Laboratory Experience Units in Biology

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Radiant Energy and Food Production in Plants

Principle to Be Developed

The ultimate source of all energy is sunlight and this energy is bound into food materials during photosynthesis.

Activities in the Unit:

A. Role of Sunlight in Photosynthesis
B. Storage of Food in Seed Leaves
C. Release of Stored Energy During Germination of Seeds

Procedures

A. *Role of Sunlight in Photosynthesis.*—Obtain two geranium, Coleus, or fuchsia plants and place them in a dark place for two days. The plants may be placed in a closet, or under a paper box. After two days, put one plant in direct sunlight for several hours. Remove two leaves from the plant which has been placed in direct sunlight, and two leaves from the plant which has been in total darkness. Nick with a razor, or otherwise mark those leaves which had been in sunlight, and immerse the four leaves in boiling water for two minutes to kill the leaves. Remove the leaves and put them into a Petri dish containing hot wood alcohol (rubbing alcohol). Let the leaves remain in the alcohol for ten minutes, or until all traces of green coloring in the leaf have disappeared. [Heat the wood alcohol in a narrow-mouthed pyrex flask, then pour the alcohol into the Petri dish.] Cool ditto fluid has been found to be satisfactory for removing the chlorophyll, however the leaf has to remain in the fluid for a few hours.

Remove the leaves from the alcohol and put them into a solution of iodine in a Petri dish [Iodine Solution: 1 gram of potassium iodide and ¼ gram iodine in 10 cubic centimeters of water. Mix the sodium and potassium iodide thoroughly, and add water to make a total of 250 cubic centimeters of solution]. Note the reaction of the leaves to the iodine solution. Try some of this iodine solution on some laundry starch, on a piece of potato, and on a piece of bread. Record the reaction of iodine with starch.

B. *Storage of Food in Seed Leaves.*—Fill a large drinking glass half-full with dry lima beans, and cover them with water overnight. The next day, split open the seeds, and put several drops of iodine solution on each half of the seed, as shown in Diagram 7. Record the changes that take place and determine whether or not the change is prominent over all parts of the surface of the lima bean seed leaves.

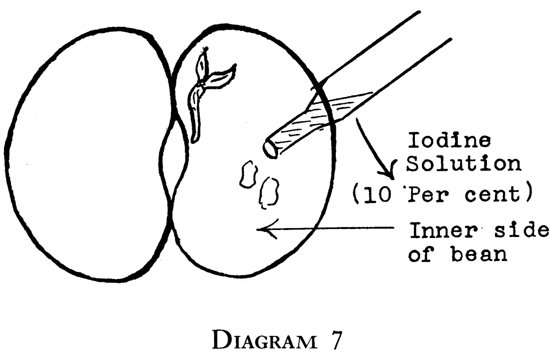

DIAGRAM 7

C. *Release of Stored Energy During the Germination of Seeds.*—Fill a large drinking glass half-full with dry, packaged lima bean seeds, and cover them with water overnight. Bore a hole one-quarter of an inch into the center of a cork of a thermos bottle (one pint capacity). Insert a Fahrenheit thermometer into the cork so that the bulb of the thermometer reaches about halfway into the bottle. Put the seeds into the thermos bottle, add about a third of a cup of water, and replace the cork. Seal the cork to the bottle with plastic clay, and seal around the thermometer in order to prevent heat from escaping from the bottle, as shown in Diagram 8.

