eggs in the incubator. Let the students ask questions about the incubator. Many important points may be made concerning thermostates, humidity, insulation, etc. The activities that follow will stress the development of the egg along with the protein, carbohydrate, and fat content of foods, and the relationship of heat to life. In the calculation of days development the first three (3) hours should not be counted.

The procedure for opening eggs should be demonstrated to the class. If the eggs are cracked very gently, the shell may be removed for observation of the membranes. The students should enjoy this procedure and can compete to see who can remove most of the shell without releasing the albumin and yolk. When removing the young chick embryos, always release the contents of the eggs into luke warm water. A petri dish serves well as a container to oberserve the embryos. Transparency B-45A illustrates the correct procedure for opening the eggs.

The eggs will require 21 days of incubation at a temperature of 99°F. A two degree variation is all that should be allowed. The development of fertile eggs is inhibited at 55°F. Embryonic development will begin when the temperature is increased to 99°F. The incubator should be set up several days before the eggs arrive in order to establish a constant temperature. A minimum of twenty-four hours is necessary. A prolonged variation of more than 2°F either way will retard the growth or kill the embryo. Another critical factor is the turning of the eggs. This should be done ideally each morning on arrival and then every 4 hours during the day with

the final turning in the afternoon before leaving. If the eggs are not turned, the embryos will attach to the shell and hatching will not occur. However, some development will take place. Involve class members in the turning schedule, and in the preparation of specimen jars.

All of the specimen jars (baby food jars) should be cleaned and checked and formaldehyde (10% formalin or 70% alcohol solution) prepared for use. Also after specimens are added the jars should be sealed with paraffin. A metal coffee can and a hot plate can be used. Have the coffee can half full of water and chip about one-half a bar of paraffin into the water. The lids of the specimen bottles can then be sealed by dipping the lid and a small portion of the bottle in the paraffin-water.

It will be advantageous to use student help in preparing for future laboratory activities with the chick embryo. BSCS Patterns and Processes is a good reference for the teacher but not much help for the student. BSCS Inquiry into Life (yellow version) is a good technical reference for embryology. Knowledge concerning embryology will enable the teacher to stimulate interest in reading as well as questioning. A most useful reference is A Sourcebook for Biological Science by Morholt, Brandwein, and Joseph, published by Harcourt, Brace and World. Also BSCS Laboratory Block (Animal Growth and Development) by Florence Moog, Publisher D.C. Heath Boston. The county film library has two excellent films on chick development "The Chick Embryo" and the "Development of a Chick". One could be shown at the beginning and one at the end of this unit.

Teacher Resource
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CHICK DEVELOPMENT CHRONOLOGICALLY

DAYS OF DEVELOPMENT	PARTS WHICH SHOULD HAVE DEVELOPED
First day	Primitive streak Head Differentiated Blood Islands formed Neural fold
Second Day	Neural Groove Brain Differentiated Heart Begins twitching at 33 hrs. Rythmic beating at 44 hrs. Eye and ear begin to develop
Third Day	Amnion Begins Allantois begins (SEPTIC TANK)
Fourth Day	Leg and wing buds begin (most basic structures are started)
Sixth Day	Main division of legs and wings
Eighth Day	Feather tracts
Thirteenth Day	Down color begins
Sixteenth Day	Beak, toenails and scales are well formed
Seventeenth Day	Amnionic fluid begins to decrease
Nineteenth Day	Yolk taken into the body
Twentieth Day	Pulmonary Respiration Begins
Twenty-first Day	Your chick is hatched

STUDENT B - 44

REPRODUCTION AND DEVELOPMENT

Reproduction is the process by which plants and animals produce offspring which are similar to their parents. This is perhaps one of the most important processes carried on by plants and animals. What would happen if all the animals of a certain type were suddenly unable to reproduce? No doubt within a few years that animal would become extinct. Or suppose other animals began to destroy this animal or just its young? This happens sometimes with man and certain animals for example the buffalo. The protection of different animals is the purpose of our game and fish laws. Do you remember what happened to the sea turtle eggs in Unit II?

Development is the growth of the organs or parts of the animal or plant after fertilization. In different animals the length of time involved will vary. The development of the chick to hatching requires three weeks, the development of the rat or mouse to birth requires the same amount of time.

Listed below are some of the development times to birth for other animals.

Shrew	18 days	Beaver	3 months
Chick	21 days	Bear	7 months
Mouse	21 days	Deer	8 months
Rabbit	1 month	Cow	9 months
Squirrel	1½ months	Horse	11 months
Dog	2 months	Camel	12 months
Fox	2 months	Whale	20 months
		Elephant	22 months

As a general rule, smaller animals produce many more offsprings each year than larger mammals. The length of time for development usually depends on the size of the animal.

TEACHER DIRECTION B - 45

THE CHICKEN EGG

Materials for groups of three:

1. Egg
2. Forceps
3. Petri Dish
4. Luke warm water
5. Benedicts Solution
6. Ruler
7. Scissors
8. Paper towels
9. 250 ml. beaker
10. Iodine
11. Alcohol lamp

Stress at the beginning of this activity the importance of heat to chemical activity. The eggs prior to incubation were kept at 55°F and little, if any, reaction took place, therefore, no embrionic development. Before incubation the fertilized eggs look just like unfertilized eggs. In this activity the students are to open an unfertilized egg to see its parts. Some students may want to put some unfertilized eggs in the incubator for comparison. Be sure to mark them for identification. The parts of the egg students are to observe are the shell, membrane, albumin, chalaza and the tiny embronic chick. The students are to gently crack the shell and remove a portion of the shell to expose the membrane. (See Transparency B-45). After observing the membrane they are to break it and pour the contents into a petri dish to make observations and drawings of what they see. A small amount of luke warm water should be in the petri dish. The water should be kept warm by adding more warm water as the water in the petri dish begins to cool. This will prevent too rapid a drop in body temperature, which will result in death for the embryo. A prepared transparency (B-45) of the parts (labeled) is to be placed on the overhead projector, without making reference to it. This will serve as a guide. Do not explain the parts or their function until after the activity.

LET'S INVESTIGATE AN EGG BY OPENING IT TO SEE WHAT IS INSIDE. YOU ARE TO MAKE A DRAWING AND IDENTIFY THE PARTS. List the seven parts of the egg on a clear acetate, ask the students to label the drawing with these parts and tell the purpose of each

of these parts.

WHAT DO YOU THINK IS THE PURPOSE OF EACH OF THESE PARTS?

Before the students begin work read over the directions with them very carefully. Create an atmosphere of competition in who can peel most of the shell away before the inside of the egg spills. Caution the students to work over the petri dish and towel at all times. Students will be asked to determine the freshness of the egg by placing it in a glass of water. The stale egg will float because of the accumilation of air in the air space inside the shell.

After the students complete the activity, assemble for class discussion. There should be confusion concerning the function of the parts. Using the prepared transparency, discuss each part.

1. Shell - protection and allow gases to enter and leave the egg. WHAT WOULD HAPPEN IF THE EGG WERE DIPPED IN WAX?
2. Yolk - food and support for the embryo, egg.
3. Membrane - allow gases to enter and leave the egg.
4. Albumin - food
5. Chalaza - hold the yolk (Note: This will be broken when the egg is poured into the petri dish)
6. Air sac - a reservoir of air
7. Embryo egg - the fertilized portion that will develop into the chicken.

WE HAVE DECIDED THAT THE YOLK AND ALBUMIN PROVIDE FOOD FOR THE EMBRYO. WHY WOULD THE YOUNG EMBRYO NEED FOOD? Discussion. WHY WOULD THE EMBRYO USE BOTH THE YOLK AND ALBUMIN? (they contain different kinds of food) TO OBSERVE THE DEVELOPMENT OF THE EMBRYOS, WE ARE GOING TO OPEN THE EGGS ON THE FOLLOWING DAYS OF DEVELOPMENT 5th DAY, 9th DAY, 16th DAY, and 19th DAY. REMEMBER WHAT YOU SEE AND KEEP EACH OF THE FOLLOWING ACTIVITIES FOR REFERENCE.

If time permits, have the students dilute formaldehyde to a 10% solution, wash the specimen bottles and prepare to start preserving specimens. If time is too limited do this the next day. Each group will need 4 bottles. Baby food jars are

suitable.

Each day at the end of work with the eggs a large beaker should be provided for the class to place the remains of the eggs in for disposal by one person.

As an additional activity you may have the students weigh the egg and speculate on how much the chick might weigh and why?

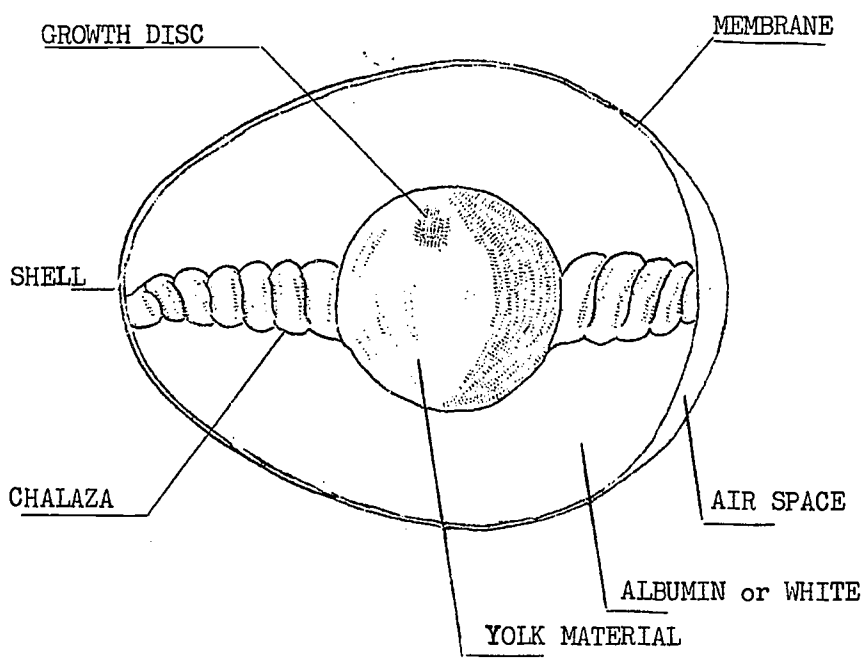
Some interesting questions for class consideration are:

1. Will the weight of the egg increase or decrease?
2. Would a larger egg produce a larger chick?
3. Why do eggs have different colored shells?
4. How does the chick embryo get air?
5. How could the diameter of the yolk be measured while still inside the egg?

TEACHER DIRECTION

B-45

TRANSPARENCY OF CHICK EGG



STUDENT B - 45

THE CHICKEN EGG

Materials for groups of three:

1. Egg
2. Forceps
3. Petri Dish
4. Luke warm water
5. Benedicts Solution
6. Scissors
7. Paper towels
8. 250 ml beaker
9. Iodine
10. Alcohol Lamp
11. Ruler

You are now beginning a study of one of the most interesting parts of science, "how life begins and develops". Life in the chick egg begins with the small white spot on the yolk. It really isn't hard to see. From this little white spot a chick will develop, grow, and become an adult chicken. In the following weeks you will open many eggs and follow the development of the embryo very closely. Today's activity will permit you to see the parts of the egg at the beginning of incubation. Follow directions very closely and use your best laboratory procedures.

Obtain an egg from your instructor. To determine if the egg is fresh or not place the egg in a beaker of water. If it sinks to the bottom it is fresh. If it floats, it is not a fresh egg. Why do you suppose a stale egg floats?? Is your egg fresh?_____ How do you know?

After determining if your egg is fresh or not, begin your investigation. You are to make a drawing and label the parts. Tell the function of each part of the egg.

Very gently crack the large end of your egg. Then with your forceps or finger nail peel part of the shell away. Be very careful not to break the thin membrane just under the shell. At the large end of the egg, a small air sac separates the shell from the membrane. What do you think is the purpose of this air space. The air sac is a very small portion of the fresh egg. At all other places on the egg shell, the membrane is just beneath the shell.

Student
page 2

After seeing the membrane, empty the egg into some luke warm water in a petri dish for observation. Make a drawing of what you see, label the parts, and tell wl you think the purpose of each part is.

Parts you are to identify are:

1. Shell
2. Membrane
3. Yolk
4. Albumin
5. Embrionic Egg
6. Chalaza (a white cord attached to the yolk)

Make a drawing below. Write what you think the purpose of each part is beside the name of the parts on your drawing. Remember, life requires air, food, warmth and protection.

Do a food test on a small amount of the yolk and albumin to determine what food it is made of starch, sugar, etc?

When you complete this activity, dispose of the eggs as your instructor directs.

TEACHER DIRECTION B - 46

FIVE DAY EMBRYO

Materials for groups of three:

1. Egg
2. Forceps
3. Scissors
4. Petri Dish
5. Luke warm water
6. 4 paper towels
7. Ruler
8. Bottle for specimen
9. 10% solution formaldehyde

This activity will be the first proof that growth is really occurring. Students will be amazed at the growth that has taken place. The heart should be beating and the outline of the chick will be seen. It is important that the food (chemicals) is being consumed. Heat is also critical or the reactions will stop, and death will occur.

After the students have gotten over the thrill of their first sight of the tiny chick have them count the number of heartbeats per minute. You may wish to have them add a few drops of Adrenalin (a stimulant) to see the increase in the number of heart beats per minute. You may also add a few drops of acetylcholine (a depressant), after the heart beat returns to normal, and note the decrease in heart beats per minutes. If this is done use transparency B-46 to record the results. Other materials may be used e.g. nicotine from a boiled cigarette, coke, etc. The two drugs mentioned earlier may be secured from a drug store with a prescription, the school doctor or your own family doctor will be glad to give you such a perscription (try him).

Have the students correlate heart beats per minute as related to the temperature of the water, a transparency has been prepared for this use (B-46). When this additional activity is done have the students come together and using the transparency compare their results. If microscopes are available the petri dish may be placed on the stage of the miscroscope and students allowed to observe the flow of blood and blood cells through the blood vessels. This is quite spectacular for students to see.

Teacher Direction
page 2

TODAY WE ARE TO OPEN THE EGGS FIVE (5) DAYS AFTER INCUBATION HAS BEGUN. IT IS IMPORTANT THAT YOU USE GOOD LABORATORY TECHNIQUES. REMEMBER TO CRACK THE EGG GENTLY ON THE LARGE END, THEN PEEL THE SHELL BACK CAREFULLY. EACH GROUP IS TO PICK UP ONE EGG AND FOLLOW DIRECTIONS CAREFULLY. BE SURE TO MAKE ACCURATE DRAWINGS. IF YOUR EMBRYO HAS NOT STARTED TO DEVELOP, SEE ME AS QUICKLY AS POSSIBLE FOR ANOTHER EGG. WHY MIGHT SOME OF THE EMBRYOS FAIL TO DEVELOP? DO NOT PLACE THE EMBRYO IN A PETRI DISH WITHOUT FIRST ADDING WARM WATER. NOTICE THE SIZE OF THE YOLK AND THE SURROUNDING MATERIAL TO SEE IF THE EMBRYO IS USING ANY OF THE PROTEINS, CARBOHYDRATES, OR FATS AS FOOD. SELECT ONE MEMBER OF YOUR GROUP TO REPORT WHAT YOU OBSERVE.

Pass out B-46

Work closely in supervising this activity. Continually ask questions and encourage students to observe specimens in other groups.

After completion of the activity reassemble for a class discussion. Using the prepared transparency B-46, go over the activity and draw in the changes that have taken place. If some of the students like to draw and have good results, let them draw the changes on a transparency prior to the class discussion.

STUDENT B - 46

FIVE DAY EMBRYO

Materials for groups of three:

1. Egg
2. Forceps
3. Scissors
4. Petri Dish
5. 4 paper towels
6. Luke warm water
7. Ruler
8. 250 ml beaker
9. Thermometer

Your eggs have been in the incubator for five days. What do you think has happened? Is the heart beating? Is the embryo eating food? Is the yolk any smaller? Take a look and see!

Crack the egg gently on the large end and remove all of the shell you can before breaking the membrane. After removing the shell, cut the membrane with your scissors and pour the egg into a petri dish that contains warm water. The warm water will prevent the cooling of the embryo too fast and prolong the life of the embryo for examination.

Remember to work over the paper towels and petri dish at all times.

Make a drawing of the egg and label the parts as you did in the last activity, B-45. Then answer the questions at the end of the activity. Select one member of your group to report your observations to the class.

Make a drawing and label the parts.

Answer the following questions:

1. What is the temperature of the water in the dish? _____
2. How many times each minute is the heart beating? _____
3. As the temperature of the water goes down, what happens to the rate of heart beat?
4. How would an increase in the temperature of the water affect the rate of heart beat?

Student
page 2

5. Measure the embryo. How long is it?_____ inches.

6. Were the eyes starting to form?_____

   How can you tell?

7. Can you see any blood vessels?_____ _____

   Where are they located?

8. Is the embryo alive:_____

   How can you tell?

9. Record the following information

   a. Temperature in the incubator._____

   b. Number of eggs opened today by your group._____

   c. Date _____/ ____/ ____

10. Did the yolk change color? yes _____ no_____

11. What color _____

12. Did the white of the egg (albumen) change color? yes _____ no _____

13. What color_____

14. What does a color change tell us? _____

TEACHER DIRECTION B - 47

TEMPERATURE CHANGES AND COLDBLOODED ANIMALS

Materials for groups of three:

1. Battery jar (Gal. Mayonnaise jar)
2. Live minnows or goldfish
3. Thermometer
4. Crushed ice
5. Warm water

As we wait for the development of the nine-day embryo we will return to our discussion of temperature and the important part it plays in living organisms.

WE HAVE DISCUSSED THE IMPORTANCE OF HEAT TO A LIVING ORGANISM. ALL ANIMAL LIFE CAN BE GROUPED ON THE BASIS OF BODY TEMPERATURE, ONE GROUP WARM-BLOODED AND THE OTHER COLD-BLOODED. WHAT IS A WARM-BLOODED ANIMAL (animals that maintain a constant body temperature) WHAT ARE SOME EXAMPLES? (man, dogs, cats, etc.) ALL OF THESE MAINTAIN CONSTANT BODY TEMPERATURES REGARDLESS OF THEIR ENVIRONMENT. HOWEVER, COLD-BLOODED ANIMALS CHANGE BODY TEMPERATURE IN RELATION TO THEIR ENVIRONMENT. FOR EXAMPLE, IF THE ENVIRONMENT TEMPERATURE DROPS, THEIR BODY TEMPERATURE DROPS ALSO. COLD-BLOODED ANIMALS INCLUDE: FROGS, SNAKES, LIZARDS, FISH, AND TURTLES. AS THE TEMPERATURE DROPS, THEIR BODY ACTIVITIES SLOW DOWN. AMONG THESE ACTIVITIES IS RESPIRATION RATE (number of times organism inhales and exhales). IN FISH THIS RATE MAY BE MEASURED BY THE NUMBER OF TIMES THE GILLS OPEN AND CLOSE.

Students are to place a goldfish in the jar and add ice until the water is near freezing. Care should be taken not to excite the fish since this will upset the respiration rate.

Pass out B-47

After all groups have collected their data, have them reassemble for a class discussion of their results and to compile results for the entire class.

STUDENT B - 47

TEMPERATURE CHANGES AND COLDBLOODED ANIMALS

Materials for groups of three:

1. Battery jar
2. Live goldfish or minnows
3. Thermometer
4. Crushed ice
5. Warm water

Put the goldfish into a gallon jar half-filled with water. Place a thermometer at one side of the jar so that it can be read without disturbing the fish. What does the thermometer read? Record _____ For 1 minute count the number of gill beats and record. In order to reduce the shock factor and avoid exciting the fish, add the crushed ice to the water slowly. Continue to add ice until the water temperature is reduced to near freezing, 32°F. Read and record the water temperature now.

