Are Plastic Bags Permeable?

Problem: Will the polyethylene membrane allow iodine to cross the membrane? Will the polyethylene membrane allow starch to cross the membrane? Your plastic bag is the membrane.

Hypothesis:

Experiment:

Materials: 400 mL Beaker  Resealable Sandwich Bags
Starch Solution  Graduated Cylinder
Iodine Solution

Methods:

1. Collect all of your materials.
2. Decide if you want the iodine solution to go in the plastic bag or in the beaker.
3. DO NOT ALLOW THE STARCH AND IODINE SOLUTIONS TO MIX THEY WILL GIVE A BLACK COLOR IF THEY DO.

Beaker
a) Put the chosen solution in the beaker and leave it alone.

Bag
a) Put the chosen solution in the plastic bag.
b) Seal the bag tightly.
c) Wash the bag off to get any excess mixture off the bag.

4. Place the bag carefully inside the beaker, seal end up.
5. Place the beaker in a safe, undisturbed place for at least thirty minutes.
6. Look at the beaker and plastic bag after thirty minutes to see what happened.

Independent Variable:
Dependent Variable:

Controls:

Results.
1. Did the iodine move through your membrane? How do you know?
2. Did the starch molecules move through your membrane? How do you know?
3. How do you know that your plastic bag is "permeable?"
4. What can you infer about the size of the iodine molecule as compared to the size of the starch molecule by the movement across the membrane in this experiment?
5. What type of permeable membrane is the plastic bag? How do you know?

Conclusions:
Osmosis & Diffusion in an Egg

Objective: In this investigation, you will use a fresh hen's egg to determine what happens during osmosis & diffusion across membranes.

Materials: (per lab group) 1-2 fresh hen eggs in their shells, masking tape & marker, distilled water, clear sugar syrup (Karo, for example), vinegar, 500 mL beaker, electronic balance, paper towels, paper, pencil

*Record your responses in your notebook.

Procedure:
Day 1
1. Label the beaker with your lab group name.
2. Mass the egg with the electronic balance & record in the data table.
3. Carefully place the raw egg into the beaker & cover the egg with 250mL of vinegar.
4. Predict how the vinegar will affect the egg.
5. Allow the jar to sit for 24 to 48 hours.

Day 2
1. Carefully remove the egg to a paper towel & pat it dry.
2. Record the appearance of your egg in your data table.
3. Answer question 1 under Questions & Conclusion.
5. Measure the amount of vinegar remaining in the beaker. Record.
6. Answer question 2, parts a – c.
7. Clean the beaker.
8. Carefully place the egg into the beaker & cover the egg with 250mL of clear syrup.
9. Predict how the syrup will affect the egg.
10. Allow the egg to sit in the syrup for 24 hours.

Day 3
1. Carefully remove the egg & rinse off the excess syrup under slow running water. Place on paper towel & pat it dry.
2. Record the appearance of your egg in your data table.
4. Measure the amount of syrup remaining in the beaker. Record.
5. Answer question 3, parts a – c.
6. Clean the beaker.
7. Carefully place the egg into the beaker & cover the egg with 250mL of distilled water.
8. Predict how the distilled water will affect the egg.
9. Allow it to sit in the distilled water for 24 hours.
Day 4
1. Carefully remove the egg to a paper towel & pat it dry.
2. Record appearance of your egg in your data table.
4. Measure the amount of distilled water remaining in the beaker. Record.
5. Answer question 4, parts a – c.
6. Clean up your work area & put away all lab equipment.

Data:

<table>
<thead>
<tr>
<th>Beaker</th>
<th>RESULTS OF DIFFUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount of liquid</td>
</tr>
<tr>
<td></td>
<td>present when egg was</td>
</tr>
<tr>
<td>VINEGAR</td>
<td>put in</td>
</tr>
<tr>
<td>SYRUP</td>
<td></td>
</tr>
<tr>
<td>WATER</td>
<td></td>
</tr>
</tbody>
</table>

Questions & Conclusion:
1. Vinegar is made of acetic acid & water. Explain how it was able to remove the calcium shell.
2. (a) What happened to the size of the egg after remaining in vinegar?
   (b) Was there more or less liquid left in the jar?
   (c) Did water move into or out of the egg? Why?
3. (a) What happened to the size of the egg after remaining in syrup?
   (b) Was there more or less liquid left in the jar?
   (c) Did water move into or out of the egg? Why?
4. (a) What happened to the size of the egg after remaining in distilled water?
   (b) Was there more or less liquid left in the jar?
   (c) Did water move into or out of the egg? Why?
5. Was the egg larger after remaining in water or vinegar? Why?
6. Based on your results, which liquid(s) were hypotonic to the egg? Explain.
7. Based on your results, which liquid(s) were hypertonic to the egg? Explain.
8. Why are fresh vegetables sprinkled with water at markets?
9. Roads are sometimes salted to melt ice. What does this salting do to the plants along roadsides & why?
ACOS Standard 1 & 3

Bubbling Oxygen
(Teacher Notes)

Lab Time: Three days: Day 1 - 55 minutes, Day 2 - 20 minutes, Day 3 - 20 minutes

Background: See student handout.