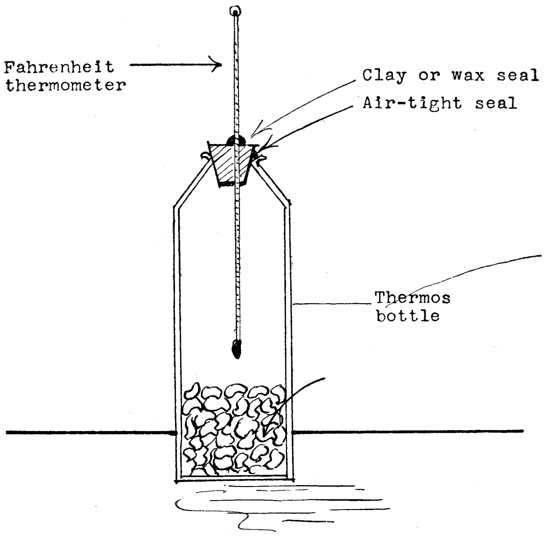

DIAGRAM 8

Keep the bottle out of direct sunlight or other heat sources. Record the temperature in the inside of the bottle, and repeat the reading after fifteen minutes to obtain a correct reading of the temperature inside the bottle. Repeat readings during the second, third, and fourth days. Keep a record of the temperature inside the bottle during the time from onset of germination until the fifth day, and construct a graph to show the changes which have taken place.

Appended Questions

1. In the experiment on photosynthesis, of what value was the "control plant"?
2. What was the purpose of removing the green coloring matter in the leaves with alcohol?
3. What can be said with regard to the value of using iodine solution as an indicator of certain food materials?
4. What are some probable reasons for the results in the activity concerned with the release of energy during seed germination? What was the original source of this energy?
5. Where does the plant get food material during its growth from a seed to a seedling?

Outcomes

Specific Understandings

1. Energy from the sun is necessary for food production by a green leaf.
2. A seedling obtains its food supply from food stored in the seed leaves, or cotyledons.
3. Heat energy is released during seed germination since the food is oxidized, thereby releasing bound heat energy.
4. The energy stored in a seed leaf has its origin in the sunlight used during food production.

The Transportation System in the Human Body

Principle to be developed

In man, food and oxygen are carried to all parts of the body through a system of blood circulation.

Activities in the Unit:

A. Viewing of the film *The Heart and Circulation*
B. Blood Circulation in Capillaries
C. Pumping Action of the Heart in the Frog
D. Study of a Beef Heart and Model of the Human Heart
E. Heart Beat and Arterial Pulse (Human)
F. Effect of Exercise on the Rate of the Heart Beat

Procedures

A. *Viewing of the Film* The Heart and Circulation.—To the instructor: Students will be asked to observe the film on the heart and circulation. This film will be used to introduce the subject of the transportation system in the human body for the following reasons: (1) Movement of the heart can be introduced at this time to all students since the film captures motion [students will observe the beating of the heart of an animal in further study], (2) the motion picture through its animated drawings can present a process which is difficult to perceive about the human heart in the laboratory, and (3) the film makes it possible for the group as a whole to participate in a common experience which should prove helpful in further studies about the human heart.

Prior to the showing of the film, the instructor should discuss the general aspect of the circulatory system, pointing out the principal functions of this system. The action of the heart as a pumping station, and the meaning of a closed system of circulation should be emphasized. The students need to be oriented with respect to some of the content which they are to observe, hence the use of a model of the human heart, a chart, or reference to drawings during a brief talk about the circulatory system should prove most helpful at this time. Students should be instructed to pay special attention to the following during the showing of the film:

1. The rhythmic beating of the heart in the experimental animals.
2. The function of the heart valves.
3. Path of blood through the heart.
4. The origin of the pulse beat.
5. The nature of the different kinds of blood vessels comprising the transportation system in man.

B. *Blood Circulation in Capillaries*—Wrap a small aquarium fish or tadpole in moist cotton, exposing the tail of the animal. Put the animal on a piece of glass about four by five inches, as shown in Diagram 9.

Examine the thin end of the tail with a low power of a microscope, and look for tiny blood vessels through which blood is flowing. Keep in mind that both the size of the blood vessels and the speed of flow of blood in these vessels are exaggerated when viewed with a microscope. Look for blood vessels of different sizes and compare the flow of blood in these vessels.