Watch the movement of the gill covering. Count the number of times the covering moves during a one-minute interval. Record this number on the chart. Now, slowly add warm water to the jar, again try to avoid exciting the fish. Add enough warm water to raise the temperature of the water five degrees. Allow the fish to adjust to a new temperature at five-degree intervals, counting and recording the respiration rate each time the temperature is raised. Continue adding warm water until the temperature reaches 90°F.

1. What happens to the heart-beat as the temperature decreases?
2. Why are patients for open-heart surgery sometimes packed in ice?
3. Would a frog become more active or less active in cold water?
4. Would fish need more food or less food in winter?
5. Would you be more likely or less likely to get snake-bite in the winter? (snakes are coldblooded) Why?

Student
page 2

RESULTS FOR OUR GROUP	Temp. in Degrees	Gill Beats Per Min.
TEMPERATURE OF THE WATER AT THE START OF THE EXPERIMENT		
LOWEST TEMPERATURE RAISED 5 DEGREES F		
+ 5 Degrees _____		
+ 5 Degrees _____		
+ 5 Degrees _____		
+ 5 Degrees _____		
+ 5 Degrees _____		
+ 5 Degrees _____		

TEACHER DIRECTION B - 48

BODY MOVEMENT AND TEMPERATURE

Materials for groups of three:

1. Ice
2. Large beaker, 600 ml
3. Thermometer
4. Stirring rod

This activity should demonstrate the relation of low temperatures to functions of the body. It is obvious that placing one's hand in cold water causes something to happen that is uncomfortable. The transfer of heat energy will be from the warm body into the foreign medium, water, if the medium is colder than the body. This activity should demonstrate this idea.

WE HAVE DISCUSSED AND INVESTIGATED HEAT AND HOW WE MEASURE CALORIES. LET'S NOW LOOK AT WHAT HAPPENS WHEN WE ARE PLACED IN A VERY COLD SITUATION. WHAT WOULD YOUR BODY DO TO MAINTAIN ITS NORMAL TEMPERATURE? (React in ways that tend to conserve heat energy). List all responses on the overhead projector. LET'S FIND OUT WHAT YOUR HAND WOULD DO IF PLACED IN A FREEZING CONDITION. BY THE WAY, AT WHAT TEMPERATURE DOES WATER FREEZE?

Pass out B-48

Using transparency B-48 discuss the procedure and instruct the students to begin work immediately.

The students are to place ice in a beaker half filled with water, and stir until the temperature reaches 32°F, then remove the ice. The first activity is to submerge a hand without moving it for two minutes. At 30 second intervals, students are to record the temperature of the water. Starting with the same amount of water at 32°F, the second activity requires the students to move their hands by opening and closing their fingers for two minutes while in the water, recording the temperature of the water as before at 30 second intervals. It will be obvious that more heat exchange will take place when moving the hand.

The data sheet asks that each member of the group determine the heat exchange, for his hand and then determine the average for their group. Students should be a

cautioned to lower the temperature of the water each time back to 32°F before the the next student starts. This may be done by adding ice and then removing the ice before placing the hand in the jar. The students may need help in calculating the average.

After completing the activity, reassemble for class discussion. Using the transparency, calculate a class average and point out the difference in temperature variation with regard to movement. It would also be a good idea to compare hand size and temperature differences. Ask students to describe how their hand felt at this low temperature.

Many other class activities could be developed using different materials as well as differing medias. If time permits, students may devise other experiments and try them.

STUDENT B - 48

BODY MOVEMENT AND TEMPERATURE

Materials for groups of three:

1. Ice 2. Large beaker (600 ml) 3. Thermometer

The human body is a magnificent machine, but it must run at a certain temperature to operate properly. As we have already found, chemical reactions give us the necessary heat energy, but how does the body "know" to speed up or slow down the production of this heat energy. Many important questions concerning this very important question are now being studied in research laboratories. Many of the answers still are not known. Scientists must take small parts of a larger question and study them individually. Later they put the smaller answers together in order to answer the larger question. In this activity we will only look at two small parts of the heat energy question. Let's find out what the hand does when placed in cold water. Will the hand give off heat if you move your hand, or will it give off more heat if your hand does not move? You probably know the answer, but can you prove it?

Half fill a beaker with water and place some ice in the beaker. Gently stir the water and ice until the temperature reaches about 32°F. Then remove the ice and place your hand in the ice water for two minutes. During this time, have one of your lab partners record the temperature of the water at 30 second intervals. YOU ARE TO KEEP YOUR HAND IN THE WATER FOR TWO MINUTES WITHOUT MOVING IT. Record the results in the table on the next page. When each member of the group has completed this part of the activity, repeat the activity but this time moving your hand by opening and closing your fingers.

Student
page 2

TEMPERATURE CHANGE FOR NO MOVEMENT

STUDENT NUMBER ONE

Temperature of water when the hand is first placed in the ice water _____ °F

_____ 30 sec.
_____ 30 sec.
_____ 30 sec.

Temperature of water 2 minutes after the hand is placed in the ice water. _____ °F

Temperature difference in water _____ °F

STUDENT NUMBER TWO

Temperature of water when the hand is first placed in the ice water _____ °F

_____ 30 sec.
_____ 30 sec.
_____ 30 sec.

Temperature of water 2 minutes after the hand is placed in the ice water _____ °F

Temperature difference in water _____ °F

STUDENT NUMBER THREE

Temperature of water when the hand is first placed in the ice water _____ °F

_____ 30 sec.
_____ 30 sec.
_____ 30 sec.

Temperature of water 2 minutes after the hand is placed in the ice water _____ °F

Temperature difference in water _____ °F

The data obtained will be more meaningful if you find an average. So add all the temperature differences and find out the average by dividing the total difference by three.

The average temperature difference for my group is _____ °F

Student
page 3

TEMPERATURE CHANGE WITH MOVEMENT

STUDENT NUMBER ONE

Temperature of water when the hand is first placed in the ice water. _____ °F

_____ 30 sec.
_____ 30 sec.
_____ 30 sec.

Temperature of water 2 minutes after the hand is placed in the ice water _____ °F

Temperature difference in water _____ °F

STUDENT NUMBER TWO

Temperature of water when the hand is first placed in the ice water _____ °F

_____ 30 sec.
_____ 30 sec.
_____ 30 sec.

Temperature of water 2 minutes after the hand is placed in the ice water _____ °F

Temperature difference in water _____ °F

STUDENT NUMBER THREE

Temperature of water when the hand is first placed in the ice water _____ °F

_____ 30 sec.
_____ 30 sec.
_____ 30 sec.

Temperature of water 2 minutes after the hand is placed in the ice water _____ °F

Temperature difference in water _____ °F

The data obtained will be more meaningful if you find an average. So add all the temperature differences and find out the average by dividing the total difference by three.

The average temperature difference for my group is _____ °F

Student
page 4

Remember that this is the temperature change for no movement of the hands. Next find out what the average temperature difference will be when you move your hand. Each student is to move his hand by opening and closing his fingers only. Again record the temperature at 30 second intervals.

TEACHER DIRECTION B - 49

SEXUAL REPRODUCTION IN BRINE SHRIMP

Materials for groups of three:

1. Gallon jar
2. Table salt
3. Hand lens
4. Package of brine shrimp
5. One teaspoon

Brine shrimp are salt water crustaceans that can easily be grown in the laboratory. They are extremely interesting animals for study and can be used as a source of living food for small aquarium fishes. In nature the resting eggs of the brine shrimp float in the water and require drying before they will hatch. The dried eggs remain viable (alive) for several years if kept in a dry, cool place.

The eggs will hatch quickly (within 24 to 48 hours) after being placed in a brine solution which is kept at a temperature of 70 to 75°F. Natural or artificial sea-water may be used if available. The brine solution used as a hatching medium may be almost any concentration from about 0.1% to 6%. When sea-water is not available make up a brine solution by adding two teaspoonfuls of common table salt to one quart of water.

Yeast will serve as a satisfactory food; also any of the one-celled floating algae. These may be obtained by scraping some of the green slime from the glass sides of a fresh-water aquarium and placing a little of this in the brine shrimp culture.

STUDENT B - 49

SEXUAL REPRODUCTION IN BRINE SHRIMP

Materials for groups of three:

1. Gallon jar
2. Table salt
3. Hand lens
4. Pkg. of brine shrimp (shared by at least 12 people)
5. One teaspoon

In sexual reproduction, an egg is produced by a female plant or animal. This may also be called a female "sex cell". The male produces sperm, or male "sex cells The egg need only come into contact with one sperm, and when they join, a new plant or animal may be produced.

Brine shrimp are salt water animals. They have from 10 to 30 pairs of small leaflike swimming arms, and are almost microscopic.

Be sure to examine the dry eggs with a hand lens. These shrimp eggs were laid by female shrimp. They were fertilized (when one sperm entered one egg) by sperm from male shrimp. Let's see if we can get baby brine shrimp to hatch from these eggs.

In a gallon jar add 4 teaspoonfuls of table salt to a $\frac{1}{2}$ gallon of tap water. Add a little less than $\frac{1}{2}$ teaspoon of dried shrimp eggs. Keep the jar loosley covered. It will take about 2 days before the brine shrimp begin to hatch. As they begin to hatch you will notice small white "specks" moving through the water. Questions of importance are:

1. The female sex cell is called_____.
2. The male sex cell is called a _____.
3. What happens when an egg and a sperm join?
4. Why did you add salt to the tap water?
5. Why did you leave the cover of the jar slightly open?
6. What do you mean when you say an egg is fertilized?

TEACHER DIRECTION B - 50

NINE DAY EMBRYO

Materials for groups of three:

1. Petri dish
2. Scissors
3. 4 paper towels
4. Forceps
5. Ruler
6. Luke warm water
7. 1 specimen bottle
8. 250 ml beaker

Development of the embryo by this time should be extensive. Most of the body will be formed and many blood vessels will be evident. Students will have no trouble recognizing the blood. A membrane holding waste material, called the alantois can be seen. The amnion, a membrane covering the embryo, will also be readily visible. Do not use these terms as they will only detract from the physical phenomenon being stressed. These membranes may be referred to as the membrane covering the embryo (amnion), and the (alantois) as the membrane forming the septic tank. Another easily observed structure is the tube attached to the stomach of the embryo leading to the yolk of the egg. This is equivalent to the umbilical cord in the human. The point of attachment correspondence to the navel in the human.

TODAY WE OPEN ANOTHER EGG. IT HAS BEEN 9 DAYS SINCE INCUBATION STARTED. THE PROCEDURE WILL BE THE SAME AS BEFORE. REMEMBER TO CRACK THE LARGE END OF THE EGG GENTLY, THEN PEEL THE SHELL AWAY LEAVING ONLY THE MEMBRANE. REMOVE AS MUCH OF THE SHELL AS POSSIBLE BEFORE POURING THE EMBRYO INTO THE WARM WATER IN THE PETRI DISH. AS BEFORE, YOU ARE TO MAKE A DRAWING AND LABEL THE PARTS. (Discussion) WHEN MEASURING THE EMBRYO, MEASURE ALONG THE BACK OF THE EMBRYO. THIS TIME YOU SHOULD BE ABLE TO SEE A MEMBRANE COVERING THE EMBRYO (AMNION) AND A SEPTIC TANK (ALANTOIS). I BET YOU CANNOT FIND THE SEPTIC TANK!

The students should bring to class specimen bottles to preserve the better specimens. It will be obvious that some embryos are not good specimens and should be discarded. Make sure the students label the jars properly giving: student name, stage of development, date of opening, and the title nine day etc. "Chicken Embryo" A 10%

formaldehyde solution (formalin) or alcohol may be used as the preservative. It is recommended that a collection of the embryos at different stages be made and compared to show how the embryo develops.

Students are to begin by removing the shell and placing the contents of the egg into a petri dish containing luke warm water. It will take most of the period to draw and label the contents of the egg. As the students work, pass among the groups asking questions.

If some of the students want to make a transparency let them draw a picture of their results, then use this transparency to lead the class discussion. If students do not make a transparency, use transparency B-50. Discuss embryonic development. Point out that food for the embryo is the albumin and the yolk, found in the egg. Therefore, the amount of albumin and yolk should be reduced. Air is diffused in and out of the egg through the shell and the membrane next to the shell. Also stress the protein, carbohydrates, and fat relation as food for the developing embryo.

STUDENT B - 50

NINE DAY EMBRYO

Materials for groups of three:

1. Petri dish
2. Scissors
3. 4 paper towels
4. Forceps
5. Ruler
6. Luke warm water
7. Specimen bottle
8. 250 ml beaker

Your eggs have now been in the incubator for nine days. What do you think has happened? Can you predict what you expect to see when you remove the shell? Will the heart be beating faster or slower than it was in the five day embryo? Will the amount of yolk and albumin be the same as before, or will it be less? Let's find out by opening the egg as you did in the five day embryo.

Crack the egg gently on the large end and remove all of the shell you can before breaking the membrane. After removing the shell, cut the membrane with scissors and pour the contents of the egg into a petri dish that contains luke warm water. The warm water will prevent the rapid cooling of the embryo and prolong life. Remember to work over the paper towels and petri dish at all times.

Make a drawing of the egg and label the parts as you did before. Comparison with your last drawing will be surprising. Many changes will not be noticeable. Make your drawings and label the parts below.

Student
page 2

How many times each minute is the heart beating?_____

Is it beating slower or faster than the five day embryo?_____

If you cannot see the heart, is there any way you can determine the number of heartbeats?_____ How?

Select one member of your group to report your observations to the class.

Measure the embryo. How long is it?_____

Are the eyes well formed?_____

Describe what you see.

- Can you recognize any parts other than the eyes and heart forming? If you do not know some of the parts, ask your instructor for a reference book. List the parts below.

1. Is the embryo alive?_____ How can you tell?

2. Record the following information:
   a. Temperature in the incubator _____
   b. Number of eggs opened in your group_____
   c. Date eggs were opened _____/_____/_____/
   d. Do you think the eggs are developing as they should?_____
      How can you tell?
3. Did the yolk change color? yes_____ no_____
4. What color?_____
5. Did the white of the egg (albumen) change color? yes_____ no_____
6. What color?_____
7. What does a color change tell us?

TEACHER DIRECTION B - 51

SEXUAL REPRODUCTION IN BRINE SHRIMP

Materials for groups of three:

1. Hand lens
2. Glass slides
3. Medicine dropper
4. Hatched shrimp from B-49

Students will be able to see the shrimp in the jar by this time. They will appear as tiny white specks moving about with an irregular motion.

WHERE DID EACH OF THESE SHRIMP COME FROM? DID ALL OF THE EGGS HATCH? HOW DO YOU KNOW? WHY DO YOU SUPPOSE ALL OF THE EGGS DID NOT HATCH?

TAKE YOUR MEDICINE DROPPER AND REMOVE SOME OF THE TINY SHRIMP AND PLACE THEM ON A SLIDE AND EXAMINE THEM. THEY WILL SHOW UP BETTER IF THE SLIDE IS PLACED ON A DARK SURFACE. TRY TO MAKE A SIMPLE DRAWING OF WHAT YOU THINK THE SHRIMP LOOKS LIKE.

STUDENT B - 51

SEXUAL REPRODUCTION IN BRINE SHRIMP

Materials for groups of three:

1. Hand lens 2. Glass slides 3. Medicine dropper

Since 2 days have passed, the shrimp have had enough time to hatch. Use a medicine dropper to remove a few and place them on a slide. Observe them with a hand lens, or microscope if available.

Make a drawing of the shrimp here. Compare your drawing with the transparency.

Can you answer these questions?

1. What 3 things were needed before the brine shrimp could hatch?
2. What does the brine shrimp use for swimming?
3. How many sperms have entered the egg?
4. What is another name for this egg?
5. What is another name for the sperm?
6. Why do you suppose the egg formed a layer or membrane around itself?
7. When an egg and a sperm join, this is a form of _____ reproduction.

TEACHER RESOURCE

Up to this point we have dealt with the reproductive process as related to animal life. This particular approach capitalizes on student interest in the reproduction of animal life. Now this information must be related to other forms of living organisms, namely plants. Students will probably be surprised to find that many of the processes found in animal reproduction are similiar if not the same for plants, for example: male and female plants, eggs and sperm produced by plants, development of an embryo, etc. Although reproduction in some plants becomes quite involved and complicated we shall investigate the most highly developed and most familiar group, the flowering plants.

At this point it would be well to discuss with the class the subject of structure and function. In flowering plants the most outstanding structures are: roots, stems, leaves, and flowers.

The main function of these structures are:

Roots: - The absorbtion of water and nutrients (chemicals) from the surrounding soil. Anchorage of the plant, movement of materials and in some cases the storage of large amounts of food materials produced by the plant.

Stem: - The connecting link in the transportation system of a plant joining the root system where nutrients are received, and leaves where these materials are used. Their main function is one of support and transportation.

Leaves: - The main photosynthetic organs of the plant, responsible for converting the raw materials carbon dioxide, water, sunlight, etc, into food for the plant. (See unit one cell energy)

Flowers: - The main reproductive unit in the plant which usually insures the continuation of the species.

Reproduction in flowering plants involves both pollination and fertilization (the union of sperm and egg or sex cells.) Pollination is the process of trans-

ferring the pollen grains (male) to the female part of the flower. This may be accomplished in any number of ways insects, wind, water, man, etc. When this occurs on the same individual flower we refer to this as self-pollination. If this process occurs between flowers of two different plants the term is cross-pollination. Fertilization is the union of the sperm, in the pollen grain, with the egg found deep inside the base of the flower. POLLINATION MUST PROCEED FERTILIZATION.

TEACHER DIRECTION B - 52

REPRODUCTION IN FLOWERING PLANTS

Materials for groups of three:

1. Hand lens
2. Single edge razor blade
3. Paper towels
4. Assortment of flowers
5. Forceps

In this activity we will examine the reproductive parts of common flowers brought to class by students. You should announce beforehand to the class what they are going to do and ask them to bring in any kind of flowers they may have at home. Extra credit may be offered to those who do so. Caution them to be sure to get permission before bringing flowers from other sources such as neighbors, parks, etc. In season the Azealea blossom makes an excellent example to study; others that may be used are Lillies, Hibiscus, Camellia, Daffodill, Rose, Tulip, Gladiola. If students cannot supply sufficent quantities of flowers, a nearby florist will probably supply you with unused flowers, just before they are discarded. These flowers although wilted in some cases may still be used for study.

Although individual flowers may differ slightly we will discuss flowers in general. If enough flower specimens are available students may work individually. Have them separate out all the parts of the flower, counting the number of each part, and then placing them on a piece of paper with the name and number of each part beside it.

THE MALE PART OF A FLOWER WE CALL THE STAMEN --- IT HAS TWO PARTS THE ANTHER AND THE FILAMENT. Place transparency B-52 on the overhead. INSIDE THE ANTHER ARE THE MALE POLLEN GAINS.

THE FEMALE PART OF THE FLOWER IS THE PISTIL. IT IS MADE UP OF THE STIGMA, STYLE, OVARY.

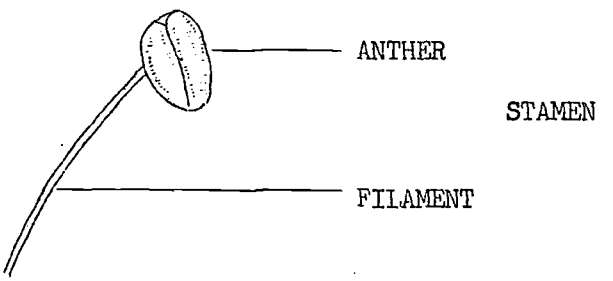
WHEN THE POLLEN GAINS ARE RELEASED FROM THE ANTHER THEY ARE THEN TRANSFERED TO THE STIGMA. (Transparency B-52) HOW DO YOU SUPPOSE THEY GET THERE? (wind,

water, insects, man). ONCE THE POLLEN REACHES THE STIGMA IT IS HELD THERE BY A STICKY FLUID COVERING THE STIGMA. THE POLLEN GRAIN THEN MAKES ITS WAY DOWN THE STYLE AND INTO THE OVARY WHERE IT RELEASES THE SPERM TO COMBINE WITH THE EGG INSIDE THE OVARY. FROM THIS UNION THERE DEVELOPS A TINY EMBRYO PLANT INSIDE THE SEED SURROUNDED BY THE OVARY WHICH ENLARGES TO BECOME IN SOME CASES A FRUIT SUCH AS AN APPLE, ETC.