Materials: See student handout.

Pre-Activity:
Discuss with the class the processes of photosynthesis and cellular respiration. Be sure to cover the basic equation for photosynthesis: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (in the presence of sunlight and chlorophyll).

Activity:
After 24 hours, students should see tiny bubbles of oxygen on the plant in the sun or in the upper end of the test tube and no bubbles on the set-up in the dark. On Day 3, test for oxygen as a demonstration for the students. To do so, remove the test tube while holding it in an inverted position. Unplug the stopper allowing the water to drain out of the test tube. Thrust a glowing splint into the test tube. The glowing splint should glow brighter or burst into flame if oxygen is present. Follow this same procedure for the set-up from the dark. Students should record their observation. CAUTION SHOULD BE EXERCISED HERE!

Post-Activity:
Students will write the equations for photosynthesis and cellular respiration on their student handouts. They also will write a word equation for both of these processes. Have students describe their observations from Day 2 and Day 3. They should explain the differences in their observations and in the results of the test for oxygen.

Student Questions and Answers:
1. What are the reactants and products of photosynthesis and cellular respiration? Photosynthesis uses carbon dioxide and water in the presence of light to produce glucose and oxygen. Cellular respiration uses glucose and oxygen to produce carbon dioxide, water, and energy.
2. What are the purposes of these two processes? Photosynthesis produces food in the form of glucose. Cellular respiration releases the energy in the glucose molecule so those organisms can use it for all life functions.
3. What are the equations for photosynthesis and cellular respiration?
   Photosynthesis: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
   Respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + energy (ATP)$
4. What are the differences in the two tests for oxygen and why was there a difference? The splint glowed brighter or burst into flame in the presence of oxygen and remained the same or went out when no oxygen was present.
ACOS Standard 1 & 3

Additional Questions:
1. What would happen if most of the world's photosynthesizing plants died out? Explain your answer.
2. What happens to the water produced by respiration? Hint: Breath on a cold glass.
3. What happens to some of the carbon dioxide released by respiration?
4. Draw a carbon cycle showing several places a carbon atom could go.

Extensions:
Discuss the importance of photosynthesis in producing food and oxygen for all living things, the cyclic relationship between photosynthesis and respiration, and the connection between this and food webs. Explore other cycles in nature such as the nitrogen cycle.

Resources:
Books:

Internet:
Access Excellence High School Biology site
ACOS Standard 1 & 3

**Bubbling Oxygen**
(Student Handout)

**Purpose:** To identify the reactants and products associated with photosynthesis and cellular respiration and to know the purpose of these two processes

**Background:**
The cycle of photosynthesis and respiration maintains the Earth’s natural balance of carbon dioxide and oxygen. Green plants, using the sun as their energy source, take in carbon dioxide from the atmosphere and water from both the soil and atmosphere. They use these materials to produce food (sugar) and oxygen. All of our food come either directly or indirectly from this energy-converting process. Plants and animals burn the food by combining it with oxygen to release energy for growth and life activities. This process is called respiration and is the reverse of photosynthesis. Oxygen is used and carbon dioxide and water are given off.

**Materials:**
2 water plants (such as Elodea)  
2 rubber stoppers  
Bottled water  
2 test tubes  
2 test-tube racks  
Wax pencil

**Safety Considerations:** Always follow lab safety procedures. Wear goggles during the lab.

**Procedure:**
1. Students are to fill two test tubes full of bottled water.
2. Place a water plant in test tubes and close tubes with a rubber stopper so that no water can leak out.
3. Invert the test tubes and place one on each rack.
4. Place one in the sun and the other in a dark place. Leave for 24 hours.
5. After 24 hours, students should observe both set-ups and record their observations.
6. Repeat Step 5 for the next two days.

**Data Table: Observations:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Observations</th>
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</thead>
<tbody>
<tr>
<td>24 hours</td>
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<tr>
<td>48 hours</td>
<td></td>
</tr>
<tr>
<td>72 hours</td>
<td></td>
</tr>
</tbody>
</table>

**Questions:**
1. What are the reactants and products of photosynthesis and cellular respiration?
2. What is the purpose of these two processes?
3. What is the equation for photosynthesis and cellular respiration?
4. What are the differences in the two tests for oxygen and why was there a difference?
Create a Flower
(Teacher Notes)

Lab Time: 105 minutes

Background: See student handout.

Materials/Equipment: See student handout.
Real lilies work best and can be obtained from a local florist. It may be necessary to substitute a real one with a silk flower.
Floral wire comes in two-foot cut lengths or in rolls. Walmart has both kinds, and it is inexpensive ($2.00 or so for enough to do several classes).
If only the large-sized sheets of white construction paper are available, cut them in half.

Pre-Activity: (15 minutes)
Have the students follow the instructions on the student handout to become familiar with the names and functions of the flower’s reproductive structures.

Activity: (45 minutes)
1. Give each group two flowers. The teacher or a group leader will take one flower apart and give each student in the group one part to draw and color. Since the sepals and pistil are easier, give some students more than one of these if needed. The group will be responsible for drawing and coloring all of the parts of the lily. Keep the other lily in one piece so that students can see what it looks like all together.
2. As the students begin assembling their flowers, walk around and offer suggestions if needed. Usually they will observe each other and correct assembly problems.
3. Make sure that each group member gets a chance to name the parts and explain their functions.
4. Display them around the room. Since the wire will hold the flower’s form, they can be put on the wall, ceiling, or anywhere.