In the event fish are not available, an anaesthetized frog can be used. Cut out a hole equal to the size of the opening in the stage of the microscope, in a piece of cardboard 4 x 8 inches. Pin the outstretched web of the frog's leg over the aperture in the cardboard and superimpose this aperture over that in the stage, as shown in Diagram 10.

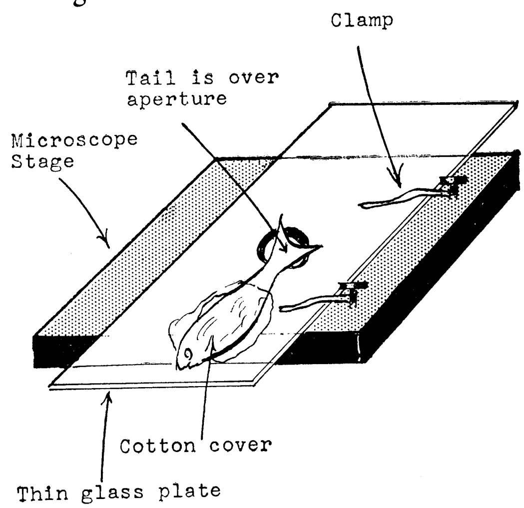

DIAGRAM 9

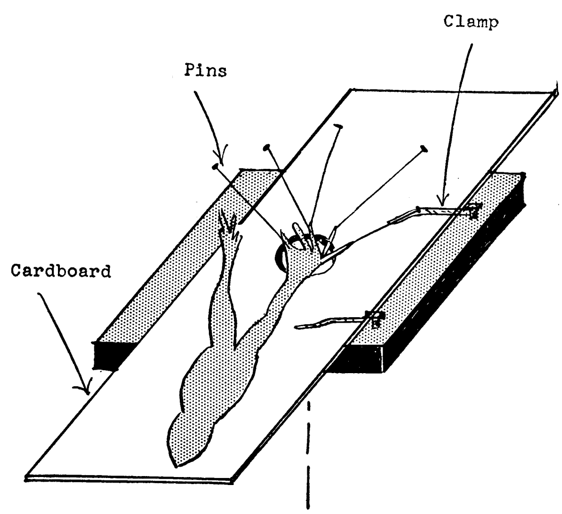

DIAGRAM 10

Examine the web for tiny blood vessels in the thin membraneous portion of the web. Compare the speed of flow of blood in the larger vessels in the web with that in the much smaller blood vessels. As in the fishtail, both the speed of blood circulation and the size of the blood vessels are greatly exaggerated when observed by a microscope.

C. *Pumping Action of the Heart in the Frog*—Examine a demonstration of an anaesthetized or pitched frog showing an exposed heart. Note that the tissues over the heart have been removed with scissors and/or scalpel, and that the incision had to be made slightly to the left because of the sternum, or bone in the thoracic cavity. This bone had to be cut in order to expose the heart.

Observe the contraction of the heart, and ascertain by observation which part of the heart appears to contract with greater force. Record the rate of the heart beat in terms of the number of beats per minute, then pour warm water over the heart and record the rate of the heart beat again. Pour a few drops of ice water over the heart and observe the effect of cooling the heart.

D. *Study of a Beef Heart and Model of the Human Heart*—Examine a beef heart which has been cut longitudinally by your instructor to expose the chambers of the heart. Examine as follows:

1. Find the large, rather heavy-walled vessel which emerges from the left side of the heart. Compare the thickness of this vessel with the large blood vessels which lead into the upper right chamber of the heart.
2. Compare the walls of the two upper chambers of the heart with the walls of the lower chambers of the heart.
3. Examine the valves of vessels carrying blood away from the heart (vessels carrying blood away from both of the lower chambers of the heart), and the valves between the upper and lower chambers on both sides of the beef heart.
4. Examine the wall of muscle which divides both sides of the heart. Determine whether or not it would be possible for blood to go from the right side of the heart to the left side without going out of the heart.
5. Examine the model of a human heart and compare your observations of the beef heart with the structure of the human heart, using a model of the human heart.