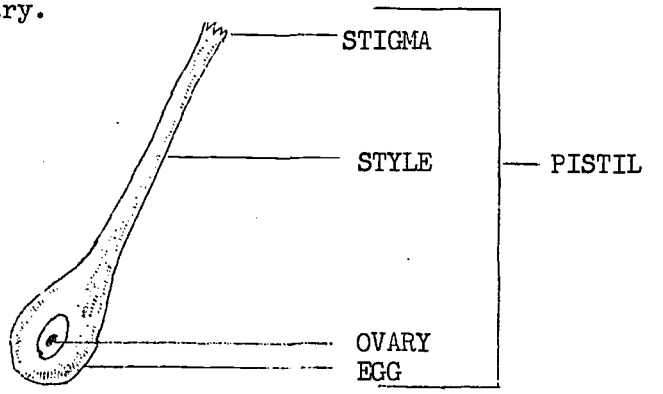
Pass out B-52

Read over the introduction to this activity and answer any questions that may arise.

The male part of a flower is referred to as the stamen (Stay-men) it is composed of the anther and filament. The anther is filled with pollen grains. When these grains are mature the anther breaks open releasing pollen for pollination.



The female part of a flower is the pistil, It is composed of three main parts: the stigma, style, and ovary.



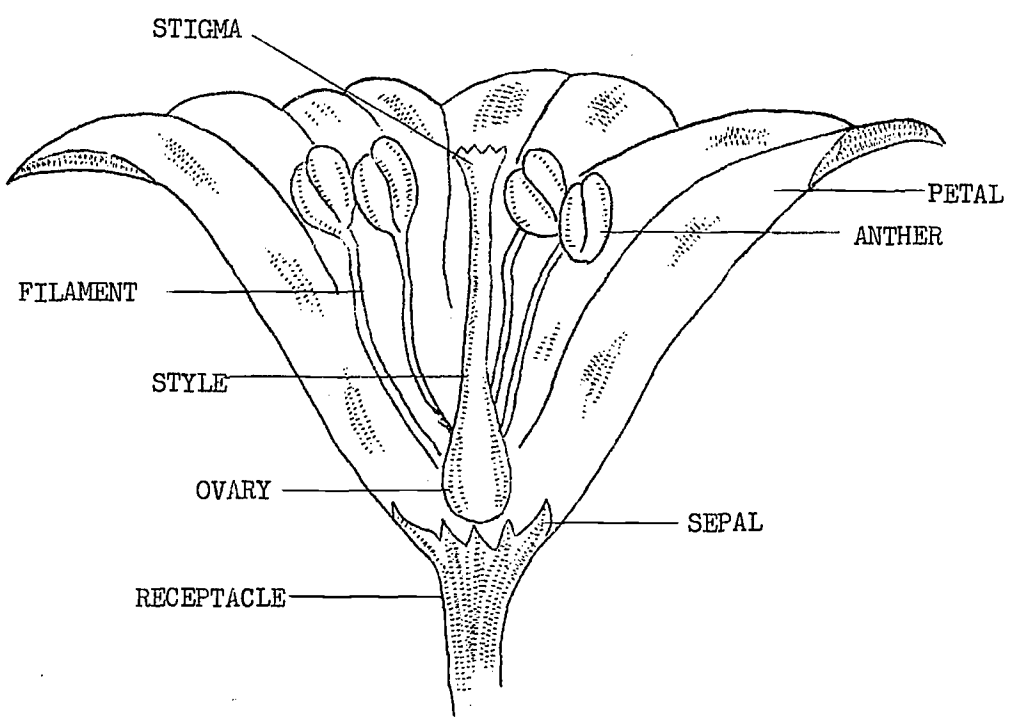
Teacher Direction
page 3

The stigma is the top of the pistil which contains a sticky material for holding any pollen grains that may reach this surface. The long slender neck is referred to as the style, it is through this slender neck that the pollen tube must make its way to deposit the sperm with the egg in fertilization.

The egg is located inside the ovary and it is here that fertilization occurs. The fertilized egg then develops into a tiny embryo plant inside the seed, while the ovary may enlarge to produce what we recognize as a fruit, such as an apple, etc. Other accessory parts of the flower are petals for attraction of insects, and the green receptacle at the base of the flower which supports and holds the flower parts together.

TEACHER DIRECTION B-- 52

TRANSPARENCY OF A TYPICAL FLOWER



STUDENT B - 52

REPRODUCTION IN FLOWERING PLANTS

Materials for groups of three:

1. Hand lens
2. Single edge razor blade
3. Forceps
4. Assortment of flowers
5. Paper towels

Today you will look at one of the most interesting parts of the plant kingdom reproduction. You will probably be surprised to find many similarities between reproduction in plants and animals, for example, did you know there are male and female plants, that plants produce sperm and eggs, that when these two combine a tiny embryo develops? Male and female are separated in some plants such as the Holly and Willow trees, perhaps you can find others.

Your instructor will provide each group with as many kinds of flowers as possible. Try to locate all the parts we have discussed. Count to see how many petals stamens, pistils as well as other parts each flower has. Record your findings in the chart.

Using your forceps carefully remove each flower part and place it on paper with its name and the number you found of each.

With your razor blade open the anther and examine some of the pollen grains with a hand lens. Make a cross cut through the ovary and examine it. Make sure your instructor checks your paper with all the parts labeled.

Now let's record what you see:

1. Do all of the flowers have both male and female parts?
2. Is there any similarity in the number of each part?
3. What part do the petals play in reproduction?
4. From the arrangement of the pistils and stamens would you guess that your flower is self-pollinating or cross-pollinated?

Student
page 2

FLOWER # 1	
NAME	
NUMBER OF PETALS	
NUMBER OF STAMENS	
NUMBER OF PISTILS	
NUMBER OF SEPALS	

FLOWER # 2	
NAME	
NUMBER OF PETALS	
NUMBER OF STAMENS	
NUMBER OF PISTILS	
NUMBER OF SEPALS	

FLOWER # 3	
NAME	
NUMBER OF PETALS	
NUMBER OF STAMENS	
NUMBER OF PISTILS	
NUMBER OF SEPALS.	

TEACHER DIRECTION B - 53

SEEDS

Materials for groups of three:,

1. Large seeds (pinto bean, butter bean) soaked 48 hrs.
2. Single edge razor blade
3. Paper towels
4. Hand lens
5. Iodine
6. Benedict Solution
7. Test tube
8. Alcohol lamp

In this activity students will examine the results of fertilization in a flower, the seed. The seeds should be soaked for 48 hours to allow enough time for the growth of the embryo so that students may examine it with a hand lens. Add enough water to the seeds to cover them, too much water will cause the seeds to decay.

TODAY WE ARE GOING TO LOOK AT SOME SEEDS. WHERE DO SEEDS COME FROM? (Union of sperm and egg in a flower) WHAT DO YOU THINK WE WILL FIND INSIDE THE SEED? (embryo, tiny plant) HOW WILL THIS TINY PLANT GET FOOD UNTIL IT CAN PRODUCE ITS OWN? CAN YOU NAME SOME SEEDS THAT WE EAT? WHY ARE SEEDS GOOD SOURCES OF FOOD? (Food stored inside). Place transparency B-53 on overhead projector.

Pass out B-53

Students may not remember the tests for carbohydrates, proteins, and fats. Do not tell them at first, but allow them to discuss it among themselves to try to arrive at the proper test. You may help by mentioning the chemicals used in the different test.

STUDENT B - 53

SEEDS

Materials for groups of three:

1. Three large seeds (that have been soaked)
2. Single edge razor blade
3. Paper towels
4. Hand lens
5. Forceps
6. Iodine
7. Benedict Solution
8. Test tubes
9. Alcohol lamp

After fertilization a tiny plant embryo develops inside the seed. Today you will open a seed and try to find the embryo -- be very careful as you open the seed since the embryo is easily destroyed.

Examine the seed on the outside, can you find the place where the seed was attached to the inside of the ovary? Is there a similar scar in man?

Make a drawing of the seed and label the outer parts.

Why do seeds swell when soaked?

Carefully remove the seed coat --- what do you suppose is its function? The seed should now break open. Examine the inside with your hand lens. Can you find the embryo? Do you find any stored food?

Make another drawing of the inside of the seed?

Let's test to see what kind of food the embryo is using? Do you remember the food tests we did earlier with iodine and benedict solution? Test the seed for carbohydrates, fats and proteins.

Now let's record our results:

1. What color was the embryo?
2. Why was it not green?
3. How many leaves will this embryo have at the start?
4. Did the seed contain starch? How do you know?
5. Where is this food stored in the seed?

Student
page 2

6. Did the seed contain sugar? How do you know?

7. Did the seed contain Protein? How do you know?

8. Which was more abundant sugar or starch? How do you know?

9. How does water get into the seed?

10. Does water get into a chick egg?

11. What did get into the chick egg?

12. Does air get into a seed?

TEACHER DIRECTION B - 54

REPRODUCTION IN THE FROG

Materials for groups of three:

1. Single edge razor blade
2. Forceps
3. Tripod magnifier
4. One preserved frog
5. Paper towels

In this activity students should see that most animals and plants produce many more sperm and eggs than can survive, in order to insure continuation of the species. Secondly students should become familiar with the location of the reproductive organs of the frog as well as other major organs. The activity should serve to enforce the basic principles of reproduction in general.

Pass out B-54.

TODAY WE ARE GOING TO EXAMINE THE REPRODUCTIVE SYSTEM OF A COMMON AMPHIBIAN. DOES ANYONE KNOW WHAT AN AMPHIBIAN IS? (Discussion) WHILE WE LOOK AT THE REPRODUCTIVE SYSTEM WE WILL TRY TO FIND OTHER ORGANS SUCH AS THE HEART, LUNGS, STOMACH, INTESTINES, KIDNEYS, LIVER, ETC. IN THE MALE FROG THE REPRODUCTIVE SYSTEM IS COMPOSED OF TWO YELLOW, BEAN SHAPED STRUCTURES LOCATED NEAR THE KIDNEYS. THESE ARE THE TESTIS. YOU WILL FIND THEM UNDER THE STOMACH AND INTESTINES.

Show transparency B-54

SPERM CELLS ARE PRODUCED BY THE TESTIS, FROM HERE SPERM CELLS TRAVEL DOWN SMALL TUBES TO THE KIDNEYS AND OUT OF THE BODY THROUGH THE URINARY SYSTEM TO FERTILIZE THE EGGS.

IN THE FEMALE FROG EGGS ARE PRODUCED IN TWO STRUCTURES KNOWN AS OVARIES. FROM THESE STRUCTURES THE EGGS TRAVEL DOWN COILED TUBES CALLED OVIDUCTS INTO A COLLECTION CHAMBER AND OUT OF THE BODY INTO THE WATER WHERE FERTILIZATION OCCURS. NOW LET'S SEE IF WE CAN FIND EACH OF THESE PARTS.

To show development of the egg after fertilization use acetate (B-54)

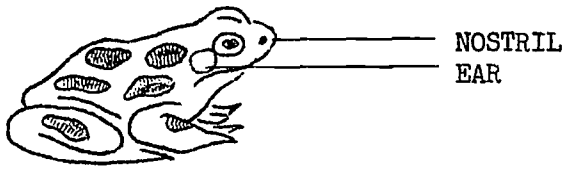
STUDENT B - 54

REPRODUCTION IN THE FROG

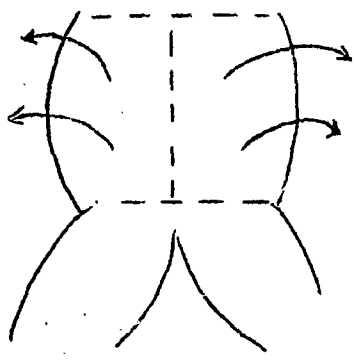
Materials for groups of three:

1. Single edge razor blade
2. Forceps
3. Tripod magnifier
4. Preserved frog
5. Paper towels

Place the frog on its stomach and try to find the circle just behind the eye. This area functions as an ear for the frog. Try to locate the transparent eyelids that protect the eyes under water. How is the foot of the frog adapted for swimming? How does the head of the frog protect the animal in water?



Turn the frog over on it's back and with a single edge razor blade begin a cut just below the throat and continue to the end of the stomach area. Do not cut too deep since this will destroy organs just below the skin and muscle. After you have made this long cut make a cut at each end in order to fold the muscle back.



Student
page 2

The organ you will see first will probably be the large brownish liver, slightly above the liver and between its three lobes is a small heart. Beneath the heart and on either side are the lungs. Just below the liver the stomach and intestines may be seen. If your frog is a female these organs will probably be covered with eggs. Remove these carefully and save them since they will be used later. Under the intestines and attached to the body wall are the kidneys. If your frog is a male you should see near each kidney a small, yellow, bean shaped, organ the testis. These are the organs that produce thousands of sperm cells that are released into the water to fertilize the eggs.

If your frog is not a female join a group that has one. Compare both frogs as to reproductive systems and other organs. Now begin a careful count of all the eggs found in the female frog. Look at a single egg through the hand lens and make a drawing of what you see.

Now let's record our results.

1. How many eggs did you find?
2. If so many eggs are produced why is the world not filled with frogs.
3. How many of these do you think will develop into frogs?
4. How many males and how many females would you expect from this total?
5. Why do you suppose so many eggs are produced?
6. Would there be more or less sperm cells produced? Why?
7. How does the sperm reach the egg?
8. Can you think of any other animals that produce large numbers of eggs?
9. Can you think of any animals that produce only a small number of eggs?
10. Can you think of a reason for these animals producing such small numbers?

STUDENT B - 55

OFFSPRING THAT LOOK LIKE THEIR PARENTS

Anyone who did not know the life histories of milkweed butterflies, silkworms, and ants could never guess what kind of insects would grow from each kind of larva. The larvae of these insects do not look at all like their parents. Frogs, toads, and tadpoles also are unlike their parents.

On the other hand, the young of many animals look almost exactly like the parents. It is easy to tell that a kitten is a young cat and that a puppy will grow into a dog. Baby elephants and baby whales look like their parents. So do baby zebras and baby hippopotami.

Even among insects there are many kinds in which the young resemble the parent very closely. Visit a grassy field in spring, and catch some young grasshoppers. These tiny grasshoppers have hatched directly from eggs that were laid in the ground during the fall. They have not passed through any larva or pupa stage. Except that they are smaller and have no wings, they look like their parents.

In the fall, the female praying mantis crawls up the stem of a shrub or weed and prepares to lay her eggs. The egg case is a large, oval cluster with two rows of eggs inside. The egg cases of the mantis are often as large as a hen's egg. They are easy to find in the winter, but should never be gathered or destroyed. The eggs do not hatch until late the following spring. Then, when the weather becomes warm enough, dozens of the little green insects about the size of mosquitoes come out of each cluster. Each insect is a tiny praying mantis that looks almost exactly like a full grown mantis. Their regular food is other insects. For this reason, they are of great value to farmers.

All birds hatch from eggs. Some kinds are able to find food and take care of themselves almost as soon as they are hatched. Others are very helpless and have few or no feathers, but otherwise they are like their parents.

The eggs of birds contain a great deal of stored food. This food is used to feed the young birds while they are inside the eggs.

Student
page 2

Most birds sit on their eggs and keep them warm until they hatch. While they are doing this, many changes are taking place inside the egg. These changes are just as wonderful as the changes that take place during the growth stages of butter flies, ants or toads. We do not see these changes, because they happen inside the shells of the eggs.

Reptiles, also, hatch from eggs. Female turtles and female snakes lay their eggs on the ground or in the sand. Sometimes they cover the eggs to hide them, and sometimes the parents guard the eggs until they hatch. A few reptiles protect their eggs by keeping them inside their bodies until they hatch.

Mammals do not hatch from eggs in the way that insects, toads, reptiles and birds do. But every mammal starts to grow from an egg. The eggs of most mammals are very tiny. When a young mammal starts to grow, it remains inside the body of its mother. As it grows, it receives food directly from the mother. Many changes took place while the young mammal is growing. When these changes are complete, the young mammal is born. At birth, young mammals look like their parents, but continue to grow in size.

TEACHER DIRECTION B - 56

SIXTEEN DAY EMBRYO

Materials for groups of three:

1. Petri dish
2. Scissors
3. Forceps
4. 4 paper towels
5. Ruler
6. Luke warm water
7. Specimen bottles

The methods for opening the eggs are the same as used for the five-day embryo. The same prepared transparency may be used. The embryo will show a great deal of development. Students should be able to see that the embryo is looking more like a chicken. Directions should not need to be extensive. Much time can be used in individual attention.

Pass out B-56

Reassemble for discussion after the completion of the activity. This is an excellent time for testing understanding. Do not test until understanding is accomplished.

STUDENT B - 56

SIXTEEN DAY EMBRYO

Materials for groups of three:

1. Petri dish
2. Scissors
3. Forceps
4. 4 paper towels
5. Ruler
6. Luke warm water
7. Specimen bottles

Your eggs have now been in the incubator for 16 days. What do you think has happened? Could you predict what you expect to see when you remove the shell? Will the heart be beating faster or slower? Will the amount of yolk and albumin be the same as before? Will the septic tank be larger or smaller? Let's find out by opening the egg as before and observing the embryo.

Crack the eggs gently on the large end and remove all the shell you can before breaking the membrane. After removing the shell, cut the membrane with scissors and pour the contents into a petri dish containing luke warm water. The warm water will prevent rapid cooling of the embryo and prolong its life. Remember to work over paper towels and petri dish at all times.

Now let's check the yolk and albumen for food content sugar, starch, protein.

Make a drawing of the egg and label the parts as you did before. A comparison with your last drawing will be surprising. Make your drawing and label the parts.

Measure the embryo. How long is it?_____

Are the eyes well formed?_____

Can you see any feathers?_____ What color are they?_____

Can you predict what color the chicken will be?_____

How can you make this prediction?_____

Hold the egg very still and see if the embryo moves any.

Write a short paragraph describing what you see.

Student
page 2

Is the embryo still alive? _____ How can you tell?

Record the following information:

1. Temperature of the incubator_____
2. Number of eggs opened in your group_____
3. Date eggs are opened (today) _____/_____/_____
4. Do you think the eggs are developing as they should?_____
   How can you tell?

5. When do you think the chickens will hatch? _____ days.
6. Did the yolk change color?_____
7. What color?_____
8. Did the white of the egg (albumen) change color?_ (yes_____no_____)
9. What color?_____
10. What does a color change tell us?_____

TEACHER DIRECTION B - 57

NINETEEN DAY EMBRYO

Materials for groups of three:

1. Petri Dish
2. Scissors
3. Forceps
4. 4 paper towels
5. Ruler
6. Luke warm water
7. Specimen bottle

The development of the chick will almost be complete. The chick should be well formed and completely fill the shell. Instruct students to proceed as in previous activities and follow up the activity with discussions as before.

The eggs, if on schedule, will be hatching in two days. It will be necessary to remove the eggs from the paper holders and place them in a box in the incubator. The hatching chicks will need a place to move around in for several hours after hatching to gain strength and dry out. There will need to be an extensive amount of preparation and planning to determine how to best handle the newly hatched chicks.

After the chicks have hatched, the incubator should be thoroughly cleaned a formalin solution and aired out.

Many activities may be performed after hatching, observing peck order, eating habits, evidences of imprinting, etc.