Post-Activity: (45 minutes)
Have the students write a short story about their journey through a flower. They can pretend they have shrunk and are crawling around inside, or they can be an insect closely examining each structure as they encounter it. They can include the weather condition, the mood they are in, the colors and textures they see, the nectar they smell. Where would this flower be best suited to live? (dry, wet, cold, warm, hot) Why would it need such an area? After students finish writing, they can read the short stories aloud.
ACOS Standard 1 & 10

**Student Questions and Answers for Diagram:**

1. Flower parts and their functions.

   Sepals – *protect the petals before the flower opens*
   Petals – *attract insects and birds*
   Stamen – *male reproductive structure*
     Anther – *contains the pollen*
     Filament – *hold up the anther*
   Pistil – *female reproductive structure*
     Stigma – *sticky part that pollen sticks to*
     Style – *long tube the pollen travels down*
     Ovary – *contains the ovules that become seeds*

2. Label the parts of the flower below.

   ![Diagram of a flower](image)

**Resources:**

*Books:*
ACOS Standard 1 & 10

Create a Flower
( Student Handout )

**Purpose:** To identify the names and functions of the parts of a flower

**Background:**
Angiosperms or flowering plants are the most modern type plants. They reproduce by producing flowers and seeds. (The seeds are enclosed in a structure.) Each part of the flower has an essential function. The reproductive organ in an angiosperm is the flower. Most flowers are complete and contain both the male and female reproductive parts. The flower shown below is a complete flower. Each flower part has a specific name and function.

1. Using the textbook or another source, write the function of each of the following flower parts.

   - Sepals
   - Petals
   - Stamen
     - Anther
     - Filament
   - Pistil
     - Stigma
     - Style
     - Ovary

2. Label the parts of the flower below.

   ![Flower Diagram]

**Materials/Equipment:**
- 2 lilies per group
- 1 piece of foam board per group (12" X 12")
- Clear tape
- Crayons for each student
- Floral wire
- White construction paper

**Safety Considerations:** Always follow lab safety procedures.
ACOS Standard 1 & 10

Procedure:
1. Divide into groups. Each group should have about six members.
2. The teacher will give each group a flower. Carefully take the flower apart so that each part can be seen. The group leader will give each member a flower part to draw and color. A few students may need to draw two parts. Color both sides of the structure. Make them as large as possible on the paper. Each petal should be about the same size as the others in the group. Notice the different shades, colors, and spots contained on each structure. Try not to leave any white spaces showing.
3. After finishing the coloring of the flower part, tape a piece of floral wire to the back of it with clear tape. Leave about three inches of wire sticking out of the bottom end of the structure.
4. Next, take a piece of cardboard or foam board, punch a small hole on the middle, and begin assembling the 3-D flower. Begin with the petals, then the stamen, and finally the pistil. Tape the wire under the cardboard as you go. When everything is taped in, bend the wire to make the flower petals, sepals, stamen, and pistil look more realistic.
5. Have each group member identify the reproductive structures of the flower and discuss their function.
6. Display the flowers in the classroom.

Questions:
1. Which part of the flower is considered the female reproductive structure?
2. Which part of the flower attracts insects?
3. What role do insects play in flower reproduction?
4. Why is the pistil sticky?
5. To what part of a flower are most people allergic?
ACOS Standard 1 & 10

**Gymnosperms and Angiosperms**
*(Teacher Notes)*

**Lab Time:** Part A Gymnosperms - 30 minutes; Part B Angiosperms - 30 minutes

**Background:** See student handout.

**Materials:** See student handout.

**Sample Drawings:**
**Part A - Gymnosperms**
1. Draw a picture of the pollen cone in the space below.

   ![Pollen Cone](image)

2. Observe the grains through the microscope and sketch them below. If a microscope is not available, use a magnifying glass.

   ![Grains](image)

3. Draw a picture of the seed cone below.

   ![Seed Cone](image)

4. Observe the seed and scale and draw them below.

   ![Seed and Scale](image)

**Part B - Angiosperms**
1. Draw a picture of the bean from each view and color it with crayons or colored pencils.

   ![Bean](image)

2. Break the bean seed open. If it does not open easily, use a scalpel or scissors. Observe and identify the parts of the seed. Compare it to the diagram below.