E. *Heart Beat and Arterial Pulse (Human)*—Find your pulse by placing your forefinger and the two adjoining fingers on your left wrist at the points indicated in Drawing 11.

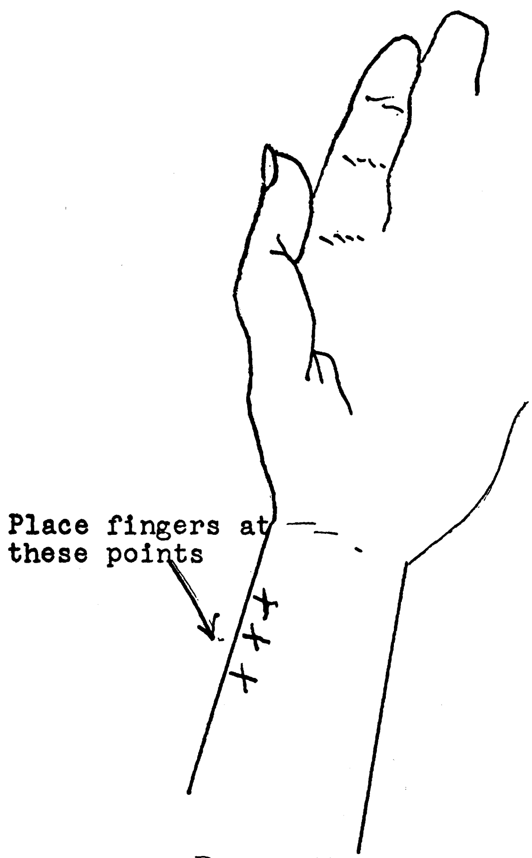

DIAGRAM 11

Now try to find your partner's pulse in the same manner as you have found your pulse. Keeping one hand on your partner's pulse, find your partner's heart beat using a stethoscope. Does the heart beat and the pulse beat register at the same instant?

Determine the rate of the heart beat per minute, by taking three readings and calculating the average heart rate. Determine the rate of the pulse beat and compare this rate with the heart rate.

F. *Effect of Exercise on the Rate of the Heart Beat*—Ask your partner to sit down and rest for a few minutes. Calculate the average pulse beat per minute while at rest. Next, ask your partner to jump alternately on each foot twenty-five times. Immediately after the exercise, tell your partner to sit down and proceed as follows:

1. Immediately take the pulse and count the number of beats for 30 seconds. Record the number of beats but be sure to keep your fingers on the pulse.
2. Rest for 30 seconds.
3. Take the pulse for another 30 seconds. This constitutes the one-minute reading. Record the pulse beat.
4. Rest for 30 seconds.
5. Take the pulse for another 30 seconds. This constitutes the two-minute reading. Record the pulse beat.
   Continue taking 30-second readings until the pulse rate per minute approximates the pulse rate while at rest.

Record your observations on the blackboard, indicating the pulse rate at rest, the pulse immediately after exercise, and the pulse rate at one-minute intervals subsequent to the reading after exercise. Calculate the average pulse per minute for your class. What is the average number of minutes required for the pulse to return to the rate at rest after exercise?

Appended Questions

1. Assume that you are a witness to an accident in which the individual has just cut his arm. The blood is spurting out from a vessel, and you are faced with the problem of helping to stop the flow of this blood. Is the blood coming out of a vein or artery, and where would you plan to apply pressure? What reasons would you offer in defense of your intended action?
2. Blood is flowing from a cut in the forearm in an even flow. How would you attempt to stop the flow of this blood? Would you apply pressure above or below the location of the cut on the arm? What reasons would you give in support of your action?
3. What part of the heart structure indicates that blood must leave the heart before it can go from the right side of the heart to the left side? Where does the blood go in the meantime?
4. In what ways would you consider the human heart to be like the beef heart?
5. Explain the formation or origin of the arterial pulse, and its ultimate disappearance in the veins.
6. Why is it likely to be expected that the musculature of the lower chambers of the heart should be greater than that of the chambers of the upper part of the heart?
7. Explain the action of the valves of the heart. What is referred to as a "heart murmur"?