STUDENT B - 57

NINETEEN DAY EMBRYO

Materials for groups of three:

1. Petri dish
2. Scissors
3. Forceps
4. 4 paper towels
5. Ruler
6. Luke warm water
7. Specimen bottle

Your eggs have been in the incubator for 19 days. What do you think has happened? Predict what you expect to see when you remove the shell? Will the heart be beating faster or slower? Will the amount of yolk and albumin be the same as before? What do you think will have happened to the septic tank? Let's find out by opening the egg and observing the embryo.

Crack the egg gently on the large end and remove all of the shell you can before breaking the membrane. After removing the shell, cut the membrane with scissors and pour the contents into a petri dish containing luke warm water. The warm water will prevent cooling the embryo too fast and will prolong its life. Remember to work over paper towels and the petri dish at all times.

Check the yolk for food.

Check the albumen for food.

1. Has the yolk changed color?_____
2. What color is the yolk?_____
3. Did the albumen change color? yes _____ no _____
4. What color?_____
5. What does a color change tell us?_____

Make a drawing of the egg and label the parts. A comparison with your last drawing will be a surprising event.

TEACHER DIRECTION B - 58

THERE IS A GREAT VARIATION AMONG LIFE FORMS

The theme of this activity is obvious. Most students have already been well acquainted with this concept. The goal of this activity is to take information students already posses (that there is a great variation among life forms) and develop it in such a way that the student will be aware of the implication and depth of such a statement.

Have the students make an organized account of themselves by looking closely for differences in ears, nose, hair, eyes, height, body frame, size of feet, size of hands, size of teeth, etc. These are just a few, the student should be encouraged to seek others. Before this is undertaken, the teacher should warn students that this should be done in a serious manner to the utmost objectivity is used in recording data. In recording similarities and differences, students should use a chart similar to those used in preceeding activities. When students begin answering the activity questions, the teacher might find it helpful to emphasize the gravity of some questions by reading them. For example, "WHAT ACCOUNTS FOR SUCH LARGE VARIATIONS IN THIS CLASS?, "IS THIS CLASS AN EXCEPTION?", "WHAT WOULD THIS WORLD BE LIKE IF ALL LIFE FORMS WERE EXACTLY ALIKE?" Don't answer the questions, let the students answer them. Let them think on their own, these questions cannot be limited to any one set of answers. Encouragement should be shown when student answers are even remotely in the right direction. Success breeds success.

Students generally like the hand-clasping exercise and this is something which goes along with the main idea of the activity and can be done with little difficulty.

STUDENT B - 58

THERE IS GREAT VARIATION AMONG LIFE FORMS

Materials:

1. Regular class of students

There is great variation among all living forms. No two individuals are exactly alike, even identical twins from the same fertilized egg are different. No two plants bear leaves or flowers in the same way. Even peas in a pod may vary visibly as well as chemically.

Make an organized observation of the students in your class. Look closely for differences in ears, noses, hair, eyes, body frame, height, size of feet, size of hands and size of teeth. List variations from student to student in this class. List the similarities and differences you see in the individuals in your class. Why is it necessary that there be variation in life forms. Why aren't all people and living things alike? Clasp your hands together so that your fingers interweave and your thumbs cross in front of you. Which thumb is over the other? Right over left or left over right? What about the other people in the class? Are they different? When putting on a pair of shorts, which leg do you put in first? What about the rest of the class? Are they different? Why?

OTHER CHARACTERISTICS TO LOOK FOR ARE:

1. Attached or unattached ear lobes.
2. Direction of hair whirl in back, clockwise or counter-clockwise.
3. Eye color
4. Wiggle ears
5. Rolling your tongue.

TEACHER DIRECTION B - 59

TWENTY-ONE DAYS OF DEVELOPMENT

Today will either be a climax activity or a bitter disappointment. If the eggs have not been turned properly no hatching will result. However, full development will take place, eyelids, feathers, claws, etc. Students will be eager to get to class for this activity, let them start as soon as they are ready.

If some eggs hatch during the class period have students observe the process and later try to put into words what they observed. Should hatching not take place this would be a good time to show two films from the county library "THE CHICK EMBRYO" and "THE DEVELOPMENT OF A CHICK" these are excellent color films.

STUDENT B - 60

THE NATURAL WONDER OF BIRTH

Birth is the magical link in life's eternal chain. Wherever creaturers live whether in the deepest caves of the ocean bed or atop the bleakest mountain nature's first rule to them is to multiply. And nature, in turn, has devised astonishing ways, in unbelievable circumstances, for her diverse creatures to keep the earth replenished.

Birth at the bear's house is little short of miraculous. Nature has provided not only anesthetized obstetrics for Mamma Bear, she also sleeps through the first 40 days of motherhood. A baby bear, one of the tiniest in comparison to its mother and apparently one of the most helpless of infants, must often shift for itself while mamma dozes comfortably until spring. And Papa Bear is no help. Contrary to the nursery tale he is never around to serve any porridge.

So childbirth is a snap for a bear. The four-hundred pound mother snores blandly on while her 10-ounce, blind, hairless and toothless babies arrive and set up housekeeping in the soft fur of her underside. She furnishes milk without knowing anything about it. And by the time she wakes up, the children have opened their eyes, begun to cut their teeth, and are pretty well able to take care of themselves--except for training and some feeding.

Look at a half-hour old porcupine, covered with hundreds of bristling needle-sharp quills, and you will say it's completely unbelievable that it could have been born--unless you know nature's marvelous secret for porcupine mothers. Even so, you would probably say the youngster could not have been born rump first and that the mother surely could not survive. But it is of no concern whether the plump little fellow arrives head first or rump first. He's delivered in a membranous sac, his quills soft and moist and harmless. The mother rips open the

sack after birth, and releases him. And within minutes he's so formidable nothing in the woods would dare touch him.

Birth in the bat family also seems impossible. These mammals live an upside down life---when not on the wing. And mothers make no change of position to bring forth their young.

To observe a female bat hanging upside down by her feet high above the ground, it appears hardly believable that in this seemingly awkward and hazardous position she could give birth to her infants without at least the terrible risk of them crashing down to their death below.

But the mother, at the proper moment, bends her tail and body into an arch, and the emerging youngster is received safely into a swinging fur-lined cradle. From then on it's rock-a-bye-baby in the cave-top.

Just as some mammals fly, and give birth to their young on high perches, others inhabit the briney deep, and thus this seemingly unnatural water world must serve for life's beginnings for air breathers. A porpoise may never see land. This air breathing creature gives birth to her young under water. But a newborn calf as it is called, like any other mammal, must breathe air. And once born this vital function cannot be delayed.

This wise mother knows that as soon as junior arrives his first trip--a fast one-must be to the surface of the water. So, often before taking time to cut the umbilical cord, she boosts him up rapidly with her nose to the surface. At a porpoise birth, timing must be right, or all is lost.

Timing in general for the birth processes is often a matter of life and death in the animal world. For wild creatures, unlike people, cannot adequately adjust to adverse weather and food supplies. Many must be born at the proper time, or

they may freeze or swelter or starve. Animals have neither the foresight nor control to regulate their mating so their progeny will arrive at a suitable time for survival.

Only nature's remarkable time clock saves some species from extinction. It is mysteriously geared to her creature's extraordinary reproductive needs. Normally, after fertilization of the egg, the embryo develops steadily until birth. The period of development can be measured with certainty. But there are some astonishing exceptions.

In regions where winters are severe and food more scarce during normal seasons for birth, nature stops the birth clocks, so to speak. Badgers, minks, weasel and armadillo, among others, may mate in varying months, thus fertilizing the egg--but development does not begin immediately. Nature's timer will go off later at just the right time to permit the embryo to resume development, so that, regardless of mating time, the young will arrive at a season warm enough to permit survival.

Among other animals, such as deer and rats, development of the embryo may be slowed at varying periods after it has started. This pregnancy may be from a few days to months -- until weather and food supplies are adequate for the mother to properly care for her young.

The guardian time clock works for another group, including most bats. Mating season for brown bats range from late summer through fall. Yet the young are born only after three months of warm weather--three months after spring begins. In this instance fertilization does not occur at the time of mating, but with the first warm weather of spring. So regardless of the time of different matings, the entire female bat colony will bear their young at approximately the same time--according to the order of the weather-set clock.

Student
page 4

If a female bat of this species is taken out of her cold natural habitat and placed in a warm room, fertilization takes place. Time for birth is then set, and no tampering with nature's process will change the birth date. Once pregnancy starts it proceeds on a strict schedule until birth.

Prolonged nursing, in some instances, will prolong pregnancy. Nature usually requires that the table be cleared and reset for new arrivals.

One of the most familiar examples of arrested development occurs in the eggs of birds. The egg is made up basically of a fertilized ovum, surrounded by stored food inside a shell. The egg has been fertilized before it is laid. No development occurs until temperature changes are made. Without this control of the birth date by the mother through temperature control applied by setting, the species probably would perish. Should the hatching date be determined by the laying date the young birds would hatch in the same nest over a continuing period. Then the mother would be faced with the fateful decision of either abandoning the unhatched chicks to care for the first-born, or of neglecting the first-born, to incubate the remaining eggs.

Experience in birth and child care seem to affect the birth mechanism, and also influence birth rate. Among some animals, such as the moose, the first-born is a single calf. Thereafter twins are the rule.

A feeling of security also appears to influence the birth process among some animals. Mountain goats of Southern India, for example, have single kids when roaming wild. But when domesticated they bear triplets, as a rule. Do comforts and luxury of security trigger the birth tabulator for these goats. Possibly. But the example does not prove anything in the argument on security versus freedom. For many animals, deprived of their natural freedom, will not give birth to young at all.

Student
page 5

Will it be a boy or girl? Many of the wild creatures not only know, they are able to call their shots, and determine both sex and the ratio of boys and girls. Ants and apis, for instance, can arrange their families at will. The queen ant carries fertilization cells in a small sac in her body. Muscles control their passage. If these cells are held, the offspring is a male. Thus by muscle control, sex of the offspring is determined.

Just how the queen mother concludes what the balance between the sexes should be for the best advantages for her descendents seems a mystery known only to her. But the result is one of nature's marvels--for the organization of one of these insect colonies is mystifying in its apparent social and economic harmony.

Papa and Mamma armadillo may not know whether it will be boys or girls until they arrive. But two things are certain: there will be four, always quads; and they will always be of one sex, all boys or all girls. So far as we know, the armadillo is the only animal that reproduces in this fashion. Research has revealed that the four are identical litter mates; one fertilized egg splits four ways.

The sex ratio of some breeds always seems unbalanced. Among gall flies it's a woman's world. Males often number less than 2 per cent.

Actually, sex among some species is of little apparent importance. If you have a grudge against termites, you cannot lay the blame directly on either the males or females. In a nest of millions of individuals only two reproduce at all. One secret of the amazing parenthood of these creatures may lie in the fact that a termite may live for thirty years. Among insects that affords a long period for child bearing.

Student
page 6

If life in general is more hazardous for animals than people, nature has provided compensation in the birth processes. No wild animal is known to reach an age that they cannot bear young. Whereas child-bearing ability among human mothers may last on an average of less than thirty years, some animals bear offsprings for 75 years or more. A 75 year-old elephant mother is not unusual.

Nature does not delay her wonders for her creatures. Her most astonishing marvels are wrought at life's beginnings.

by Ross Phares
from Florida Wildlife 1968 by permission

TEACHER DIRECTION B - 61

ANIMALS, INCLUDING MAN, HAVE ALSO DEVELOPED SUCCESSFUL REPRODUCTIVE MECHANISMS

Materials:

1. Life filmstrip: "Reproductive Systems"

In a unit of this nature, it is necessary to keep in mind some very definite things. First, this discussion should not be sprung on the students, moreover, the teacher should have laid the delicate groundwork in earlier frank discussions so that there will be little sensation involved with the reproduction of higher mammals since the process has been discussed in virtual duplication in groups of animals taken up earlier.

The concept that man is no exception in the reproductive process should be stressed at every opportunity. Too many students confuse the reproductive processes of man with some mystical power not found elsewhere. This should be corrected early. This unit's success or failure lies in the hands of the teacher. Nervousness and feelings of ill-at-easeness are easily picked up by the class.

It is important for the teacher to supply a frank, informative answer to any honest question. Do not hedge.

Distinguishing characteristics of mammals should be stressed by showing illustrations (pictures) pointing out hairy skin and specialized structures for embryonic development, such as the uterus, amnionic sac, and placenta; and specialized glands in the skin for perspiration, milk production (a milk cow is a good example).

The placenta should be defined as a temporary reproductive structure in which capillary circulations of the mother and embryo lie in intimate position (See transparency B-61). Discussion of some mammals which lack these structures such as the opossum and duck-billed platypus should be mentioned and pointed out in the student reading material.

In showing the filmstrip and film on reproduction, the teacher should check with the principal affirming the necessary backing as these policies will vary from school to scnool.

In general, reproduction among mammals shows a tendency of fewer offspring and greater protection of the young. The care of the young may go beyond the embryonic developmental period. Most mammals remain with their offspring for varying periods of time while the young learn to take care of themselves.

A frank discussion of puberty should be carried on and this period can best be described as the age at which the reproductive organs become functionally mature. It should be explained that it occurs sometime between the ages of 12 and 17. In the female, menstruation occurs and girls begin to take on the typical secondary female characteristics of body contour, breast, growth, etc.In the male, seminal discharge occurs, growth of a beard, and a change of voice are noticeable changes leading to puberty. Puberty in a broader sense, is more than a physical change, it involves social, emotional, and mental changes.

Adolescence, a period of growth, may be explained to students as the time when one finds himself in a social environment considerably more complex than anything he has encountered previously. Due to a combination of inexperience and immaturity the student may find that he is unequal to the situation, thus he makes improper adjustments. A marked consistency of responses shows signs of emotional maturity.

NOTE:

A brief, to the point discussion of the male and female reproductive system may be found, along with drawings, diagrams, and illustrations in BIOLOGY, AN INTRODUCTION TO THE SCIENCE OF LIFE, by Goodnight, Professor of Biological Sciences, Purdue University.

Teacher Direction
page 3

Another excellent source is Biological Science: an inquiry into life, BSCS-Yellow Version, also the BSCS Patterns and Processes has an excellent section on human reproduction along with teacher direction for this unit.

STUDENT B - 61

REPRODUCTION IN MAMMALS

Materials:

1. Filmstrip: Reproductive Systems

Man is no exception in reproductive processes. Requirements of embryonic maintenance and development in man are met by specialized structures, such as: The uterus, amniotic sac, and placenta. Mammals are widely distributed in nature and include many types that are very familiar and important.

Mammals are distinguished by their hairy skin, mammary glands in the skin and in higher mammals the possesion of a placenta. This is a temporary reproductive structure in which blood vessels of the mother and the embryo come very close together and yet do not join. Blood from the mother does not mix with that of the unborn. This permits the mother to nourish the embryo and keep it in the uterus until it reaches a rather advanced stage of development. A small group of mammals do not have a placenta, and lay eggs, such as the Duck-billed Platypus, still another group lacks a placenta and delivers the young from the uterus while they are still exceedingly immature, such as the opossum.

The higher forms, man included, have a placenta and are able to carry and nurture the embryos in the uterus and postpone delivery until the young have developed to a relatively advanced state.

STUDENT B - 62

A LONG LONG LIFE

How long do different animals live? This is a hard question to answer, because many kinds of animals cannot be kept in captivity. Others do not live as long in captivity as they would if allowed to remain free. But there are several interesting ways to tell how long some kinds of animals live.

The age of most turtles can be found by counting the number of ridges on their shells. A new ridge is grown each year. The number of scales on a young fish is the same as that of an old fish. But scales grow a little larger each year, and there are lines to show where each year's growth began. The shells of mussels show that a new layer is added each year. The ages of horses, cows and sheep can be found by looking at their teeth. Records have been kept of how long monkeys, elephants and other animals have lived in zoos.

The following table gives the number of years some common animals are known to have lived.

Toad	36 years	Carp	150 years
Frog	12 years	Eagle	104 years
Catfish	50 years	Pelican	41 years
Turkey	16 years	Monkey	30 years
Goose	57 years	Bear	40 years
Parrot	120 years	Tortoise	150 years
Swan	100 years	Elephant	100 years

A great many kinds of animals do not live to be more than one year old. Crickets and grasshoppers live about six months, and most spiders live less than one year.

The may-fly and some other insects live only a few hours in the adult stage. Adult May-flies come out of the water in late afternoon, lay their eggs and usually die before sunset. One of the most shortlived animals is the water flea, whose whole life is finished in about thirty days.

Student
page 2

There are many short-lived plants, just as there are short-lived animals. When fall comes, large numbers of plants die or are frozen. The seeds of these plants remain over the winter, and new plants grow from them in spring. Thus the life of annual plants is usually about six months.

The longest lives are lived by plants, not animals. Certain trees are believed to live as long as five thousand years. In California there are many trees between two and three thousand years old. One tree there is supposed to be about three thousand eight hundred years old.

TEACHER DIRECTION - 63 -

PREDICTING THE AGE OF A TREE

Materials for groups of three:

1. Cross section of tree 2. Tripod Magnifier 3. Ruler

Students probably questioned the validity of the dates of some of the organisms in reading activity B-62. The two following activities deal with the subject of estimating the age of organisms. Students will need the magnifier to see some of the smaller rings near the center of the tree section. The type of tree may be determined by the bark, most of the sections used will be sumac. After they have examined the section and have done all necessary measurements you should allow a few students to go to the library to begin work on matching historical events with the age of the tree. Some of the better students should be encouraged to try the problem mentioned in the activity. Growth each year = $\frac{\text{diameter}}{\text{age of tree}}$ Do not give the students the formula at first.

Those who work the solution should be praised and referred to as "Genius"

You may also want to discuss the age of some of the trees in the "Giant Redwood Forest" some hundreds of years old and large enough in diameter for cars to drive through them.

Counting the rings of a tree gives only the age of the section of the tree. The actual age of the tree is given only if the first years growth at the very base of the tree is included.

STUDENT

B - 63

PREDICTING THE AGE OF A TREE

Materials for groups of three:

1. Cross section of tree 2. Tripod magnifier 3. Ruler

After reading activity B-62 you probably asked yourself, "How do scientists know the age of such organisms as turtles, fish, and trees?" In this activity you will try two methods used by scientists to figure the age of trees and fish.

Most methods of telling age have to do with the way things grow. For example, have you ever seen a five-year old boy with a beard? It would be very unusual if you had, because this part of growth does not take place until about age 14-16 years.

We have learned certain things about the ways trees grow. This growth takes place just below the bark of the tree in cells that are long and tube-like, these cells carry materials up the tree and down. What would happen to a tree if you made a cut through the bark all around the tree? Why?

Each year a new layer of cells is produced beneath this outer bark. These layers can be seen as light and dark areas in a cross section of a tree. The bands are called annual rings and give us much information about the conditions under which the tree grew, for example, age and weather conditions.

Now examine the cross section of the tree in your classroom with your magnifier and see how much information you can find.

1. What kind of tree do you think this is? How can you tell?
2. With a ruler, measure the thickness of the bark.
3. What is the diameter of the tree?
4. Now, count the number of annual rings and try to estimate the age of this tree.
5. With the aid of your teacher, try to fill in as many statements as you can.

Student
page 2

For example:

This tree was living ten years before I was born.

This tree was living when World War I happened.

This tree was living when _____.
(Date of Event)

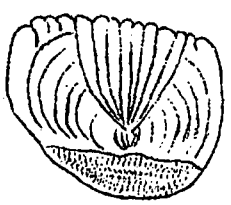
Genius Work

Can you figure how many inches in diameter this tree grew each year?