   ![Seed Diagram](image)

   - Embryo
   - Seed coat
   - Food supply
ACOS Standard 1 & 10

**Student Questions and Answers:**

**Part A - Gymnosperms**
1. In nature, how does the pollen grain get to the seed cone? *wind pollination*
2. How does the shape of the pollen help with this process? *It has little wings on each side to help it fly in the wind.*
3. How does the shape of the seed relate to the way it is dispersed? *It is winged to help it fly in the wind.*
4. Is the seed enclosed in a fruit or is it naked (exposed)? *naked*
5. Name three kinds of plants that are gymnosperms. *pine, redwood, spruce, fir or Ginkgo*

**Part B - Angiosperms**
1. Why is it advantageous for the seeds to be enclosed in a fruit? *a. protection, b. aids in seed dispersal (The fruit, seeds and all, is eaten by other organisms and leaves the digestive tract ready to grow. Also some fruits have barbs that attach to animal fur.), c. fruit decomposes and becomes nutrients for the plant.*
3. Why is it an advantage for flowers to have such varied shapes, sizes, colors, and odors? *These are all used to attract animals that aid in pollination and seed dispersal.*
4. Fill in the following chart comparing gymnosperms to angiosperms. Check the box for the characteristics that apply.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Gymnosperms</th>
<th>Angiosperms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naked seeds</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Seeds inside a fruit</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Flowering plants</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Produce cones</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Produce fruits</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Wind Pollination</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Insect Pollination</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examples</th>
<th>Gymnosperms</th>
<th>Angiosperms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Grasses</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ginkgo</td>
<td>X</td>
<td></td>
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<tr>
<td>Rose</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Pine</td>
<td>X</td>
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</tr>
<tr>
<td>Tomatoes</td>
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<td>X</td>
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<tr>
<td>Apples</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Redwood</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
ACOS Standard 1 & 10

Resources:
Book:

Internet:
Christopher J. Earle’s - Gymnosperm Database
http://home.earthlink.net/~earlecj/
Encyclopædia Britannica, Inc - on-line search engine
http://www.eb.com/cgi-bin/g?keywords=
Gymnosperms and Angiosperms
(Student Handout)

Purpose: To observe and record differences in the seeds of two major groups of plants.

Materials: (Set up for every two students.)
1 male or pollen cone
1 female or seed cone (Try to use some that still contain seeds.)
1 pod with the beans or peas inside
1 microscope (If a microscope is not available, use a magnifying glass.)

Safety Considerations: Always follow lab safety procedures.

Part A - Gymnosperms
Background:
Both gymnosperms and angiosperms produce seeds. Gymnosperm means “naked seed,” and the seeds are not encased in a fruit. Conifers such as pine trees, produce cones as you will observe in this lab. Spruce, redwood, fir, and ginkgo are all examples of gymnosperms. Most gymnosperms are evergreens with needlelike or scalelike leaves.

The pine tree produces two different types of cones. The pollen cone produces pollen that contains sperm cells. The pollen is carried by the wind and lands on the sticky female (seed) cone. It takes about 15 months for the pollen to unite with the egg cell in the female cone. An enormous amount of pollen is produced, and some of it lands on ovules. This yellow pollen can be seen on the sidewalks, puddles, and lakes in the springtime in Alabama.

Procedure:
1. Begin by observing the pollen cone. Describe the male cone. Some things to consider are size, texture, smell, shape, color, etc.

2. Draw a picture of the pollen cone in the space below.

3. Dust some of the pollen grains onto a microscope slide. Put a drop of water and a coverslip on it.

4. Observe the grains through the microscope and sketch them below. If a microscope is not available, use a magnifying glass.
ACOS Standard 1 & 10

5. Now observe the seed cone. Write a description of the seed cone including how the scales are arranged, their texture, shape, color, etc.

6. Draw a picture of the seed cone below.

7. Gently shake the cone. Remove one of the scales and examine its base. Perhaps some seeds will be present. However, even if they aren’t, there are usually impressions of the seed on the scale.

8. Observe the seed and scale and draw them below.

Questions:
1. In nature, how does the pollen grain get to the seed cone?

2. How does the shape of the pollen help with this process?

3. How does the shape of the seed relate to the way it is dispersed?

4. Is the seed enclosed in a fruit, or is it naked (exposed)?

5. Name three kinds of plants that are gymnosperms.

Part B - Angiosperms
Background Information:
The word angiosperm means “flowering plants.” This group of plants produce flowers and seeds encased in a fruit. Angiosperms make up the largest group of plants. They include grasses; corn; daisies; tomatoes; and apple, orange, and pear trees. These plants rely on many different insects, birds, and mammals for pollination. Some are self-pollinated or wind-pollinated. The fertilization of flowers and production of a seed take place quickly when compared to gymnosperms.

Procedure:
1. Observe the bean pod from the outside, then open it up, and examine it from the inside. Describe it in writing from each view.

   Outside:  
   Inside:
ACOS Standard 1 & 10

2. Draw a picture of the bean from each view and color it with crayons or colored pencils.

3. Break open the bean seed. If it does not open easily, use a scalpel or scissors. Observe and identify the parts of the seed. Compare it to the diagram below.

Questions:
1. Why is it advantageous for seeds to be enclosed in a fruit?

2. Name three fruits and tell how the seeds of each are dispersed.

3. Why is it an advantage for flowers to have such varied shapes, sizes, colors, and odors?

4. Fill in the following chart comparing gymnosperms to angiosperms. Check the box for the characteristics that apply.

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</table>
ACOS Standard 4&9

Poor Primitive Prokaryotes
(Teacher Notes)

**Lab Time:** approximately 50-60 minutes or 1 class period

**Background:** See student handout.

**Materials:**
Index cards (12 per group of 4 students)
1 poster or butcher paper
1 metric ruler per group
String or twine for students to measure and serve as radius to draw game circle

**Pre-Activity:** (10-15 minutes)
1. As groups divide responsibility for descriptions of cell components, tell them to include a simple sketch of that component as well, especially if this activity is the foundation for further cell studies.
2. The string may be used as the radius for drawing the circle for the game board.