Outcomes

Specific Understandings

1. The blood is sent out into a system of blood vessels under the pressure of the contracting muscles of the heart.
2. The heart is a muscular organ capable of exerting strong and continuous pressure.
3. Blood courses through a closed system of blood vessels.
4. The flow of blood in arteries is under direct influence of the beating heart and the elasticity of the walls of arteries, hence the spurting movement of blood in arteries. As blood continues into capillaries and then into the veins, the pressure forcing the blood to move away from the heart is lost.
5. The pulse beat in the wrist reflects the beating of the heart.
6. Valves located in strategic places in the heart and in certain blood vessels helps to channel blood in specific directions.

Transmission and Distribution of Bacteria

Principle to Be Developed

Disease germs may be spread from one place to another through different media; dust, liquids such as sputum, and droplets which are given off during coughing and sneezing. In some instances, food is a carrier of disease germs.

Activities in the Unit:

A. Preparation of sterile media, sterile swabs, and sterile glassware
B. How Microbes Are Carried from One Place to Another: Dust, Personal Objects, and Droplets.
C. Microscopic Study of Bacteria
D. Food as a Carrier of Bacteria

A. *Preparation of Sterile Media, Sterile Swabs, and Sterile Glassware—*

1. *Sterile media.* Obtain nutrient agar which is available in powder form [the agar will be supplied by your instructor who will procure the agar from a biological supply house], and follow directions on the bottle to make 300 cubic centimeters of agar medium. Dissolve the agar in 200 cc. of water in a flask, and bring the solution to a boil. Allow the solution to cool, but not to the point where the agar begins to gel. Pour the agar into a 500 cc. graduated cylinder, or into a container so marked as to indicate the level at which 300 cc. would be contained in the container. If a large graduated cylinder is not available use a small one, pouring 300 cc. of water into a container and indicating the 300 cc.-level with adhesive tape. Add water to the agar to make 300 cc. of medium, and pour off 150 cc. of the agar into two smaller flasks. The agar is ready for sterilization.
2. *Sterile swabs.* Twist some absorbent cotton about the thicker ends of a toothpick, preparing at least a dozen of such swabs. Put the swabs into a test tube and plug the tube with cotton so that the cotton plug extends about one inch into the tube and one inch out of the tube for easy handling. The swabs are ready for sterilization.
3. *Sterilized Petri dishes.* Wash and dry a dozen Petri dishes. In the event the dishes are to be sterilized at home in an oven, wrap each dish in newspaper and secure the paper to the dish with string. Use a bow knot to facilitate the removal of the paper from the plate at the time of pouring the agar plates.
4. *Sterilization process.* Put a cotton plug into the flasks containing the agar solution. Put the flasks, swabs, and glassware into an autoclave for 20 minutes at 15 pounds pressure. Your instructor will help you to get this material sterilized for you, or you can have this done for you at your nearest health laboratory. Should this form of sterilization be impossible, then put all materials into an oven for 45 to 60 minutes at a temperature of about 360 degrees Fahrenheit.
5. *Pouring agar plates.* Remove the cotton plug from one flask of agar, flame the lip of the flask over a flame, and proceed as follows:
   a. Raise the cover of a Petri dish and pour in enough agar to form a layer of agar about one-quarter of an inch thick, as shown in Diagram 25.