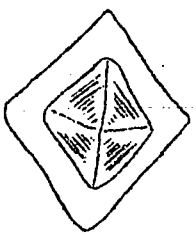
TEACHER RESOURCE B - 64

PREDICTING THE AGE OF A FISH

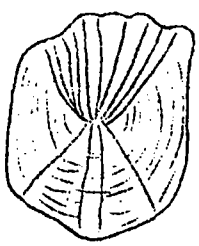
Fish may be divided into five groups on the basis of shape of scales. There are:



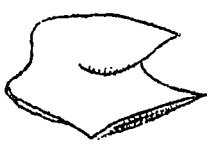
CTENOID SCALE



GANOID SCALE



CYCLOID SCALE



PLACOID SCALE

The final group has no scales at all but rather a thin skin covering the body. In addition to the protection offered by scales, glands found in the skin produce a slimy mucous which covers the body and aids in reducing friction as the fish moves through the water. This mucous also protects the fish from infectious bacteria. The most common scale types are the ctenoid, cycloid type. These scales can be used with greatest accuracy to estimate the age of the fish. The other types are more difficult and are used to a lesser degree in the aging process.

The two most common types mentioned above are aged by a process similar to that used in determining the age of trees. As you view the fish scale on the overhead projector, alternate light and dark areas should be obvious. These two rings (light and dark) equal one year of growth

Teacher Resource
page 2

A fish grows much more rapidly during the warm months than in the colder months due to availability of food and rate of body processes. The scales serve as a protective body coating and must grow as the rest of the body grows, since at birth or hatching a fish has all of the scales he will ever have.

This uneven growth causes the scales to grow fast and thin in the summer when food is plentiful. Growth of the scale in winter is slow and thick! This growth may be compared to the human fingernail. The fingernail is an outgrowth of the epidermis or the "waste skin." Students will be able to see clearly the dark and light - thick and thin areas of the scale. These account for one year of growth.

TEACHER DIRECTION B - 64

PREDICTING THE AGE OF A FISH

Materials for Class:

1. Overhead projector
2. Large fish scales
3. Prepared transparency of fish scale

The scales when received may be curled somewhat. This may be overcome by soaking in water and pressing with a heavy book until flat. The scales have already been thined down, by sanding, to permit the passage of light. If for some reason they do not show up on your projector, they may be thinned more by rubbing with fine sandpaper.

Place the scale on the overhead and point out the thick and thin area.

THIS IS A FISH SCALE. FROM THE SIZE OF THE SCALE, WHAT SIZE DO YOU THINK THE FISH WAS? WHY? FISH SCALES GROW AS THE BODY OF THE FISH GROWS. THE SCALES MUST LAST THE FISH A LIFETIME SINCE IT HAS ALL OF ITS SCALES AT BIRTH OR HATCHING.

HAVE YOU EVER TRIED TO PICK UP A FISH IN YOUR HANDS? WHAT HAPPENED? NOT ONLY DID IT SQUIRM, BUT IT WAS PROBABLY VERY SLIPPERY. WHY? ALL OVER THE SCALES IS A VERY SLIMY MUCOUS THAT HELPS THE FISH SWIM FAST, BUT IT ALSO PROTECTS THE FISH FROM SKIN INFECTION.

AS THIS FISH GROWS, THE SCALE GROWS. DO YOU THINK THE FISH WOULD GROW MORE IN THE SUMMER OR IN THE WINTER? WHY? BECAUSE OF THIS RAPID GROWTH IN SUMMER AND SLOW GROWTH IN WINTER, WE CAN PREDICT THE AGE OF THE FISH BY LOOKING AT THE SCALE. YOU SHOULD SEE LIGHT AND DARK AREAS. THE LIGHT AREA IS SUMMER GROWTH AND THE DARK IS WINTER GROWTH. BOTH OF THESE EQUAL ONE YEAR.

Teacher Direction
page 2

NOW LOOK AT THIS DRAWING OF ANOTHER FISH SCALE. (Use Transparency B-63 point out and count the rings for the class) THIS FISH IS ABOUT $5\frac{1}{2}$ YEARS OLD. NOW, USING THE SAME PROCEDURE, TRY TO FIGURE THE AGE OF THE FISH SCALE YOU HAVE. (If each group has one, let each group make their own calculation. If you have only one scale, have each member of the class make a determination.

MAKE A DRAWING OF THE SCALE AND SHOW HOW YOU ARRIVED AT THE AGE OF THE FISH.

STUDENT B - 64

PREDICTING THE AGE OF A FISH

Materials:

1. Overhead projector
2. Fish scale
3. Paper and pencil for drawing

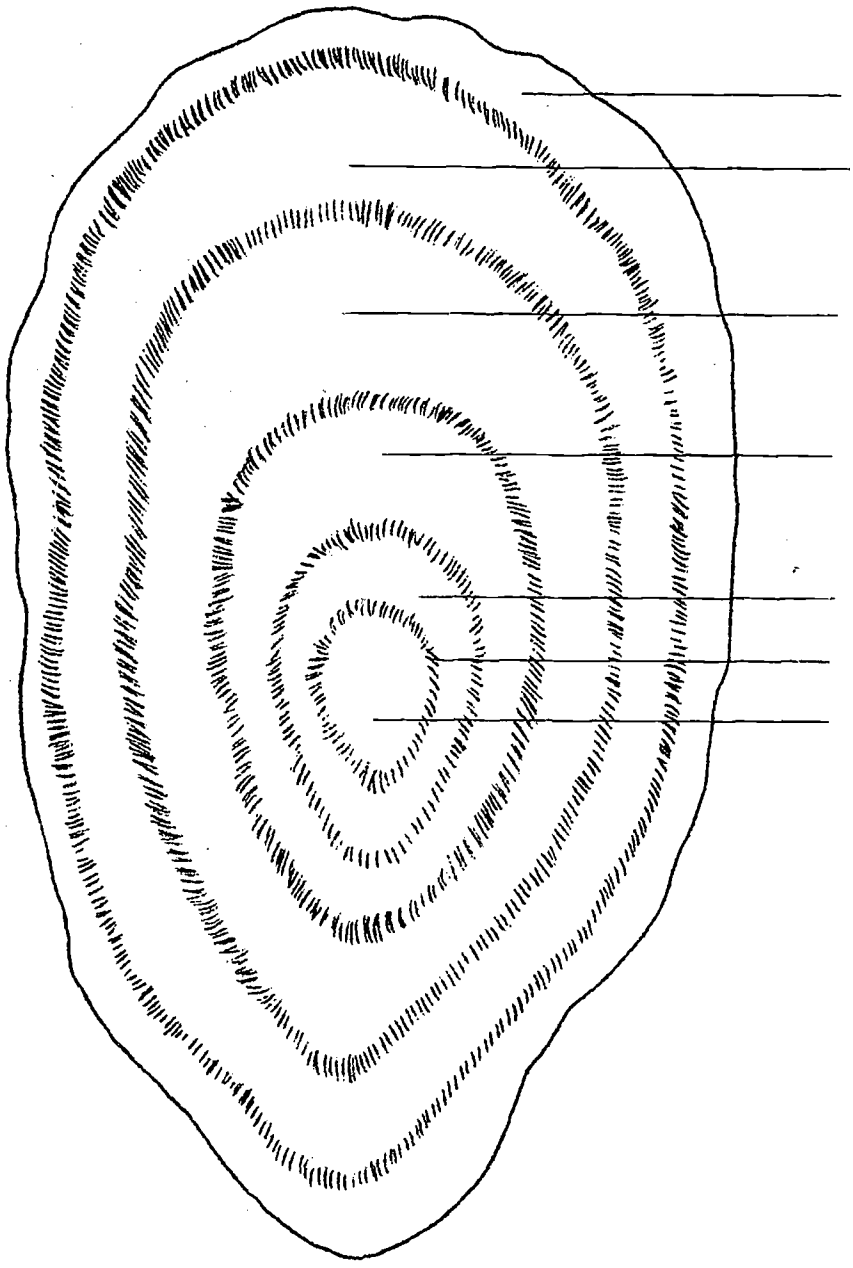
Have you ever wondered how scientists can tell the age of a fish? Most fish are aged by "reading" their scales. These scales are "read" in much the same way that you read the age of a tree on a stump. In the tree family, each ring equals one year. On a fish, scale, two rings equal one year.

A fish grows much faster in the hot summer months than in the winter months. Can you think of any reasons that may explain this? Scales grow at the same rate as the body, fast in the summer and slow in the winter. Think about your fingernails, they grow thin and long in the summer and slow and thick in the winter. Since humans are warm blooded, our feeding is not as much affected as the cold-blooded fish. However, we do grow at different rates in summer and winter.

At birth, or hatching, a fish has as many scales in number as he will ever have. Since these scales are a protectiive covering or "armor plates" they must grow as fast as the rest of the body. Growth is rapid in warm months and slow in colder months. This produces light and dark areas or thick and thin areas. By counting these, we may tell the age of the fish.
Each light and dark band together equal one year.

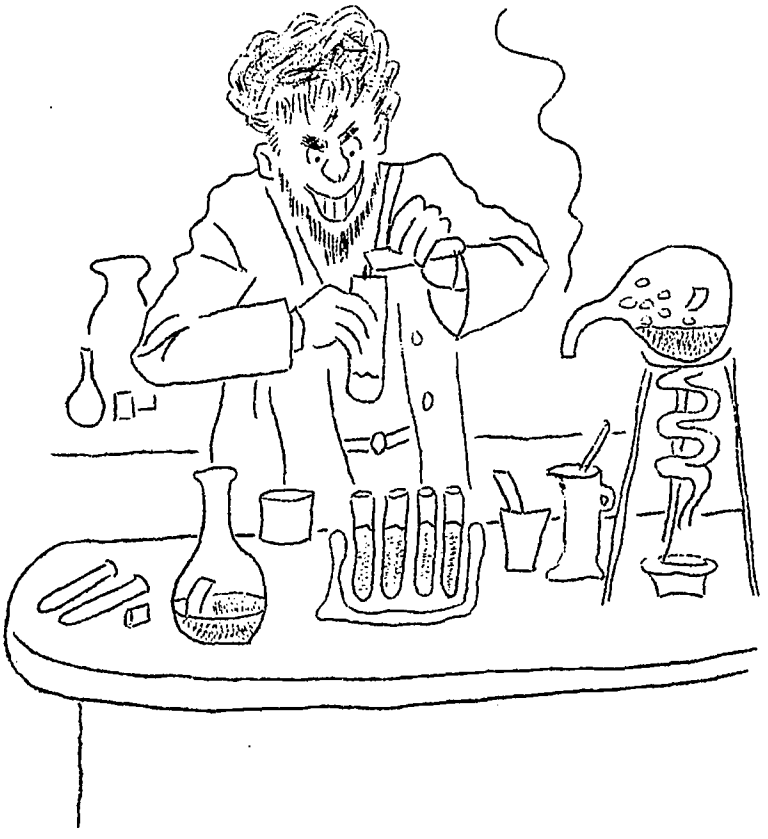
1. How large do you think this fish was?
2. How old is your fish scale?
3. Can you name some other fish that have scales?
4. Can you name some fish that do not have scales?

Student
page 2



UNIT FIVE

GENETICS



JOE FOURE 9

UNIT V

GENETICS

Some of the major fronts in scientific research today are in the field of Genetics. The mystery of the cell and how it reproduces after its kind has puzzled the scientist for ages. Perhaps the answer to this question also holds the answer to important problems of our own age for example: cancer, birth defects, mental retardation etc. The geneticist has progressed far beyond the meager beginnings of Gregor Mendle, but answers to the above questions hold far greater potential than perhaps any realize. Genetics at best is a very difficult and involved study calling on knowledge from various areas. The activities listed here are very simple in order to introduce the study of Genetics and are not intended to lead the student into an in-depth understanding of Genetics.

The Activities included in Unit V are:

B-65 Probability Using One Coin

B-66 Probability Using Two Coins

B-67 Pairing I

B-68 Pairing II

B-69 Pairing III

B-70 Tasters and Non-Tasters

B-71 Other Inherited Human Characteristics

B-72 Gathering Research Data

B-73 Can Chlorophyll Producing Genes Act Without Light?

B-74 How Does Radiation Affect Genes?

UNIT V

GENETICS

TEACHER RESOURCE

Understanding some rules and assumptions of probability will help us to understand genetics. In setting forth rules for probability, the following conditions must be met: (a) ALL EVENTS MUST HAVE AN EQUAL OPPORTUNITY OF OCCURRING (b) IT MUST BE POSSIBLE FOR ONLY ONE EVENT TO OCCUR AT A TIME (c) ALL OF THE KNOWN EVENTS MUST BE THE ONLY POSSIBLE EVENTS.

Three Laws of Probability:

1. The results of one occurence of a chance event does not affect the results of a later occurrence of that same event.
2. The larger the number of trials (up to a point), the closer to expected ratios the actual ratios obtained should be.
3. The chance that independent events will occur at the same time is equal to the product of their occurring separately.

TOPIC 1 - The results of one occurrence of a chance event does not affect the results of a later occurrence of the same event.

It may be difficult for the students to accept this first law of probability. Look for a moment at chance from the "point of view" of a coin: since the coin cannot have any understanding of how it has landed in the past, previous results cannot possibly affect the future. Each time we flip a coin the probability of it landing "heads" is always equal to the probability of it landing "tails".

TEACHER DIRECTION B - 65

PROBABILITY USING ONE COIN

Materials for each pair of students

1. one coin, such as a penny, nickle, or dime (try to have all coins the same)
2. pencil

PROBABILITY IS THE MATHEMATICAL SCIENCE WHICH DEALS WITH PREDICTING THE CHANCES THAT A CERTAIN EVENT WILL HAPPEN. OUR UNDERSTANDING OF GENETICS DEPENDS UPON OUR KNOWLEDGE OF PROBABILITY. SO, IN OUR FIRST ACTIVITY, WE SHALL TRY TO SEE HOW TO PREDICT THE OCCURRENCE OF A CHANCE EVENT. Pass out Activity B-65. Read the instructions to the students, down to the statement: "Your instructor will discuss ratios with you and you will learn how to determine them."

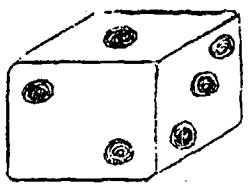
After the students have completed the activity to this point, you must explain to them how probability is expressed.

NOW THAT YOU HAVE FLIPPED A SINGLE COIN TEN TIMES EACH AND RECORDED THE RESULTS LET US SEE HOW OUR RESULTS COMPARE TO THOSE WHICH WERE EXPECTED. BEFORE WE CAN MAKE ANY COMPARISON, WE MUST FIRST DETERMINE THE EXPECTED RESULTS.

PROBABILITY IS EXPRESSED MATHEMATICALLY. USUALLY IT IS WRITTEN AS A FRACTION. THE NUMERATOR (the first number written) IS THE NUMBER OF TIMES A CERTAIN EVENT IS EXPECTED. THE DENOMINATOR (the number written after the slash mark (1) IS THE NUMBER OF TRIALS. FOR EXAMPLE, A COIN HAS HOW MANY SIDES? (two) WHAT IS THE PROBABILITY OF TOSSING A HEAD? (one out of two $\frac{1}{2}$) OR A DIE (singular of dice) HAS HOW MANY SIDES. (six) SO, THE PROBABILITY OF ROLLING A FOUR WITH A SINGLE DIE WOULD BE WHAT? (one time out of six trials) THIS WOULD BE EXPRESSED AS THE FRACTION 1/6 OR IT MAY BE WRITTEN 1:6 (read one to six, meaning one out of six trials) IN USING RATIOS, FRACTIONS ARE ALWAYS REDUCED TO LOWEST TERMS. CONTINUING TO USE THE EXAMPLE OF A DIE, WHAT ARE THE CHANCES (or what is the probability) of rolling an even number? Discussion. You may not get the answer reduced to lowest terms. If someone answers 3/6 (there are three even numbers: 2, 4, and 6),

Teacher Direction
page 2

try to get him to reduce this to lowest terms: 1/2 [Optional example: thinking of our numbers as they usually appear in print (Arabic numeral), what is the probability of throwing a number which has one or more curves in it? Answer 4/6 or, reduced to lowest terms, 2/3. (2, 3, 5, and 6 all have one or more curves).. This can also be written 2:3]



STUDENT B - 65

PROBABILITY USING ONE COIN

Materials for each pair of students:

1. A coin, such as a penny, nickle or dime
2. Pencil

One person will flip the coin and another will record the results. How many flat surfaces does a coin have? _____. When a coin is flipped, how many surfaces face upward after it has landed? _____. How can one side be distinguished from the other?_____

Flip the coin one time. If, for example, the coin lands head-side up, make a mark in the column labeled "Heads". Use the table provided below to record your results.

"Heads"	"Tails"

Now that the coin has landed with a certain side up, what are the chances that on the next try the other side will land facing upward? _____. Continue to flip the coin, recording the results each time until 10 flips have been recorded.

Now the student who flipped the coin will sit as recorder while the other student flips the coin. Follow the same procedure as before, flipping the coin ten times and recording the results.

"Heads"	"Tails"

Student
page 2

1. How many times did you flip heads?_____ _____

2. How many times out of twenty was heads flipped? _____

3. How many times did you flip tails? _____ _____

4. How many times out of twenty was tails flipped?_____

Your instructor will discuss ratios with you and you will learn how to determine them. What ratio was expected from these results? _____ Was this the ratio obtained?_____

Record on the overhead projector each teams results. From the class total answer the following questions:

How many times was heads flipped?_____ How many times was tails flipped?_____ Out of the total number of flips, how many would you expect to be tails?_____ Out of the total number of flips how many heads would you expect?_____ Are the class ratios closer to the expected ratios than the results of your team?

TEACHER DIRECTION B - 66

PROBABILITY USING TWO COINS

Materials for each pair of students:

1. Two coins 2. Pencil

TOPIC 2 - The larger the number of trials (up to a point), the closer to expected ratios the actual ratios obtained should be. This should have come out in the discussion at the end of the previous activity as you compare each teams's results with the class results.

FROM THE RESULTS OF THE ACTIVITY IN WHICH ONE COIN WAS FLIPPED (B-65) WE CAN SEE ANOTHER RULE OF PROBABILITY. THE LARGER THE NUMBER OF TRIALS (up to a point -if this is graphed from actual experimentation, after 500 or so trials, the actual results will approach the expected results. But thereafter, you will not get any closer.), THE CLOSER TO EXPECTED RATIOS THE ACTUAL RATIOS OBTAINED SHOULD BE. Pass out Activity B-66.

TOPIC 3 - The chance that independent events will occur at the same time is equal to the product of their occurring separately.

Read the directions to the students down to "The instructor will record each team's results on the overhead projector." After students have completed this portion of the activity, call for the results. Record them on the transparency for activity B-66.

After you have recorded the total obtained and the total expected on the transparency (totals expected would be equal numbers of each HH/HT/TH/TT) out of 300 flips, it would be expected to come out 75 of each (300 divided by 4). Read the rest of the directions to them and have them continue.

NOW THAT YOU HAVE COMBINED THE RESULTS OF THE HEAD-TAIL AND TAIL-HEAD COMBINATION HOW MANY OF EACH OF THE THREE GROUPS DID YOU OBTAIN? Record these results on the transparency.

Teacher Direction
page 2

HOW MANY OF EACH GROUP WOULD BE EXPECTED? (Now the ratio expected out of 15 pairs is 75/150/75). THE EXPECTED NOW IS TWICE AS MANY OF THE HT/TH COMBINATION AS EITHER OF THE OTHER TWO. REDUCE THIS TO LOWEST TERMS. (They should come out with $\frac{1}{2}$/1 or 1:2:1).

After the groups have finished B-66 pass out student page 2. Let each team call out their results and other members of the class record their results.

STUDENT B - 66

PROBABILITY USING TWO COINS

Materials for each pair of students

1. Pair of coins 2. Pencil

If you and your partner flip a coin at the same time, how many combinations are possible: (Use H for heads and T for tails.)

HEAD-HEAD	HEAD-TAIL	TAIL-HEADS	TAIL-TAILS
HH	HT	TH	TT

When you record the results of the flipping, always record the same person's flip first. This will provide a distinction when the first person flips heads and the second person flips tails (HT), or vice versa (TH). Flip the two coins together a total of twenty times. Record the results after each flipping. Start each flip with the same side up.

The teacher will record each team's results on the overhead projector.

How many of each combination (HH, HT, TH, TT) did you and your partner obtain?