**Activity:** (15-20 minutes)
1. During the game play, circulate among groups to assess appropriate selection and/or justifications for changing a placement.
2. When called to review a group’s cell pie, reveal only the total number in each of the three segments that have been incorrectly placed. Pose questions or direct attention to guide students toward more accurate responses.

**Post-Activity:** (15-20 minutes)
1. Circulate again to determine appropriate components included in drawings.
2. Discuss the post-activity questions and allow groups to explain their responses.
Sample Data and Calculations:
Components in the "P" section = none
Components in the "E" section = nuclear envelope, vacuoles, endoplasmic reticulum, mitochondria, lysosomes, Golgi bodies, nucleolus
Components in the "B" section = cell wall, cell membrane, DNA/chromosome, cytoplasm, ribosomes

Student Questions and Answers:
1. Use the drawings and the lab chart to explain why prokaryotic cells are considered more primitive than eukaryotic cells. *Strong biochemical and fossil evidence indicates that prokaryotes were the earliest life forms on Earth. The separation and specialization of certain chemical activities into membrane-bound compartments (organelles) is considered an evolutionary advance in the eukaryote cells.*

2. Scientists have noticed that certain organelles strongly resemble the primitive prokaryote cells. Which cell part (organelle) of the eukaryote cell looks the most like a bacteria cell? *The double-membrane bound mitochondria and chloroplasts each have their own DNA and strongly resemble prokaryote bacteria cells.*
ACOS Standard 4&9

Additional Questions:
1. Why have bacteria been placed in the kingdoms Archaeabacteria and Eubacteria rather than the previous kingdom Monera?
2. What specialized function does each membrane-bound organelle perform within an eukaryotic cell?

Extensions:
This activity could easily form the basis for further comparisons of plant vs. animal cells. Another extension would be the evolutionary development of cells, i.e. endosymbiosis theory (Margulis's Theory).

Resources:
Internet:
University of Wisconsin-Madison, Microbiology for the General Public
http://www.bact.wisc.edu/MicroTextbook/BacterialStructure/siteoutline.html
Access Excellence High School Biology - Cell Organelles-Joyce R. Calo
Access Excellence High School Biology - The Cell-Lisa Fernandez
Poor Primitive Prokaryotes
(Student Handout)

**Purpose:** To identify and define similarities and differences between prokaryotic and eukaryotic cells.

**Background:**
Cells are the basic units of life. New and better instruments, such as electron microscopes, have allowed scientists to study the structure of living cells in increasing detail. In doing so, it was discovered that there are two basic kinds of cells: prokaryotic and eukaryotic.

Prokaryotic cells do not have a nucleus or any internal membrane-bound structures. Within these cells, membranes do not separate different areas from one another. Bacteria in the Kingdom Monera are prokaryotes. There are some universal structures that all bacteria have. Like every living organism, they have the basic building blocks of life -- DNA, RNA, and protein. Therefore, these prokaryote cells will generally have an area of genetic material but no nuclear membrane. They will also have RNA and free-floating ribosomes for protein synthesis. In addition, all bacteria have a cell membrane, and most have a cell wall outside that. Since prokaryotic means “without or before nucleus,” it may help to remember them as the POOR, PRIMITIVE PROKARYOTES. (*Pro* means before and *karyote* means nucleus.)

In contrast, eukaryotic cells have many kinds of internal membrane-bound structures called organelles. Essentially then, eukaryotes have EVOLVED EVERYTHING IN ENVELOPES. The most important of these is the nucleus where the hereditary DNA is separated. Compared to prokaryotes, eukaryotes are much more compartmentalized and specialized. Eukaryotic cells are present in all living things except bacteria that would include protists, fungus, plant, and animal cells. (*eu* means true and *karyote* means nucleus.)

The following activity will provide practice in recognizing the similarities and differences between prokaryotes and eukaryotes.

**Materials/Equipment:**
- Index cards
- Poster paper
- Metric ruler
- String

**Safety Considerations:** Always follow lab safety procedures.

**Pre-Activity:**
1. Divide the cell structures listed on the observation Data Table among the group members. Use descriptions and diagrams from the text to write a brief summary on an index card to describe the nature of that cell part.
2. Draw a circle with a 25cm radius on the poster board. Divide the circle into three equal segments labeling the sections as “P,” “E,” and “B.”
ACOS Standard 4&9

Activity:
1. When all cards have been prepared, shuffle them and place the stack face down in the center of the circle.
2. Take turns having a group member draw a card from the center, read its description aloud, and place it into one of the three pie segments. If the cell part would only be found in prokaryote cells, the card should be placed in the “P” segment. If the cell part would be found in eukaryote but not in prokaryote, then the “E” segment should be chosen. However, if the cell part would be common to all cells, the card should be placed in the “B” segment for both.
3. Once the card has been played, the group has the opportunity to agree or disagree with the decision. Another group member may move the card but must justify the new placement. Play resumes in a counter-clockwise fashion until all cards have been placed.
4. Ask the teacher to review the cell pie. If all of the selections were correct, mark them on the Data Table.
5. If cards have been incorrectly placed, the teacher will reveal only the number in each segment that should be reevaluated. The group may discuss these, make new placements, and ask for another review until all are accurately arranged. Post these corrected selections in the Data Table.