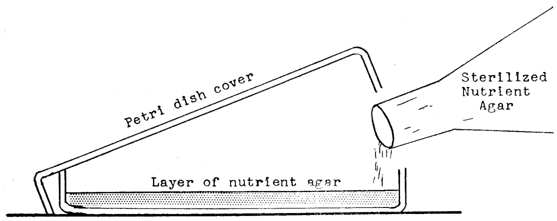

DIAGRAM 25

   b. Replace the cover and stir the entire dish in a clockwise rotation to remove all air bubbles. Stir gently enough so that agar will not spill over the lip of the dish.
   c. Let the agar harden, then invert the dish with its cover and put the agar plates into the refrigerator.
   d. Prepare a dozen agar plates this way.

B. *How Microbes Are Carried from One Place to Another: Dust, Personal Objects, and Droplets*—Inoculate agar plates as follows:

1. Remove the cover of one agar plate for thirty minutes. Replace the cover and label this plate "Exposed to Air." Use a glass marking pencil or gummed labels.
2. Rub a dust cloth over some dusty furniture. Remove the cover of one agar plate and shake the dust over the agar. Label this plate "Exposed to Dust."
3. Rub a pocket comb gently over the agar in a Petri dish, and label this agar plate "Exposed to Personal Item—Comb."
4. Put a penny on the agar, remove the penny and label "Handled Objects—Money."
5. Remove some of the dirt from underneath the fingernail and "roll" the dirt

over the agar. Label this plate "Dirt from Fingernails."

6. Touch the agar with a *soiled* handkerchief, and label the agar plate "Nasal Secretions."
7. Let two or three drops of tap water fall on the agar and label this agar plate "Exposed to Tap Water."

Set two agar plates aside without inoculating these plates and label them "Control Plates." Keep all agar plates at room temperature and examine them at the end of 24 hours and again at 48 hours. Count the number of colonies of bacteria (small bodies or aggregates of bacteria which will appear usually as white to gray bodies) and record the number of colonies in each plate which has been inoculated as well as the "control" plates.

C. *Microscopic Study of Bacteria*—To be sure that the colonies on the agar plates are bacteria, and to see bacteria with the aid of a microscope, obtain the following materials:

1. Several microscope slides.
2. A wire loop which is to be constructed as shown in Diagram 21.
3. A solution of gentian or crystal violet (to be supplied by the instructor).
4. A glass dish, or metal pan approximately 5 inches wide, 8 inches long, and 3-4 inches deep.
5. Two pieces of glass tubing 12 inches long, and one piece 6 inches long.
6. A small metal file.
7. A drinking glass.

Prepare a wire loop as follows: Heat one end of a piece of glass tubing twelve inches long until it is red hot and in a molten state. Insert a piece of nickel, nickel silver (electric-resistance wire), or steel wire about four inches long into the tip of the glass tube, as shown in Diagram 21.

Preparing and staining slides of bacteria. Set up a staining dish as shown in Diagram 27. To prepare the cross pieces of glass tubing it will be necessary to cut glass tubing. Measure off 3 inches on the glass tube and scratch into the glass at this point with the edge of a metal file. Take the tube in both hands, holding the tube with the side which has been scratched away from you. Press forward and crack the tube at the point where the scratch is located. The tube will break easily, and without much force.