HH_____: HT_____: TH_____: TT_____

How many of each combination were expected?

HH_____: HT_____: TH_____: TT_____:

Notice that HT is the exact same combination as TH. Combining these two groups, figure out how many of the three groups were obtained.

HH_____: HT-TH _____: TT_____:

How many of each combination were expected?

HH_____: HT-TH_____: TT_____:

Keep a record of these results for later use.

Student
page 2

TEAM	HH	HT	TH	TT
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
TOTAL OBTAINED:				
TOTAL EXPECTED				

TOTAL OBTAINED: HH _____ HT/TH _____ TT _____

TOTAL EXPECTED: HH _____ HT/TH _____ TT _____

TEACHER RESOURCE

The following glossary is for your convience. Students should not be required to memorize these terms or definitions.

Allele (a lel') a form of a gene. For example, in humans, there are three different forms of the gene for blood type-A, B and O. These are called alleles, all different forms of the gene which influences blood type.

Backcross (back' cross) a cross between pure (Homozygous) organism and a hybrid (heterozygous) organism

Dihybrid (die high' brid) hybrid for two traits, as Aa Bb.

Diploid (dip'loyd) having a pair of genes, Examples: AA, Aa, aa (AA is homozygous dominant:Aa is heterozygous, and aa is homozygous recessive)

Dominant (dom' i nant) a gene which is stronger then its allele

F_1 (eff one) first generation of a cross (F stands for filial which means children); first generation offspring. This is obtained by making a P_1 cross. B=black b = white

P_1 BB x bb
(Pure Black male) Bb (Pure white female)

F_1 All offsprings Hybrid Black

F_2 Cross Bb X Bb

BB	Bb	Bb	bb
Pure Black	Hybrid Black	Hybrid Black	Pure White

Genotype ratio

1	2	1
Pure Black	Hybrid Black	Pure White

Phenotype

3 to 1
Black White

Genotype (gee' know type) describes the gene make-up of an organism, during fertilization when two haploid cells unite, a diploid organism is started) This is also called monoploid.

Heterozygous (He" tero zy' gus) hybrid

Homozygous (Ho" mo zy' gus) pure

Teacher Resource
page 2

Hybrid (High'brid) having a pair of genes, one of which is dominant and the other recessive; having an unlike pair of genes.

Monohybrid (Ma" know high' brid) hybrid for only one trait, as Aa

P_1 (Pea one) cross of the parents; parental generation

Phenotype (Fee' know type) describe the appearance of an organism because of its genotype. Examples: if an organism is heterozygous (Aa-this is its genotype), its phenotype will be that of the dominant trait. Thus the two different genotypes AA and Aa have the same phenotype, dominant. Only the homozygous recessive has the recessive phenotype.

Pure (pure) having a pair of genes, both of which are alike. An organism may be either pure dominant or pure recessive.

Recessive (Rec Sess' ive) a gene which is weaker than its allele.

Several things can be shown using ratios of two coins. The significance of using two coins is, of course, that genes occur in pairs (diploid). The first ratio obtained in B-64 was 1:1:1:1-that is, there are four possibilities HH;HT;TH;TT; and each has an equal chance of occurring. In the kind of inheritance described by the Father of Genetics, Gregor Mendel, a ratio of 1:1:1:1 would be expected if you cross an organism which is pure for two traits (aabb) with one which is hybrid for those traits (AaBb). This is called a dihybrid backcross, and can be visualized by using letters. Use a capital letter for a dominant trait and a corresponding little letter for a recessive trait.

When combining the HT with the TH, you have put all the hybrids together. The ratio obtained here, 1:2:1, is the ratio of genotypes in the F_2 from a monohybrid cross: 1 pure dominant, 2 hybrid, 1 pure recessive. If the pure dominant and hybrid are combined, the ratio 3:1 is obtained. This is the phenotypic or (what they look like) ratio of 3 dominant to one recessive.

The foregoing has been a capsule lesson in genetics. If more information is desired, or additional explanation is necessary, see any good biology text.

Teacher Resource
page 3

WE SHOULD BE READY NOW TO ACCEPT THE THIRD LAW OF PROBABILITY. IT STATES THAT THE PROBABILITY THAT TWO DIFFERENT EVENTS WILL OCCUR AT THE SAME TIME IS EQUAL TO THE PRODUCT OF THEIR OCCURRING SEPARATELY. THE PROBABILITY OF TOSSING HEADS IS $\frac{1}{2}$ (one head out of 2 throws, or heads half the time). AND THE PROBABILITY OF TOSSING TAILS IS ALSO $\frac{1}{2}$. THIS IS TRUE FOR EACH COIN. YOU CAN FIND THE PROBABILITY OF TOSSING HH, HT/TH, AND TT BY SETTING UP A MULTIPLICATION PROBLEM. (Show this on an transparency or on the blackboard)

$\frac{1}{2}$ Heads — $\frac{1}{2}$ Tails — Coin # 1
$\frac{1}{2}$ Heads — $\frac{1}{2}$ Tails — Coin # 2

	Coin # 1		Coin # 2		Out of four tosses you expect
1.	$\frac{1}{2}$ Heads	x	$\frac{1}{2}$ Heads	=	$\frac{1}{4}$ heads and heads
2.	$\frac{1}{2}$ Tails	x	$\frac{1}{2}$ Tails	=	$\frac{1}{4}$ Tails and Tails
3.	$\frac{1}{2}$ Tails	x	$\frac{1}{2}$ Heads	=	$\frac{1}{4}$ Tail and Heads *
4.	$\frac{1}{2}$ Head	x	$\frac{1}{2}$ Tails	=	$\frac{1}{4}$ Head and Tail *

* Note that since number three and four are the same head-tail and tail-head we can put them together. Our results would then be stated as 1:2:1

Another method of illustrating the results is with the "checker board".

Coin # 1

Coin # 2

	H	T
H	HH	HT
T	HT	TT

HH - 1
HT - 2
TT - 1

TEACHER DIRECTION

B - 67

PAIRING I

Materials for groups of three:

Twelve assorted objects

TOPIC 4 - Something in the sex cells of organisms (chromosomes) determines the characteristics. Chromosomes occur in pairs. In the process of gamete (Sperm, Egg) formation, paired chromosomes separate, each going into a different sex cell (haploid). During fertilization when the sex cells unite, chromosomes come together again to form pairs (diploid).

The purpose of this activity is to introduce students to the idea of pairing and that objects do not have to be identical to be paired. This is necessary to prepare them to accept the idea that a pair of genes need not be alike (heterozygous or hybrid condition).

Suggested objects for this lab are as follows:

Two gloves of different size or color

Two matches of different lengths

Two nails, one with a head and the other without

Two washers of different sizes

Two playing cards of different suit or number

Two pencils of different length

Two pencils of different color

Two socks of different length

Two paper clips of different length

Two pipecleaners of the same length, one white and one green.

Two beakers of different size

Two flasks of different size

Teacher Direction
page 2

Pass out activity B-67. Read the directions to the students. When they have finished pairing the objects, ask individuals to say how they paired them. Ask why they paired the objects as they did.

Their answers should enable you to point out that IN ORDER FOR OBJECTS TO BE PAIRED, THEY MUST HAVE SOMETHING IN COMMON. THAT IS, THEY MUST BOTH BE OF THE SAME GENERAL TYPE, LIKE BOTH GLOVES OR BOTH NAILS. THEY DO NOT HAVE TO BE EXACTLY ALIKE. THEY MAY, FOR INSTANCE, BE DIFFERENT COLORS LIKE THE SOCKS, OR DIFFERENT LENGTHS LIKE THE PENCIL OR MATCHES.

STUDENT B - 67

PAIRING I

Materials for groups of three:

Twelve assorted objects

Examine these objects. Notice that no two are exactly alike. Some of these objects are enough alike to be grouped together. Arrange the twelve objects so they are in six groups of two objects each. Be sure that you have placed the objects which are most nearly alike in pairs.

Record the pairs.

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

TEACHER DIRECTION B - 68

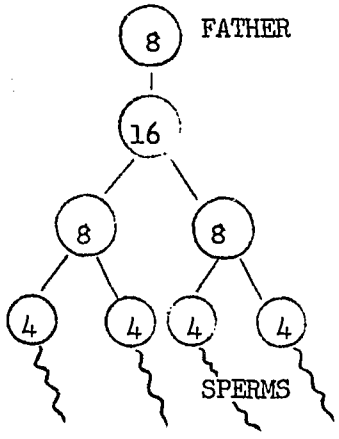
PAIRING II

Materials for groups of three:

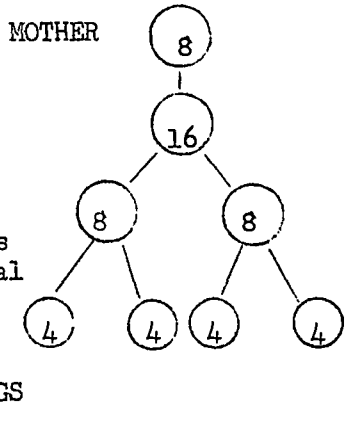
1. six white pipecleaners 2. six green pipecleaners

The pipecleaners must be of specific lengths: in each color group, one each must be 6", 5", 4", 3", 2", and 1". Pipecleaners are 6" long, so when you cut a 5" length, you can use the other end for a 1" piece, etc. There is no particular reason to use green as the color other than white, if another color is available, you may substitute it for the green. Pass out activity B-68 and read the instructions to the students.

After you have read the question "..... what is the reason for using two different colors?", try to get the answer that it is to represent the two different parents. Remember that in sexual reproduction, both male and female contribute to the next generation. They do this through the egg and sperm. Each sex cell carries a complete set of genetic instructions in its chromosomes. So the two different colors used in this activity are to represent the mother's chromosomes and those of the father. The next generation gets a set of chromosomes from each parent.



At this stage chromosomes duplicate, then split to keep number of chromosomes $\frac{1}{2}$ (haploid) of the original number



Students may at first group pipecleaners in a number of different ways if they disreguard male and female.

Teacher Direction
page 2

For example:

6 white	1 green
5 white	6 green
4 white	3 white
2 green	4 green

At first accept all answers then explain that color difference denotes male and female.

STUDENT B - 68

PAIRING II

Materials for groups of three:

1. Six white pipecleaners
2. Six green pipecleaners

Working in the same groups as before, arrange the twelve pipecleaners in six pairs. If these pipecleaners are used to represent chromosomes of a plant or animal, what is the reason for using two different colors? (Discussion)

TEACHER DIRECTION B - 69

PAIRING III

Materials for groups of three:

1. Two containers:
   One with 6" white pipecleaners
   One with 6" green pipecleaners
   (Bag of dried Navy beans and
   bag of dried Pinto beans may be substitutued
2. Gummed labels
3. Pencil

Each chromosome actually contains many units which cause development of different characteristics. These individual units of inheritance are called genes. Since genes are on chromosomes, they also occur in pairs (in the diploid condition).

It is suggested that you use 20 of each color pipecleaners for this activity, producing 20 pairs. Pass out activity B-69. Read the directions to the students. When you get to the question, "What process does this illustrate?", Try to get the answer before the students proceed with the activity. (Fertilization)

EACH CHROMOSOME CONTAINS MANY UNITS WHICH CAUSE DEVELOPMENT OF DIFFERENT CHARACTERISTICS. THESE INDIVIDUAL UNITS OF INHERITANCE ARE CALLED GENES. REMEMBER THAT CHROMOSOMES OCCUR IN PAIRS. SINCE GENES ARE ON CHROMOSOMES, THEN GENES ALSO MUST OCCUR IN PAIRS. IF A PAIR OF GENES ARE ALIKE, THEY ARE DESCRIBED BY THE TERM 'PURE.' IF THE PAIR IS NOT ALIKE, THEY ARE CALLED 'HYBRID'.

Use the overhead projector to record the results. "Which of these are pure and which are hybrid?" Pure is either two red or two whites; hybrid is one red and one white. Looking back to the results of Activity B-66 we find that HH and TT were pure and TH and HT were hybrid. Expected ratios would be 1:2:1 or, out of 15 teams, 75 Red-Red; 150 Red-White: 75 White-White.

HERE WE ARE DEALING WITH A RATIO WHICH SHOWS THE EXPECTED DISTRIBUTION OF GENES. IF THESE GENES COME TOGETHER BY CHANCE, THEN OUT OF A LARGE POPULATION WE WOULD EXPECT THEM TO PRODUCE A 1:2:1 RATIO. THAT IS, ONE PURE OF ONE TYPE, TWO HYBRID, AND ONE PURE OF THE OTHER TYPE. THIS RATIO OF GENE COMBINATION IS CALLED GENOTYPE.

Teacher Direction
page 2

In many instances, genes show different strengths. An organism having an unlike pair of genes would therefore show only the stronger trait. The strong gene is called dominant, and it is capable of completely masking the affect of its alelle. The weak gene is called recessive. An organism having a like pair of dominant genes shows the same trait (has the same phenotype) as the hybrid.

IN SOME CASES, ONE GENE IS STRONGER THAN THE OTHER. THE STRONG GENE WE CALL DOMINANT, THE WEAK GENE WE CALL RECESSIVE. WITH THIS TYPE OF INHERITANCE, THE HYBRID LOOKS THE SAME AS THE PURE DOMINANT. THE WAY IT LOOKS IS CALLED PHENOTYPE. WHERE THE GENOTYPE RATIO IS 1:2:1, THE PHENOTYPE RATIO IS 3:1. WHO WILL TELL ME WHY THIS IS SO? Answer: In a 1:2:1: ratio, the first one represents the pure dominant, and the second two represent the hybrid. These three have at least one strong gene and so they have the phenotype caused by that gene. IF RED IS DOMINANT TO WHITE, THEN THE PURE RED HAS THE PHENOTYPE RED AND THEY HYBRID ALSO HAS THE PHENOTYPE RED. THIS GIVES THE PHENOTYPE RATIO 3:1, WHICH IS THREE SHOWING THE DOMINANT TRAIT AND ONE SHOWING THE RECESSIVE TRAIT.

STUDENT

B - 69

PAIRING III

Materials for groups of three:

1. Two containers
   One with 6" green pipecleaners
   One with 6" white pipecleaners
   or One with dried Navy Beans
   One with dried Pinto Beans
2. Gummed labels
3. Pencil

Let the beans represent chromosomes, and let the labels represent genes. Use as many "genes" as you have "chromosomes". Divide the "genes" into two equal groups. Write "red" on all the "genes" of one group, and "white" on all those in the other group. Now put one-half the white "genes" together with one-half the reds. Attach the "genes" to the "Chromosomes" so that one-half the white "chromosomes" carry white "genes" and one-half carry red "genes". Repeat the process for the green "chromosomes".

Now put all the white "chromosomes" back into one container and all the green ones into the other. Let the container of white "chromosomes" represent the male and the green ones represent the female. Close your eyes and draw out one "Chromosome " from each container, open your eyes and put the two "chromosomes together. What process does this illustrate when you put the two chromosomes together?

Continue to draw out "Chromosomes" (one white and one green) closing your eyes each time until all have been paired. Record the number of pairs of white, the number of pairs of red, and the number of unlike pairs (one white and one red.)

Two Red	One Red and One White	Two White

Which of these are pure and which are hybrid?

Look back at the results of activity B-66. In B-66 which columns represent pure and which represented hybrid? How do the ratios in activity B-66 compare to the ratio you obtained in activity B-69?

TEACHER RESOURCE B - 70

TASTERS AND NON-TASTERS

BY LOUIS R. HUNDLEY

Ever since Arthur L. Fox first showed that many people are unable to taste phenylthiocarbamide (PTC), the use of this chemical and other compounds in testing tast reactions has caught the interest in geneticists, particularly those interested in human genetics. To most people PTC is extremely bitter, while to the remainder it is completely tasteless. Blakeslee and Salmon report, however, that a small minority of the people tested will assign different tastes to the substance. Taste sensitivity to PTC has been an important character in investigations of population genetics and racial research.

The ability to taste PTC is inherited, and the taste dimorphism in sensitivity appears to hinge on a pair of genes. Individuals having the recessive gene homozygously are non-tasters. Some of the frequencies of the recessive gene in different races have been reported, as follows: North American white population .550; Japanese .266; Jewish (Ashkenazic), .524; Hindu .581: and Indian (Brazil), .111. In the North white population approximately 20 per cent are homozygous tasters, 50 per cent are heterozygous tasters, and 30 per cent are non-tasters. The square of the frequency of the gene (.55) gives the frequency of the trait (.30). The other per centages are derived from the Hardy-Weinberg formula.

Even among the tasters of PTC, unless the chemical has dissolved in the taster's own saliva, it is tasteless. If PTC is dissolved in some one else's saliva or in water and placed upon the dry tongue of a taster, it cannot be tasted.

This simple classification of people as either tasters or non-tasters is misleading. As Blakeslee demonstrated, a substance "must have a certain strength

or concentration before it can be tasted and ... this concentration is different for different people". He reports that a 0.02 per cent solution of PTC was tasteless to 75 per cent of his sample but that a 0.64 percent solution was tasted by 85 per cent. In other words, some people have a higher taste-sensitivity threshold for PTC than others.

TEACHER DIRECTION B - 70

TASTERS AND NON-TASTERS

Materials for groups of three:

1. PTC paper 2. Paper 3. Pencil

Pass out activity B-70 and one piece of the PTC paper to each student. Read the directions to the students. In answer to the question, "How many students do you know are pure?", it must be the number of non-tasters. Since tasters are dominant, they can either be pure (Homozygous) or hybrid (heterozygous). But, a non-taster cannot have a gene for tasting, or he would be a taster, not a non-taster. A sample of the population in the United States revealed that there are seven non-tasters to nine tasters. This is not the 3:1 ratio expected for this kind of inheritance. There appears to be other factors than the ones we are studying which also affect the way things taste. Sometimes two or more pairs of genes influence a particular characteristic. It would be best to look for a 3:1 ratio and then remind the students that in chance events the expected is not always what is obtained.

POST THE CLASS RESULTS ON THE BOARD BY PERIODS.

	1		2		3		4		5		6		7	
	T	NT	T	NT	T	NT	T	NT	T	NT	T	NT	T	NT
BOYS														
GIRLS														
TOTAL														

You may also give two papers to each student to take to test mom and pop and bring these results back.

STUDENT B - 70

TASTERS AND NON-TASTERS

Materials for groups of three:

1. PTC paper 2. Paper 3. Pencil

Each member of the group will chew on a piece of paper which contains a harmless chemical substance called PTC (phenylthiocarbamide). Some people cannot taste this substance at all (recessive). Others taste it very strongely (dominant). Make two columns on the paper. Label one column "Taster" and the other "Non-Taster". Record the results for your group.

The instructor will write on the overhead projector how many were tasters and how many were non-tasters. How many students do you know are pure?_____

What ratio of tasters to non-tasters do we have in this class?_____

What ratio of tasters to non-taster is there among the boys?_____

Among the girls?_____

Are the ratios about the same?_____

If not, why not_____

TEACHER DIRECTION B - 71

OTHER INHERITED HUMAN CHARACTERISTICS

Pass out activity B-71. Read the directions to the students. After they have had time to evaluate each other as to those characteristics, record their findings on an acetate.

CAN YOU TELL FROM THESE RESULTS WHICH TRAITS MIGHT BE DOMINANT AND WHICH MIGHT BE RECESSIVE? Even though they may be able to tell, with so few people, it is doubful. Go ahead and let them make tenative decisions concerning dominance and recessiveness, but warn them: WITH SO FEW TRIALS, THE EXPECTED RESULTS AND THE ACTUAL RESULTS MAY NOT BE THE SAME. IF YOU HAD MORE INFORMATION, YOU COULD BETTER TELL WHICH TRAITS ARE DOMINANT?

Compile the results of all classes and see if more conclusive statements can be made.

STUDENT OTHER INHERITED HUMAN CHARACTERISTICS

The following is a list of human characteristics, each of which is determined by a single pair of genes.