Post-Activity:
1. Using the table and sampling from the text, draw and label the components of a typical prokaryotic cell and of an animal eukaryotic cell. (Note: Don’t forget the “B” items in the sketches.)

Data Table:

<table>
<thead>
<tr>
<th>CELL</th>
<th>TYPE</th>
<th>CELL STRUCTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>“P”</td>
<td>“E”</td>
<td>“B”</td>
</tr>
<tr>
<td>Cell Wall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell (plasma) Membrane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNA/Chromosome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear Envelope or Membrane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cytoplasm or Protoplasm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuoles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endoplasmic Reticulum (ER)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golgi Bodies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitochondria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribosomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lysosomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nucleolus (RNA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sketch of Prokaryote cell (bacteria)    Sketch of Eukaryote cell (animal)
Questions:
1. Use the drawings and the lab chart to explain why prokaryotic cells are considered more primitive than eukaryotic cells.
2. Scientists have noticed that certain organelles strongly resemble the primitive prokaryote cells. Which cell part (organelle) of the eukaryote cell looks the most like a bacteria cell?
Window Cells
(teacher notes)

**Lab Time:** 50 minutes

**Background:** See student handout.

**Materials:** See student handout.

**Pre-Activity:**
Hang one large sheet of bulletin board paper per group on the wall. These should be scattered around the room. Poster board or pieces of white cloth (sheets) could be used instead of bulletin board paper. Title half of these “plant cell” and the other half “animal cell.” Using a black marker, draw an outline of either a plant or animal cell on each sheet. Provide students with a handout of specified organelles that the students will be asked to identify and draw. Allow a team leader for each group to select a card that reads either “p” for plant or “a” for animal. This represents which type of cell they will display.

Ensure that students are familiar with the terminology of the two cell types (prokaryotic and eukaryotic), the kinds of cells (plant and animal), and the organelles found in each. Ask students to complete the handout on organelles while using their class notes. Determine whether an organelle is found in the plant cell, animal cell, or both. Have students draw a sketch of their cell with the appropriate number of organelles for them to use as a guide. Divide the classroom into either two large groups or four smaller groups.

**Activity:**
1. Have students draw each organelle on a sheet of construction paper.
2. Have students color and label each drawing.
3. Have students cut out each drawing.
4. Have students affix the drawings and labels to the large sheets of paper in the positions where they normally would be found in the cell.
5. Monitor students to ensure that the size of the organelles is appropriate for the size of the cell.

**Post-Activity:** Have students develop a concept map showing how the organelles interact.

**Student Questions and Answers:**
1. What are the differences between animal and plant cells? *The difference between plant and animal cells lies within the organelles that are found in each. Plant cells contain cell walls, chlorophyll, and chloroplasts. Animal cells do not. Plant cells also have only a few very large vacuoles; animal cells have several smaller vacuoles.*
2. Which organelle is considered to be the “brain” of the cell? *The nucleus*
3. Which organelle is the powerhouse of the cell? *The mitochondria*
4. Which organelle is considered to be the transportation system of the cell? *The endoplasmic reticulum*
ACOS Standard 4 & 9

Additional Questions:
1. Name five organelles found in cells and describe how each enables the cell to display the properties of life. (Example: Protein Synthesis)
2. Give evidence that suggests eukaryotes evolved from prokaryotes.

Extensions:
1. Have students present their cell displays to the other groups in the classroom.
2. Have students write a short essay contrasting the efficiency of small cells to large cells.

Resources:
Book:
pp. 56-66.

Internet:
Cells on Ceiling. Katheryn S. Hopkins
Window Cells
(Student Handout)

**Purpose:** To be able to visualize and compare plant and animal cells and to be able to recognize organelles and understand their functions.

**Background:**
According to the cell theory, the cell is the basic unit of life of all organisms. This characteristic is shared by all organisms whether it is simple, like a bacterium, or complex, like a human. There are two types of cells: prokaryotic and eukaryotic. Prokaryotic cells have no true organelles and are much smaller than eukaryotic cells. Eukaryotic cells have organelles such as the nucleus, mitochondria, and ribosomes. Organelles have specific roles much like the parts of a car. Just as no car could function properly without a battery, engine, wheels, starter, etc., neither could the cell. All of the parts must work together.