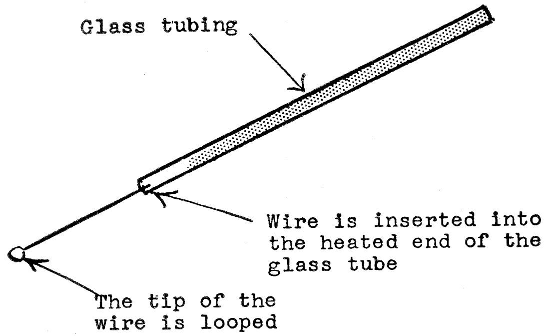

DIAGRAM 21

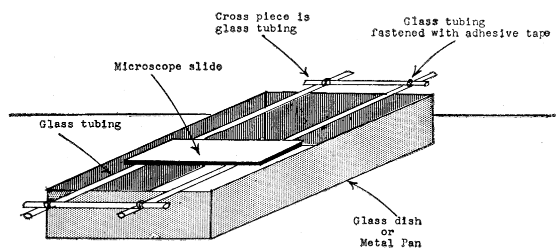

DIAGRAM 27

Put a drop of sterile water, or tap water in the center of a microscope slide. Put the end of your wire loop into the flame until it becomes red hot, in order to kill any organisms which may be present on the loop. Let the wire cool off, then pick off a single colony of bacteria from an agar culture plate of any of the first six agar plates which you had inoculated in Activity "B" of this experience unit. Mix the bacteria with the water to form a film about one-half inch in diameter. Flame the slide gently to speed up the drying of the film. This heating also helps to affix the film to the slide so that the bacteria will not wash off during the staining process. Put the slide on the glass holder over the dish, and add enough gentian or crystal violet to cover the film on the slide. Stain the bacteria for two minutes, then wash the dye away from the slide with water. Blot the film against a white absorbent paper such as mimeograph paper or filter paper. Put a drop or two of immersion oil, or mineral oil on the slide and examine the film under the low and high powers of your microscope.

D. *Food as a Carrier of Bacteria.*—Sandpaper a spot on the skin of an unspoiled orange. Touch this spot to the skin of an orange showing considerable decay in this area. Let the unspoiled orange remain at room temperature for several days. To direct immediate attention to the spot which is rubbed against a spoiled orange, draw a circle around this area with a glass marking pencil or with ink.

Obtain two apples, one which appears unspoiled, the other showing a definite area of spoilage. Sterilize a fork by immersing the forked end into 70 per cent alcohol, or into commercial rubbing alcohol. Plunge the fork into the decaying portion of the apple, then stab an unspoiled apple once or twice. Let the unspoiled apple remain at room temperature for a few days. Observe the apple each day, and record the changes that are taking place.

Appended Questions

1. Situation: During the beginning of the school year, one third grade teacher asked each child to bring a large box of cleansing tissues (kleenex) for their use during the school year.
   Question: What necessary precaution has this teacher taken in this class? What may have been the reasons why this teacher has taken this action?
2. Situation: A child is trying to help with the cleaning in the home and starts to sweep the rooms, including sweeping the rugs and in general stirring considerable dust into the air.
   Question: What possible menace is this situation to the child and to others in the home? Base your reasoning on your experience in this unit.
3. Situation: A public washroom maintains paper towels in a dispenser for public use.
   Question: Discuss the merits of the use of paper towels versus usage of a single cloth towel which may be changed from time to time by a caretaker.
4. Situation: A mother suffering from nasopharyngitis decides to feed her infant. Before coming near to her child, she decides to put on a sterile face mask.
   Question: Of what value are these precautions to the child? How can a sterilized mask be of help in this situation?
5. Situation: It was found that one apple in a bag of apples shows signs of decay.
   Question: What precaution should be taken promptly? Upon what reasons would you base your actions?

Outcomes

Specific Understandings

1. Microbes may be spread from one infected area of one object to another object through contact.
2. Microbes may be spread through dust particles which act as a vehicle for bacteria.
3. Bacteria may be carried through human nasal secretions, or tiny droplets emitted during coughing or sneezing.
4. Bacteria are carried on personal objects such as combs.
5. Certain parts of the body house bacteria; bacteria may be found abundantly under the fingernails.
6. Certain household duties involving uncontrolled cleaning, may enhance the spread of disease throughout the household.
7. Certain household practices may involve the use of articles which may foster the spread of bacteria.
8. Certain household and community practices may affect the carriage of microbes from one place or person to another place or person.

Discovery of a new antibiotic which may help combat a variety of crop diseases was announced by Dr. Odette L. Shotwell of the United States Department of Agriculture. He reported that the compound, named Duramycin, was obtained from an antibiotic mixture which is effective against several maladies afflicting beans, wheat and bluegrass. The new antibiotic was named Duramycin because it has proved to be very stable against heat.