1. The way your hair grows from the crown of your head:

   In either clockwise or counterclockwise direction.

2. The ability to roll your tongue into a "U" or an "O" shape:

   Either can roll the tongue or cannot.

3. Freckles:

   Either have them or don't have them

4. How the ear lobes grow:

   Either free or attached to the side of the head. Pick out students to demonstrate these characteristics.

5. Dimples:

   Either have them or don't have them.

6. Ability to taste PTC

   Either can taste it or cannot (already determined).

Working in the same group, record each person's characteristics for each of the additional five traits.

The instructor will record these results on the overhead projector. Can you tell from these results which traits might be dominant and which might be recessive?

TRAIT	ME		NUMBER WITH TRAIT		NUMBER WITHOUT TRAIT
	Yes	No	My Class	All Classes	
1. Hair growth					
2. Tongue roller					
3. Freckles					
4. Ear Lobe					
5. Dimples					
6. Taster					

TEACHER DIRECTION B - 72

GATHERING RESEARCH DATA

Inherited traits may be studied in populations as well as individuals and families.

Pass out activity B-72 and read the instructions. If the students seem willing to do this work outside of class, let them pool other classes or neighbors on all of these traits. If not, assign each team only one or two traits and have them bring this information to class. Remind them the more trials, the closer to expected ratios their actual ratios will be.

In each pair of alelles, the first one named is dominant to the second.

1. Clockwise whirl is dominant to counter-clockwise whirl.
2. Ability to roll the tongue is dominant to inability to roll the tongue.
3. Abundant freckles are dominant to little or no freckles.
4. Free earlobes are dominant to attached earlobes.
5. Deep dimples are dominant to shallow dimples or no dimples at all.
6. Ability to taste PTC is dominant to inability to taste it.

STUDENT B - 72

GATHERING RESEARCH DATA

Materials for each student:

1. Check list of characteristics 2. Pen or pencil

Scientists must gather as much information as possible from as many different sources as possible before reaching a final conclusion. In this activity you will need to survey as many people as possible and keep accurate figures on the number of people having each characteristic. You may survey students in other classes, parents, family members, anyone just remember to record the results. At the end of the activity we will combine the results of each student into class totals.

TRAIT		NUMBER		NUMBER
1. Hair Whirl	Clockwise		Counter clockwise	
2. Tongue Rolling	Can		Cannot	
3. Freckles	Abundant		None	
4. Earlobes	Free		Attached	
5. Dimples	Present		None	
6. Taste (PTC)	Taster		Non-taster	

TEACHER DIRECTION B - 72

CAN CHLOROPHYLL PRODUCING GENES ACT WITHOUT LIGHT?

Materials for groups of three or four:

1. 25 Irradiated tobacco seeds
2. 25 non-Irradiated tobacco seeds
3. 2 Petri dishes
4. Disc filter paper
5. Water

Pass out activity B-73 and read the direction to the students. Mark dishes R = Radiated NR =Non-Radiated. Allow a week to 10 days for all the seeds to sprout. If they tend to dry out, water them, but don't expose them to light any more than is absolutely necessary. After the seeds have germinated, proceed with the activity. (You may wish to start with this activity about the time you are setting up activity B-69 so that the seeds will have sprouted when you get to the end of genetics.)

The leaves should be a yellowish white, since light is necessary for chlorophyll production.

Proceed immediately with activity B-74.

STUDENT B - 73

CAN CHLOROPHYLL PRODUCING GENES ACT WITHOUT LIGHT?

Materials for groups of three or four:

1. 25 Irradiated tobacco seeds
2. 25 Non-Irradiated tobacco seeds
3. 2 Petri dishes
4. Disc filter paper
5. Water

Place a piece of filter paper in the bottom of each Petri dish and wet them with tap water. Carefully spread out your irradiated tobacco seeds on the surface of the paper in one petri dish so that they are all about the same distance apart and mark this dish R =radiated. Distribute the non-irradiated seeds on the paper in the other dish, mark this dish NR =non-radiated. Place the covers over the Petri dishes and put them in the dark for several days until the seeds have sprouted How many of the irradiated seeds have started to grow? _____ How many of the non-irradiated seeds have started to grow?_____ What color are the small leaves?_____ Irradiated_____ Non-Irradiated_____

TEACHER DIRECTION B - 74

HOW DOES RADIATION AFFECT GENES?

Pass out activity B-74 and read the directions. After the Petri dishes have been in the light overnight, the students should be able to continue with their observations and answer the questions. All non-irradiated seeds are expected to be green by this time. Some from the irradiated group with still be white. Th expectation in the irradiated group is 3 green: 1 albino (white).

LIGHT IS NECESSARY FOR CHLOROPHYLL PRODUCTION. ALL SEEDS IN THE DARK WERE ALBINO BECAUSE OF A LACK OF LIGHT. AFTER BEING IN THE LIGHT FOR 24 HOURS, MOST SEEDLINGS TURNED GREEN, BUT A FEW REMAINED WHITE. THOSE THAT REMAINED WHITE DID SO BECAUSE THROUGH RADIATION THEIR GENES UNDERWENT A CHANGE WHICH MADE THEM UNABLE TO MANUFACTURE CHLOROPHYLL. THOSE PLANTS WHICH ARE ALBINO WILL NOT LIVE LONG BECAUSE THEY ARE UNABLE TO MAKE FOOD. A GENERAL DANGER SHOWN BY THIS EXPERIMENT IS THE CHANGE CAUSED IN GENES. CHLOROPHYLL IS A VITAL PIGMENT IN PLANTS. WITHOUT IT, THEY WILL STARVE TO DEATH. MAN HAS A SIMILAR PIGMENT, HEMOGLOBIN, WHICH CARRIES OXYGEN IN THE BLOOD. IT TOO, IS VITAL. IF IRRADIATION CAUSED A CHANGE IN MAN SO THAT WE DID NOT PRODUCE THIS RED PIGMENT, WE COULD NOT LIVE. RADIATION CAN ALSO CAUSE A BREAK DOWN IN CONTROLS WHICH GOVERN THE CELLS SO THAT THEY BECOME CANCEROUS

STUDENT B - 74

HOW DOES RADIATION AFFECT GENES?

Place the petri dishes (from activity B-73) in the light. After 24 hours, observe the seedlings. Are the leaves still white? Irradiated_____. Non-irradiated_____. Are they all the same color? Irradiated _____. Non-Irradiated_____. How many are now white? Irradiated_____. Non-Irradiated_____. How many are other colors? Irradiated_____. Non-Irradiated_____. Why? (Discussion)

What will happen to those plants which are not green?_____

_____

What are some of the dangers of radiation? (Discussion)

ADDENDUM

UNIT I MEASUREMENT

A. Major Concepts

1. Because of the great variations among the known measurements and the confusion caused by the differences, legal standards were established.
2. Primitive man used parts of his body and other available objects to obtain measurements; such as the hand, foot, finger, span, palm, arm, sticks, rocks, etc.
3. There are basically two systems of measurements commonly used; the English System and the Metric System.
4. In all measurements we are comparing an unknown quantity with a known quantity.
5. One complete rotation of the earth equals one day. Each day is divided into twenty-four hours. Each hour is divided into 60 minutes.
6. The development of measuring time from sundials and shadow, through water clocks and watches up the master clocks of today is based on the motion of the earth and stars.
7. In the United States, the United States Naval Observatory at Arlington, Va. keeps track of the motion of the earth and stars and from them gives us the correct time.
8. Military time is counted on a 24 hour day basis rather than a 12 hour day.
9. When the length of the pendulum or the amount of sand in a hour-glass varies, time intervals are also changed.
10. The basic units of the metric system are the meter for lengths, liter for volume, and the gram for weights.
11. Temperature is a measure of the intensity of heat in an object in units called degrees on an instrument known as a thermometer. The most commonly used thermometer scales are the Centigrade and Fahrenheit.

Unit I Measurements
page 2

12. The melting point of ice and freezing point of water are the same $0^{\circ}C$ or $32^{\circ}F$. Water turns to water vapor and water vapor condenses at the same temperature, ie. $100^{\circ}C$ or $212^{\circ}F$.

B. Suggested Questions

2. Completion Questions

1. Name one of the earliest units of measurement.
2. What was the original size of an acre?
3. List disadvantages of crude measurements.
4. Scientists usually use which system of measurement?
5. State three ways that measurement plays a part in your life.
6. Name several ancient means of keeping time.
7. Name two types of thermometers
8. How correct is the Arlington Naval time?
9. State some measuring pieces used by scientists.
10. Thermometers are used to measure_____
11. At what degrees of Fahrenheit does water boil? Degrees of Centigrade?
12. At what degrees of Fahrenheit does water freeze? Degrees of Centigrade?
13. How many degrees are there between the freezing point of water and the boiling point of water on the Fahrenheit scale? On the Centigarde Scale?
14. Suppose you dissolve salt or sugar in water. How will this affect the boiling temperature? the freezing temperature?
15. Name three other ways of telling time besides clocks and watches.
16. There are _____ seconds in a minute: _____ minutes in an hour; _____ hours in a day; _____ days in a week; _____ weeks in a year.

3. Multiple Choice Questions
Directions: Select from the choices given the best fragment that completes the statement and place the corresponding letter to the left of the statement.

___ 1. The first unit of measurement recorded by history was the: a) the foot, b) the cubit, c) the inch
___ 2. The modified Egyptian cubit which was used by the Greeks and Romans became known as the: a) inch, b) cubit, c) foot.
___ 3. The Greeks subdivided the foot into twelve thumbnail bredths which later became known as the a) inch, b) foot, c) yard
___ 4. One fathom is equal to: a) nine feet, b) three feet, c) six feet
___ 5. The fathom measurement would most likely be used by the: a) physician, b) sailor, c) teacher.
___ 6. The first yard measurement was first used by the: a) merchant of cloth, b) merchant of spice, c) merchant of gems.
___ 7. The standard yard was first established by a) King Henry I, b) King Henry II, c) King Henry VII.
___ 8. King Henry VII had the yard measurement marked on a: a) bronze yard bar, b) wooden yard stick, c) iron yard stick.
___ 9. The rod is: a) $5\frac{1}{2}$ yds long, b) 3 yds long, c) 4 yds long.
___10. Of the following measurements which is the longest: a) the yard, b) the fathom, c) the rod.

Unit I Measurement
page 3

B. Suggested Questions (continued)

4. Matching Questions
Directions: From the list of words given, select the right word or words to complete the statements and write it in the space provided.

1. Basic unit of measurement in the Metric system is _____.
2. Prefix meaning 1000 times is _____.
3. Melting points of ice are _____ and _____.
4. Unit in Metric system used to measure weight is _____.
5. Normal body temperature is _____.
6. An instrument used to measure the volume or amount of water in a test tube or beaker is called a _____ _____.
7. Prefix meaning 1/100 is _____.
8. A unit of measure equal to 6 feet is the _____.
9. The study of life and living things is called_____.
10. In the metric system the unit used to measure volume or capacity is called the _____.
11. Equal in length to 18 inches or the length of man's arm from his elbow to tip of his middle finger is the _____.
12. In the metric system the unit used to measure length is the_____.
13. The boiling points of water are _____ and _____.
14. Equal in length to $16\frac{1}{2}$ feet or $5\frac{1}{2}$ yards is the _____.
15. Prefix meaning 1/1000 is _____.
16. Degree of hotness or coldness is called_____.
17. We get the correct time today through the use of telescopes and study of the _____.
18. Galelio discovered that a _____ could be used in a clock.
19. _____ is the comparison of some object to a standard unit.
20. A _____ tells time by the shadows cast from a pointer.

B. Suggested Questions

1. Rotenone is used in our experiments to represent a) fishlife, b) pollution, c) plankton.
2. Litmus a) shows the presence of pollution, b) turns red when it is in acid, c) changes color when the temperature changes.
3. Pollution breaks the cycle of life by a) killing the micro-organisms, b) over fertilizing the water, c) turning the water dark.
4. We use a) a telescope, b) a stethoscope, c) a microscope to see micro-organisms.
5. The marine world is made up of life such as: a) insects, grass, and animals, b) algae, crabs, and dolfins, c) animals with lungs.

Read the following statements. Determine if they are correct or incorrect statements. Write true or false in the blank preceeding the statements.

____ 1. Three ways of classifying fish are by (1) their type of mouth and teeth, (2) their different kinds of scales, and (3) the body shapes.
____ 2. The bass, speckled trout, flounder, red snapper, and other fish sports fisherman like to catch are forage fish.
____ 3. The marline, sailfish, and tarpon are fish which have no teeth but have extended upper jaws.
____ 4. The american eel is born in salt water but spends its adult life in fresh water.
____ 5. The tarpon or Silver King, a member of the sardine family, carnivorous while the sardine feeds entirely on plankton.
____ 6. Green plants spread over almost the whole surface of the earth.
____ 7. The roots of water plants are usually highly developed.
____ 8. In the far arctic regions thick plant growth is called "snow plants."
____ 9. In a rain forest, trees grow very tall with thick branches at the top.
____10. Desert plants have well developed root systems.
____11. Orchids are able to obtain water from moist air.
____12. In order to live, plants need only two things, water and air.
____13. Pinnate, parallel, simple, compound or palmate are all types of leaf veins.
____14. In classifying leaves the student needs only to know the common name of the leaf.
____15. Some leaf veins run in net-like patterns.
____16. Leaves can only be grouped in one way.
____17. Leaves can only be grouped after close study under a microscope.

B. Suggested Questions (continued)

Directions: Select from the choices given the best fragment that completes the statement and place the corresponding letter to the left of the statement.

____ 1. Out of 150 eggs laid by a turtle the number that will reach maturity is approximately: a. 6; b. 8; c. 3.
____ 2. Forage fish are fish that: a. eat other fish; b. do not eat other fish.
____ 3. Fish that eat other fish are called: a. carnivorous, b. herbivorous, c. omnivorous.
____ 4. The total number of years that it takes turtles to reach maturity is: a. 3 yrs., b. 5 yrs., c. 7 yrs.
____ 5. Out of 150 turtles the number that will be females is about a. 20; b. 75; c. 30.
____ 6. Out of 100 turtles eggs, the number that will reach maturity is: a. 10; b. 8; c. 2.
____ 7. The underwater world is about: a. 3 times larger than the surface world; b. 2 times larger than the surface world; c. 5 times larger than the surface world.
____ 8. All life in the sea begins with: a. plankton; b. algae; c. fertilizer.
____ 9. The catfish is a: a. forage fish; b. carnivorous, c. neither.
____10. The shark is a: a forage fish; b. carnivorous; c. neither.

UNIT III ENERGY PROCESSES (B 20- B 32)

A. Major Concepts

1. Burning is a chemical reaction and causes a permanent change.
2. The requirements for burning are fuel, oxygen and heat.
3. CO_2 is a colorless, odorless, heavy, tasteless gas. It makes up 0.04% of the atmosphere, can be solidified at $-78^{\circ}C$. and is called dry ice. It is produced when anything containing carbon burns and when plants or animals are using energy.
4. O_2 is an odorless, tasteless, colorless gas; it makes up 21% of the atmosphere and is produced as a by product of photosynthesis.
5. Photosynthesis is the process by which green plants combine CO_2, H_2O, chlorophyll and minerals in the presence of light to produce a simple sugar which they use as food.
6. Iodine turns blue-black in the presence of starch.
7. Benedict solution (after heating) turns yellow or orange in presence of sugar.
8. Diffusion is the spreading out of molecules from a place of greater concentration to a place of lesser concentration.
9. Experiments show the effects of unnatural environmental conditions (music, light changes, radiation) on plants.
10. Seeds will germinate in light or darkness, but are green and healthier if germinated in light. Only those grown in light are able to carry on photosynthesis and continue to grow after original food in seed is used.
11. Chromatography is the separation of dissolved substances from a liquid by capillary action as the liquid is absorbed by special paper. Spreading of molecules at different rates of speed will create different colors on the paper in spectrum order. (Red-orange-yellow-green-blue-indigo-violet).

12. Chlorophyll is a green substance found in many plants and used by them in photosynthesis. It is removed by crushing the leaves and placing them in hot alcohol for several minutes.

13. Some plants contain pigment other than chlorphyll. These are always present in some plants and only in the fall or early winter in others. Red pigment may be removed by crushing the leaf and boiling it in water.

14. Carotene is one of the yellow pigments in leaves and it is soluble in acetone.

15. A catalyst is a substance which increases the speed of a chemical reaction (such as burning).

16. Sugars and starches are the main sources of energy for living things.

B. Suggested Questions from B 20 - B 32

Answer by marking T or F

___ 1. Material that will burn is called fuel.
___ 2. Carbon causes a fire to burn.
___ 3. Two of man's most important gases are carbon dioxide and oxygen.
___ 4. Carbon dioxide is found in the lower level of the atmosphere.
___ 5. Plants take in oxygen and give off carbon dioxide.
___ 6. Only a few plants contain cellulose.
___ 7. An iodine solution can be used to test for starch in plants.
___ 8. When a membrane allows for passage of materials and is able to stop some it is called permeable.
___ 9, Not all plants produce chlorophyll
___10. Plants contain only green color pigment
___11. Red and yellow color pigments are present in plants.
___12. Color pigments are masked by the large amount of chlorophyll in plants during the summer.
___13. In green plants a decrease of photosynthetic activity in the fall causes various color pigments to appear.
___14. No matter how large a potted plant becomes, the amount of soil in the pot never changes.
___15. It is possible that a plant might feel pain.
___16. The highest form of plant life is the seed bearing plants.
___17. Mushrooms contain more chlorophyll than any other plants.
___18. Some plants cannot make their own food
___19. Ashes cause a catalyst on sugar cubes allowing the sugar to burn.
___20. Sugars and starches burn in the body and so these foods should be avoided.

Unit III Energy Processes B 20 - B 32

B. Suggested Questions (continued)

Directions: Indicate which of the statements below are true or false by marking x for true and o for false to the left of the statement.

___ 1. The basic materials for a fire are a fuel, oxygen, and heat.
___ 2. Burning is a physical reaction.
___ 3. In burning, the object burned is changed and not returned to its original form.
___ 4. Carbon dioxide comprises .04% of the atmosphere by volume.
___ 5. Oxygen can be seen in the atmosphere.
___ 6. Oxygen comprises 20% of the earth's atmosphere.
___ 7. Plants take in carbon dioxide.
___ 8. Animals give off carbon dioxide.
___ 9. The green in a plant's leaf is a result of respiration.
___10. In order for food to be used in the body large amounts of oxygen are used.

From the words listed below, select the one that best completes each statement and write it in the space provided.

1. In the process of photosynthesis, plants produce the gas _____.
2. _____, or sugar, which can pass through the cell wall is a basic food used by a cell to produce energy.
3. If a membrane is _____ some materials are allowed to pass through while others are not.
4. Sunlight furnishes vast quantities of _____ for plants.
5. The green in leaves of plants is a result of _____.
6. The bright yellow in leaves is due to _____ (yellow pigment).
7. The reds in leaves are due to _____, red pigment.
8. The yellows and reds appear in leaves in the fall when the activity of _____ decreases.
9. Chlorophyll is soluble in _____ and insoluble in _____.

alcohol
anthocyanino
carotenes
chlorophyll
energy
glucose
oxygen
photosynthesis
semi-permeable
water

UNIT III ENERGY PROCESSES (B-33 - B-43)

A. Major Concepts

1. In our lungs, oxygen is inhaled and exchanged for carbon dioxide in the air sacs (alveoli). The blood transports these gases to and from the lungs.
2. The greatest volume of air that you can exhale is called your lung capacity.
3. Oxygen comprises about 1/5 or 20% of the air.
4. The more one exercises, the greater the amount of carbon dioxide produced.
5. The amount of carbon dioxide produced is a way of measuring how much food is oxidized in the cells.
6. Phenolphthalein indicates an acid (such as CO_2) by being clear; it turns pink in the presence of a base (Sodium Hydroxide).
7. Carbon dioxide is the result of burning fuels. Exercise causes us to oxidize fuels and produce CO_2.
8. Yeast cells are living plant cells which contain enzymes, or starters for chemical reactions occuring inside living cells.
9. The oxidizing of food by living cells releases energy and CO_2.
10. Non-green plants like yeast must have food in order to live.
11. During fermentation by the action of yeast on grape sugar, CO_2 and alcohol are formed.
12. The test for a simple sugar is the addition of Benedicts' solution, heat and a change from blue to an orange-red color.
13. Always add acid to water when diluting.
14. Proteins are chemical substances necessary for life.
15. The test for proteins is the addition of nitric acid and presence of a yellow color which changes to orange when ammonia is added.
16. Carbohydrates are nutrients which are called sugars and starches. They are made of elements Carbon, Hydrogen, Oxygen.
17. Carbohydrates are a rich source of energy.