**Materials:** (per group)
- 15 sheets of construction paper (assorted colors)
- Colored pencils, crayons, or markers
- Tape, glue, or glue sticks
- 1 large piece of bulletin board paper, cloth, or poster board

**Safety Considerations:** Always follow lab safety procedures.

**Procedure:**
1. Research the functions of the organelles found within plant and animal cells.
2. Complete the Cell Parts and Function handout and answer questions.
3. On a sheet of paper, draw a sketch of the type of cell the leader chooses.
4. Determine which organelles should be included in the cell display.
5. Determine the size of the organelles for the display.
6. Determine how many of each organelle are needed for the display.
7. Draw, color, cut out, and label each organelle.
8. Affix the organelles to the large poster board on the walls.
**Data Table:**

**Cell Parts and Function Handout**

<table>
<thead>
<tr>
<th>CELL PART</th>
<th>CELL FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cell wall</td>
<td></td>
</tr>
<tr>
<td>2. Cell membrane</td>
<td></td>
</tr>
<tr>
<td>3. Nucleus</td>
<td></td>
</tr>
<tr>
<td>4. Cytoplasm</td>
<td></td>
</tr>
<tr>
<td>5. Vacuole</td>
<td></td>
</tr>
<tr>
<td>6. Nucleolus</td>
<td></td>
</tr>
<tr>
<td>7. Ribosomes</td>
<td></td>
</tr>
<tr>
<td>8. Mitochondria</td>
<td></td>
</tr>
<tr>
<td>9. Golgi Bodies</td>
<td></td>
</tr>
<tr>
<td>10. Chloroplasts</td>
<td></td>
</tr>
<tr>
<td>11. Chlorophyll</td>
<td></td>
</tr>
<tr>
<td>12. Lysosome</td>
<td></td>
</tr>
<tr>
<td>13. Microtubules</td>
<td></td>
</tr>
<tr>
<td>14. Smooth Endoplasmic Reticulum</td>
<td></td>
</tr>
<tr>
<td>15. Rough Endoplasmic Reticulum</td>
<td></td>
</tr>
</tbody>
</table>

**Questions:**

1. What are the differences between animal and plant cells?
2. Which organelle is considered to be the “brain” of the cell?
3. Which organelle is the powerhouse of the cell?
4. Which organelle is considered to be the transportation system of the cell?
ACOS Standard 5

Where Do We Fit In?

Background:

In previous chapters/units we have concentrated on the biology of the individual cell, tissue, and organism. There are levels of organization above the individual organism that will be the subject of this unit. Individual organisms are grouped into populations, which in turn form communities, which form ecosystems. Ecosystems make up the biosphere, which includes all life on Earth. If there is life on other planets, will we need another level of organization?

Biosphere: The sum of all living things taken in conjunction with their environment. In essence, where life occurs, from the upper reaches of the atmosphere to the top few meters of soil, to the bottoms of the oceans. We divide the earth into atmosphere (air), lithosphere (earth), hydrosphere (water), and biosphere (life).

Ecosystem: The relationships of a smaller groups of organisms with each other and their environment. Scientists often speak of the interrelatedness of living things. Since, according to Darwin’s theory, organisms adapt to their environment, they must also adapt to other organisms in that environment. We can discuss the flow of energy through an ecosystem from photosynthetic autotrophs to herbivores to carnivores.

Community: The relationships between groups of different species. For example, the desert communities consist of rabbits, coyotes, snakes, birds, mice and such plants as sahuaro cactus (Carnegia gigantea), Ocotillo, creosote bush, etc. Community structure can be disturbed by such things as fire, human activity, and over-population.

Species: Groups of similar individuals who tend to mate and produce viable, fertile offspring. We often find species described not by their reproduction (a biological species) but rather by their form (anatomical or form species).

Populations: Groups of similar individuals who tend to mate with each other in a limited geographic area. This can be as simple as a field of flowers, which is separated from another field by a hill or other area where none of these flowers occur.

Individuals: One or more cells characterized by a unique arrangement of DNA "information". These can be unicellular or multicellular. The multicellular
ACOS Standard 5

individual exhibits specialization of cell types and division of labor into tissues, organs, and organ systems.

Organ System: (in multicellular organisms). A group of cells, tissues, and organs that perform a specific major function. For example: the cardiovascular system functions in circulation of blood.

Organ: (in multicellular organisms). A group of cells or tissues performing an overall function. For example: the heart is an organ that pumps blood within the cardiovascular system.

Tissue: (in multicellular organisms). A group of cells performing a specific function. For example heart muscle tissue is found in the heart and its unique contraction properties aid the heart's functioning as a pump.

Cell: The fundamental unit of living things. Each cell has some sort of hereditary material (either DNA or more rarely RNA), energy acquiring chemicals, structures, etc. Living things, by definition, must have the metabolic chemicals plus a nucleic acid hereditary information molecule.

Organelle: A subunit of a cell, an organelle is involved in a specific subcellular function, for example the ribosome (the site of protein synthesis) or mitochondrion (the site of ATP generation in eukaryotes).

Molecules, atoms, and subatomic particles: The fundamental functional levels of biochemistry.

Example:

It is thus possible to study biology at many levels, from collections of organisms (communities), to the inner workings of a cell (organelle).

Ecology is the study how organisms interact with each other and their physical environment. These interactions are often quite complex. Human activity frequently disturbs living systems and affects these interactions. Ecological predictions are, of a consequence, often more general than we would like.
Where do We Fit In?

**Purpose:** Identify cells, tissues, organs, systems, organisms, populations, communities, and ecosystems as levels of organization in the biosphere.

**Directions:**
1. Select the name of an organism from your teacher.
2. Research the structure of this organism as well as its place in its ecosystem.
3. Visually represent the order of levels of organization of this organism from its smallest unit to its position in its ecosystem.
   *You may draw pictures, cut out pictures from magazines, or use computer graphics to illustrate your project.*
4. Your identification should include the following levels of organization:
   - Cells
   - Tissues
   - Organs
   - Systems
   - Organism
   - Population
   - Community
   - Ecosystem
ACOS Standard 6

**Mitosis and Meiosis Motion Picture Flip Books**
*(Teacher Notes)*

**Lab Time:** 40 minutes

**Background:** See student handout.

**Materials:** See student handout.

**Pre-Activity:** (5 – 10 minutes)
The time for cutting the paper into pieces can be reduced with a paper cutter. Review mitosis and meiosis with the students and help them if they get confused.

**Answers to the Pre-Activity**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used to produce growth in an organism</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Used for sexual reproduction</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Used for the repair of damaged cells</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Begin with 46 chromosomes and end with two cells each with 46 chromosomes.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Begin with 46 chromosomes and end with 23 chromosomes in each cell.</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

**Activity:** (30 minutes per flipbook)
Make sure the students understand that they will have four or five pages that are actually the same stage (beginning prophase, middle prophase, late prophase, etc.). Make sure the students draw the cell in the same way and in the same place on each piece of paper so it will look like a motion picture when they are finished. If time is limited, half of the class can do mitosis and the other half, meiosis. They can then share and compare the processes. More slips of paper will be necessary since meiosis has more steps. They will not need all 30 sheets for mitosis.

**Student Questions and Answers:**
1. How many nuclei are produced during the process of mitosis? *Compare this to the number of nuclei produced in meiosis. 2, 4 (twice as many)*
2. Which process would the body use to repair a cut toe? *Mitosis (Point out to students that “toe” sounds like it goes in mitosis, and this is a way to remember which process goes with which function.)*
3. What happens to the double-stranded chromosomes during mitosis? Compare this to what happens to the double-stranded chromosomes during meiosis. *They separate. They stay together.*
4. Which process would be used to make sperm cells? *Meiosis*

**Resources:**

Internet:
University of Arizona tutorial
http://www.biology.arizona.edu/cell_bio/tutorials/meiosis/page4.html
Mitosis and Meiosis Motion Picture Flip Books
(Student Handout)

**Purpose:** To compare and contrast the processes of mitosis and meiosis

**Background:**
Mitosis and meiosis (also known as reduction division) are different processes by which cells reproduce. Cells within a plant or animal are constantly undergoing these processes to replace worn-out cells, grow, and produce offspring. Humans have 46 chromosomes in each somatic (regular body) cell. Since that is double the number of chromosomes found in gametes (sex cells), we refer to it as the **diploid** number. The number of chromosomes found in gametes is 23. Since it is half the number in the somatic cell, it is called the **haploid** number of chromosomes.

Put a check in the box for the process used in each example:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Begin with 46 chromosomes and end with two cells each with 46 chromosomes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>begin with 46 chromosomes and end with 23 chromosomes in each cell.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Materials/Equipment:** (per student per booklet)
5 sheets of white paper (copy paper is fine). You can make these flipbooks smaller to save paper if needed.
1 set of colored pencils or crayons per student
1 textbook with the stages of mitosis and meiosis in it per student
1 stapler for the whole class
1 pair of scissors for every 1 or 2 students

**Safety Considerations:** Always follow lab safety procedures.

**Procedure:**
This activity will be done individually.
1. Get the materials from the teacher. Cut 30 small pages for each flipbook. They should be about 6" x 4." Make them all the same size in order for someone to easily flip through the book.
2. Look at a diagram of the stages of MITOSIS in the textbook. The names of the stages are not important for this activity, just the pictures of what is happening inside the cell.
3. Use colored pencils or a regular pencil and crayons to draw the changes that take place as a cell divides. The pictures should be drawn close to the free edge of the pad, in order for them to be visible when the pages are flipped.
4. Each page should vary only slightly from the preceding one to show the very gradual changes that take place inside the nucleus of the cell. No words are necessary.
ACOS Standard 6

5. After drawing and coloring the flipbook for mitosis, make a cover for it to include the following.
   **Name for asexual reproduction of body cells**
   **Purpose**
   **Number of chromosomes in nucleus at beginning and at end of process**
   **Type of cells in which this reproduction occurs**
7. Repeat Steps 1-7 to make another flipbook for the process of MEIOSIS. Include the following on the cover of the meiosis flipbook.
   **Name for production of sex cells**
   **Purpose**
   **Number of chromosomes in nucleus at beginning and at end of process**
   **Place in which this reproduction occurs**
8. Enjoy your motion picture cell reproduction flipbooks!

**Questions:**
1. How many nuclei are produced during the process of mitosis? Compare this to the number of nuclei produced in meiosis.
2. Which process would the body use to repair a cut toe?
3. What happens to the double-stranded chromosomes during mitosis? Compare this to what happens to the double-stranded chromosomes during meiosis.
4. Which process would be used to make sperm cells?