18. The test for starch is the addition of iodine which turns starch a blue-black color.

19. Fats are grouped according to the different amounts of hydrogen they possess.

20. A test for fats is to put the unknown material on absorbent paper and allow it to dry (or stay a short while). If after a time, a translucent spot remains, fat was present.

21. A calorie is the amount of heat required to raise the temperature of one gram of water one degree centigrade.

22. Foods are measured in large calories - the amount of heat required to raise the temperature of one kilogram (liter) of water one degree C.

23. The body develops heat energy by chemical action on foods and thereby maintains its constant temperature (normal average) of 98.6°F.

24. The process of digestion begins in the mouth by the action of chemicals (enzymes) found in saliva.

B. Suggested Questions B-33 - B-43

Thought Questions:

1. What is meant by "lung capacity"?
2. What is an enzyme?
3. What waste materials are given off by yeast?
4. Explain the reaction of Benedict's solution when testing for sugar.
5. What test results will be determined when testing plants containing various amounts of sugar?
6. Define a protein
7. Into how many groups are carbohydrates divided?
8. Do you think white of egg would be good in your diet? Why?
9. In what foods do you find carbohydrates?
10. Name five fatty foods.

Thought Questions
page 2

11. Distinguish unsaturated fats from saturated fats.
12. What is meant by "calorie-counting"?
13. What is the adult calorie requirement?
14. What is a calorie?
15. Of what importance is saliva to digestion?
16. Where does digestion actually begin?
17. How does the mouth aid in digestion?
18. How can you test for sugar?
19. What is a simple test for protein?
20. Write a short paragraph on your test results using your saliva on starch and sugar.
21. Why do we put cigarette ashes on a sugar cube when we wish to burn the cube?
22. What foods known as fuel foods are best as sources of energy?

True or False

___ 1. Catalysts present in living organisms are called enzymes.
___ 2. Yeast plants make their own food.
___ 3. A saprophyte lives on non-living matter.
___ 4. Yeast give off a gas called oxygen.
___ 5. Glucose is one of the products of photosynthesis
___ 6. Lack of protein in the diet is not serious.
___ 7. Scientists believe that the abilities of people are based on the protein in their biological systems.
___ 8. Not all organisms contain protein.
___ 9. White of egg is an excellent source of protein.
___10. A well balanced diet should include carbohydrates.

True - False
page 2

___11. Carbohydrates are sources of fat.

___12. The amount of heat needed to bring the temperature of a liter of water to one degree centigrade is called a calorie.

___13. Poly-unsaturates are solid fats.

___14. Diets are measured in calories.

___15. A calorimeter can be used to determine the presence of fat.

___16. The first stage of digestion is in the mouth.

___17. Chewing food has one main purpose--to enjoy taste.

___18. Saliva is a chemical substance that acts in digestion.

___19. When you eat a very complicated process begins.

___20. By simple testing we can determine the sugar, starch, protein, fat and count the number of calories in food.

Completion Questions B-33 - 43

___ 1. The first stage of digestion begins in the: A. mouth; B. stomach; C. Large intestine.

___ 2. Scientists have found that chemical reactions begin in the: A. stomach; B. small intestine; C. mouth.

___ 3. Enzyme activity begins in the: A. stomach; B. intestine; C. mouth

___ 4. In the saliva can be found: A. elements; B. compounds; C. neither.

___ 5. A large calorie is the amount of heat required to raise the temperature of a liter of water: A. one degree centigrade: B. two degrees centigrade; C. three degrees centigrade

___ 6. Catalysts, when present in living things are called: A. sugars; B. enzymes C. food; D. chemicals.

___ 7. When yeasts digest sugar they produce and give off the gas: A. oxygen; B. nitrogen; C. carbon dioxide; D. hydrogen.

Complete Questions
page 2

___ 8. In this experiment, the yeasts used as food the: A. corn syrup; B. water; C. yeast solution; D. carbon dioxide.

___ 9. What else, besides carbon dioxide did the yeasts produce; A. corn sugar; B. Nitrogen; C. alcohol; D. bromthymol.

True - False Questions (cont.)

___21. The greatest volume of air that you can exhale is called your lung capacity.

___22. The more we exercise the less carbon dioxide the body produces.

___23. When we add phenolphtolein to water and it turns pink, this means that there is carbon dioxide in it.

___24. Digestion takes place in the entire digestive system.

___25. Enzymes are substances that aid in carrying out digestion.

___26. All food must not be broken down before it is used by the body.

___27. An adult needs about 3000 calories per day.

___28. The heat of the body and the chemical reactions that take place are vital in maintaining life.

UNIT IV REPRODUCTION

A. Major Concepts

1. Reproduction is the process by which plants and animals produce offspring which are similar to their parents.
2. Reproduction is necessary to the survival of the species but not the individual.
3. Development is the growth of the organs or parts of the animal or plant after fertilization.
4. Small animals produce more offspring each year than larger animals.
5. The length of time for the development depends on the size of the animal.
6. The parts of the egg are: shell, membrane, air space albumen or white, yolk, growth disc, and chalaza.
7. After 5 days incubation the outline of the chick can be seen; the heart should be beating and foods being used.
8. All animal life can be grouped on the basis of body temperature; warm-blooded animals maintain a constant body temperature; cold-blooded animals are those whose body temperature changes with their environment.
9. As the temperature drops, a cold-blooded animal's activities slow down.
10. The transfer of heat energy will be from the warm body into the foreign medium is colder than the body.
11. A brine shrimp is a salt water crustacean.
12. In sexual reproduction, an egg is the female sex cell; sperm is the male sex cell.
13. Fertilization occurs when one sperm enters one egg. Cell division and development follow.
14. Most of the body is formed in a nine day embryo; blood vessels are visible and food has been used.

Unit IV Reproduction

15. The amnion or protective membrane around the embryo can be seen, also the alantois or septic tank.
16. Brine shrimp eggs will hatch in from one to two days when placed in a salt water solution at room temperature.
17. The male part of the flower is called the stamen and consists of the filament and anther, which contains the pollen grains.
18. The female part is the pistil, composed of the stigma, style, ovary and ovules or eggs.
19. Pollination is the transfer of pollen from the anther to a stigma - this must occur before fertilization.
20. Fertilization occurs when the sperm combines with the egg in the ovary and from this the embryo seed develops.
21. Budding is a method of sexual reproduction in which a swelling on the parent's body grows into an organism that is like the parent. Sponges, hydras, and single-celled yeast plants may reproduce in this way.
22. An ovary is an egg making organ.
23. A testis is a sperm-making organ.
24. A gamete is a reproductive cell whose nucleus fuses with that of another gamete, thus starting a new organism.
25. An egg is a large, female gamete usually stationary.
26. A sperm is a small, male gamete usually able to swim.
27. Fertilization is the union of an egg and a sperm.
28. A fertilized egg is an egg whose nucleus has fused with that of a sperm.
29. A female parent is one that produces the female gamete or egg.
30. A male parent is one that produces the male gamete or sperm.
31. A hermaphrodite is an animal that has both ovaries and testes.

Unit IV Reproduction

32. Reproduction in the frog: a) Amphibians are animals which spend part of their lives in water and part on land. b) By dissection the various organs and systems are visible: A male frog has a testis near each kidney; the female has ovaries and oviducts which are often full of eggs.

33. Offspring look like their parents.

34. Sixteen day embryo: beak, toenails and scales are well-formed.

35. Nineteen day embryo: development nearly complete; chick completely fills shell.

36. There is a great variation among life forms: No two living things are exactly alike. No two people have exactly the same fingerprints.

37. Twenty-one days of development: It takes 21 days for the incubation and hatching of a chicken's egg under ideal conditions.

38. The natural wonder of birth: Nature has provided for variations in time and births for the greatest possible survival of offspring.

39. Animals, including man, have also developed successful reproductive mechanisms: A. The structure and function of uterus, amniotic sac, placenta.

    B. Characteristics of mammals: hairy skin, mammary glands, mother's nourishment of young.

40. A long long life:

    There are various ways of determining the ages of living things:

    a. The age of trees is determined by counting the growth rings on a cross section.

    b. The age of a fish is determined by counting the rings on a fish scale; two rings equals one year.

41. Seeds:

    a. After fertilization, (union of sperm and egg in flower), the seed develops a tiny plant embryo.

    b. Parts of seed include seed coat, hilum, embryo.

    c. Food (starch and sugar) are stored in seed.

Unit IV - V Reproduction

B. Suggested Questions from Unit IV

Answer the following discussion questions:

1. What is an amphibian?
2. Where are the reproductive organs of the frog located?
3. Describe the 16 day embryo.
4. Describe the 19 day embryo.

Read the statement. Decide whether it is true or false. Write true or false in the blank.

___ 1. The male frog produces sperm cells which pass through the body to fertilize the egg in the water.

___ 2. The frogs' outer eyelid protects its eyes under water.

___ 3. The frog has an opening just behind the eye which is like an ear.

___ 4. A frog produces a large number of eggs.

___ 5. The baby frog is very much like its parents.

___ 6. The grasshoppers pass through a larva or pupa stage in their growth.

___ 7. Baby birds are among those animals that are much like their parents at birth.

___ 8. Mammals unlike insects, toads, and reptiles remain inside the body of the mother during its earliest growth.

___ 9. Every mammal starts to grow from an egg.

___10. Reptiles, snakes, hatch from eggs just as birds do.

B. Questions

1. Why do we put the embryo in luke warm water?
2. Why did some of the eggs not hatch?
3. Mamma Bear supposedly sleeps through the first _____ days of motherhood. (10, 20, 30, 40, 50) (Circle the right response).
4. Who takes care of the baby bear during this time?
5. How many off-springs will the armadillo always have?

6. True-false questions

___ a. All individuals are exactly alike.

___ b. All plants are exactly alike.

___ c. All individuals are different.

___ d. All plants are different.

___ e. When a porcupine in born his quills are bristling needle-sharp.

___ f. Timing is very important in the birth processes.

___ g. Nature's time clock saves some species from extinction.

___ h. Some wild creatures can determine whether the off-spring will be a boy or girl.

UNIT V GENETICS

A. Concepts

1. Probability is the mathematical science which deals with predicting the chances that a certain event will happen.
2. Probability is expressed mathematically - usually as a fraction. Numerator is times a certain event is expected. Denominator is the number of trials. Reduce the fraction to lowest terms.
3. The larger the number of trials the closer to expected ratios the actual ratios obtained should be.
4. The probability that two different events will occur at the same time is equal to the product of their occurring separately.
5. Chromosomes occur in pairs. In order for objects to be paired, they must have something in common.
6. Each chromosomes contains many units which cause development of different characteristics. These individual units of inheritance are called genes. Genes, like chromosomes, occur in pairs. If a pair of genes is alike, they are "pure". If the pair is not alike they are "hybrid."
7. The strong gene is called dominant. The weak gene is called recessive. The hybrid looks the same as the pure dominant.
8. The actual genetic make up is the genotype. The way the thing looks is the phenotype.
9. In gathering research data, the scientist must gather as much information as possible from as many different sources as possible before reaching a final conclusion.

B. Suggested Questions:

1. A man has 10 pairs of black socks, 7 pairs of brown socks and 1 pair of white socks. They are not attached in pairs. One night the lights went out, and he had to find a pair of socks in the dark. How many socks did he have to take from the drawer to be certain of having a pair of the same color?
2. Suppose you have a bag containing a red, a blue, and a yellow marble. If you pick a marble out of the bag without looking, what are the chances that it will be red?
3. Suppose that you had a bag of marbles that had two black marbles and two white marbles. What are the chances of picking two black marbles from the bag without looking?
4. What is the chance of turning up two heads if we toss two coins?
5. What is the probability that in a family of two children that they both will be boys?
6. What is the probability that in a family of two children that one will be a boy and one a girl?
7. Tom has 250 blue marbles and 250 white marbles in one bag. In a second bag he has the same number of blue and white marbles.
   a. What are Tom's chances of picking a white marble from each bag at the same time?
   b. What are Tom's chances of picking a blue marble from each bag at the same time?
   c. What are his chances of picking a blue marble from one of the bags and a white marble from the other at the same time?
8. Joe has 75 white marbles in the first bag and 75 blue marbles in the second bag.
   a. What are Joe's chances of picking a white marble from the first bag at the same time as he pick a blue marble from the second time?

9. Sue has 100 raspberry gumdrops in one sack. In a second sack she has 50 grape gumdrops and 50 raspberry gumdrops.

   a. What are Sue's chances of drawing a raspberry gumdrop from each sack at the same time?

   b. What are Sue's chances of drawing a grape gumdrop from each sack at the same time?

   c. What are Sue's chances of drawing a raspberry gumdrop from one of the sacks and a grape gumdrop from the other?

A. Directions: Select from the choices given the best fragment that completes the statement and place the corresponding letter to the left of the statement.

___ 1. Taste sensitivity to PTC has been an important characteristic in investigation of population genetics and to: A. racial research; B. biological research C. plant research.

___ 2. The ability to test PTC is: A. acquired; B. inherited; C. neither.

___ 3. Tast dimorphism in sensitivity appears to hinge on: A. one gene; B. two genes; C. three genes.

___ 4. There are in the U.S. seven non-tasters to: A. nine tasters; B. five tasters; C. ten tasters.

___ 5. Chlorophyll is a vital pigment in: A. plants; B. animals; C. neither.

B. Directions: indicate which of the below statements are true or false by marking x for true and o for false to the left of the statements.

___ 6. Individuals having the recessive gene homosygously are non-tasters.

___ 7. Unless PTC the chemical has dissolved in the taster's own saliva it is tasteless.

___ 8. Sodium bensoate is a substance which can be tasted by all people.

___ 9. Tasters are dominant.

___10. A non-taster cannot have a gene for tasting.

___11. Inherited traits cannot be studied in population.

___12. Sunlight is used in chlorophyll production.

___13. Artificial light cannot be used in chlorophyll production.

___14. Chlorophyll is a vital pigment in plants.

___15. Plants which are albino will not live long because they are unable to make food.

DISCUS

Materials for Class of 30 in Groups of Three
Life Science

ITEM	QTY	COST
Supplies		
Candle, medium size, Each	12	.60
Cardboard, 2" x 2", Each	24	N/C
Cellophane tubing, dialysis, Foot	12	.60
Clips, paper, large, Box	12	3.00
Clips, paper, small, Box	24	2.40
Corn syrup, Bottle	1	.30
Cotton, roll, Box	1	.90
Eggs, brine shrimp, Pkg.	1	.50
Eggs, chicken, fertile, Dozen	5	5.00
Foil, aluminum, Roll	1	1.00
Forceps, Dozen	3	5.91
Frog, preserved, Dozen	1	5.50
Glue, white, small, 4 oz. Bottle	12	3.00
Ice, cubes, Pound	12	.60
Ink, various colored, Bottle	4	1.00
Labels, gummed, Box	1	.25
Lens, hand, 10 X	12	7.68
Litmus paper, blue, Vial	6	.90
Litmus paper, red, Vial	6	.90
Matches, wood, Box	1	.25
Paint, spray, large, Can	4	5.00
Paper, Ditto, 8½ x 11, Ream	1	.70

ITEM	QTY	COST
Supplies		
Paper, filter, 125 mm, Box	2	1.00
Pan, small, Each	12	6.00
Pencil, wax, Each	12	1.20
Pin, straight, Box	1	1.00
Pipe cleaner, green and white, 6", Each	120	5.00
Pneumatic trough, plastic, Each	12	44.92
PTC paper, Package	12	1.20
Razor blade, single edge, Each	12	1.20
Ruler, 6", metric, plastic, Each	12	2.40
Ruler, 12", 3 hole, plastic	36	3.60
Salt, table, Box	1	.20
Sand, fine, builders, Pound	6	.60
Scissors, pointed, 5", Each	12	2.81
Seeds, navy bean, Bag	1	.25
Seeds, pinto bean, Bag	1	.25
Seeds, tobacco, irridated, Set	1	3.50
Seeds, tobacco, non-irridated, Set	1	1.00
Spatula, spoon, Each	12	8.52
Spinach, frozen, Package	1	.25
Stopper, rubber, #3, 1 hole, Each	12	.60
Stopper, rubber, #6½, 2 hole, Each	12	.60
Stopper, rubber, #7, solid, Each	48	2.20
Straw, soda, Box	4	1.00
String, #6, Spool or Cone	1	1.00

ITEM	QTY	COST
Supplies		
Sugar. cube, Box	1	.50
Tape. masking 1", Roll	1	.30
Thermometer, dual scale, Each	12	13.20
Thistle top, Each	12	3.34
Tongs. Each	12	12.60
Tubing, rubber, 2' length, Each	12	2.20
Weights, metal. Each	12	1.44
Wire. large diameter, Foot	48	1.00
Wire. small diameter, 10" long, Each	24	.25
Wood. splints. Bundle	1	.85
Yeast. dry. Package	1	.15
GLASSWARE		
Beaker, 150 ml, Each	12	3.72
Beaker. 250 ml, Each	24	7.44
Beaker. 600 ml, Each	12	5.52
Bottle. collecting, Dozen	4	3.20
Bottle. specimen. 8 oz. Dozen	4	7.20
Culture tube, Each	24	1.20
Cylinder, graduated, 100 ml. Each	12	19.56
Dish. evaporating, Each	12	11.66
Dish. petri, 20 mm, Each	12	6.72
Flask, erlenmeyer, 250 ml, Each	24	9.84
Funnel, short stem, 75 mm, Each	12	8.04
Glass squares, 2" x 2", Dozen	4	2.60

ITEM	QTY	COST
Supplies		
Jars. baby food, Each	24	N/C
Jars, gallon, Each	24	N/C
Lamp, Alcohol, Each	12	5.40
Medicine dropper. Each	12	.60
Mortar and Pestle. Each	12	17.16
Slide. microscope	60	2.00
Stirring rod, Pound	1	.70
Test tube, 200 mm x 150 mm, Each	40	3.24
Tubing, Glass, 6 mm, Pound	2	1.40
CHEMICALS		
Alcohol. ethyl, Gallon	5	12.35
Acetone, Pint	1	.71
Acetic acid, Pint	1	.35
Ammonium hydroxide, Pint	1	1.70
Bromthymol blue. 100 ml. Bottle	1	1.30
Baking soda, Box	3	.45
Benedicts solution, Quart	1	1.60
Carbon tetrachloride, Gallon	1	2.75
Glucose. pint, Bottle	2	.70
Hydrochloric acid, 3N, Pint	1	1.89
Hydrogen Peroxide. 30%, Pint	1	1.78
Iodine. solution. 1N. Pint	1	2.00
Nitric acid. concentrated, Pint	1	2.37
Phenolphthalein, solution 1%, Pint	2	4.18

ITEM	QTY	COST
Supplies		
Rotenone, 5% Emulsifiable, ounce	8	N/C
Sodium hydroxide, 1N solution, 500 ml	1	1.70
Starch. solution, Quart	1	.35
OTHER		
Incubator. egg, 50 egg capacity, Each	1	29.00
Ring stand, w/ring & clamp, Each	12	48.00
Stethoscope, Each	12	48.00
Test tube support, 6 holes, Each	12	13.92
	TOTAL	$467.42