Title: What's soap got to do with it: The search for life on Mars

Subject: Biology

Grade Level: High School

Rational or Purpose:
Students will be able to explain that the polarity in the cell membrane accounts for the cell membrane shape and how the cell membrane allows substances to pass through.

Materials:

- Copies of Page 2 of the Cellular Soap Opera Activity Observation Worksheet
- A bottle of rubbing alcohol
- A bottle of vegetable oil
- A bottle of baby oil
- And other liquids of your choosing

Each group will need a material tray with the following:

- A copy of the Cellular Soap Opera Activity Handout
- Page 1 of the Cellular Soap Opera Activity Observation Worksheet
- Bubble solution (see solution recipes at http://www.exploratorium.edu/ronh/bubbles/formulae.html)
- Water
- 2 pieces of string (one 45 cm long and one 60 cm long)
- Drinking straw
- Scissors
- Aluminum pie pan
- 2 film cans, with tops and bottoms removed
- A sheet of black construction paper
- Pencil

Lesson Duration: 60 minute period

TEKS Objectives:
§112.43. Biology.

(2): C, D
(3): A, C, E
(4): A, B
(6): A. B

Background Information:

Cells have certain structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the environment. Within the cell, there is a concentrated mixture of different molecules that form a host of specialized structures to carry many essential cell functions such as energy production, molecule transportation and molecule synthesis, and the storage of genetic material.

Activity:

Like cell membranes, soap is made up of long molecules that contain a hydrophilic region and a hydrophobic region. The soap film demonstration is used here to illustrate that when a bubble forms, other molecules become trapped inside giving rise to interactions between them. This could have contributed to the formation of simple biological building blocks and therefore cells.

Procedure:

1. Place students into groups of four before beginning the lesson. Also, prepare material trays for each group.

2. Introduce the lesson by asking students what they know about Mars and the explorations that have taken place there.
    a. I.e. What have Mars' Rovers been searching for?
        i. They survey the Martian surface to discover whether water was once present and what role it may have played in the formation of local geology.

3. Further elaborate and ask students what they already know about cells and cell structure in addition to the importance of water for life. Create a list on the board as students supply answers.

4. Inform the students they will be exploring the properties of cell membranes through the use of a soap demonstration. Before beginning this activity, ask students to come up with a group name. This will be the name of their "Mars' Exploration Rover."

5. Ask one student to pick up a material tray for their group.

6. Assign jobs to students in each group:

    a. Constructor: makes the frame
    b. Holder: holds the frame in place while experiments are being done
    c. Explorer: initially explores with soap film
    d. Recorder: fills out observation sheet

7. Explain to the students that each member will need to take turns exploring with the soap film and that each member will need to contribute in answering the questions on the observation worksheet.

8. Allow students to begin the activity. Monitor each group's progress.

9. After completing the activity, ask one group or "Rover" to stand up and describe their observations and reasoning to question 7 on the observation worksheet.

10. After this group has presented, continue calling on groups until all questions on the worksheet have been answered.

11. Continue with a class discussion on what happened in this activity.

    a. What exactly is the soap film? I.e. How does it work?
        i. The soap film acts a "water sandwich: there is a layer of water in between two layers of soap molecules.
        ii. The hydrophilic heads of the soap molecules point toward the water layer, and the hydrophobic tails of the soap molecules point toward the outward of the film.

    b. How does a soap film resemble a plasma membrane? I.e. What properties do they have in common?
        i. Bilayered structures that are flexible
        ii. Allow objects to move laterally
        iii. Selectively permeable
            1. Discuss why the film allowed the coated finger to pass through and not the dry finger.
            2. Discuss how it is possible for large, unlike substances to pass through. Relate to the wet film cans inserted to the soap film.

12. Once you have stimulated your student's critical thinking, pass out Page 2 of the Cellular Soap Opera Activity Observation Worksheet. This will allow students to further explore the underlying concept of the soap film illustration. Have students continue to work in the same groups to answer these questions.

13. Discuss the answers to the questions on Page 2 as a class.

14. Inform the students that molecules with opposing ends have been found in Martian meteorites collected on Earth. Explain that scientists hope the Mars Rover will give them some clues to the mystery of whether or not life has existed on Mars.

a. Pose this question to your students: “Do they represent the early building blocks of cell membranes?”
    i. These molecules may represent the early building blocks if there was once water on the planet for them to combine with.
    ii. Have a class discussion about this question and wrap-up the lesson.

Resources:

- Exploratorium: Journey to Mars: http://www.exploratorium.edu/mars/teachers/microbes.html

Activity: Cellular Soap Opera

(adapted for "Journey to Mars" from *Human Body Explorations*, published by Kendall-Hunt © Exploratorium)

Instructions:

1) **Cut the straw** in half with the scissors.

2) **Thread the longer string** through the two half-straws and tie the ends together to make a loop. Cut the excess string from the ends of the loop's knot. Move the string through the half-straws so that the knot is hidden inside one of the straws. This is your bubble frame.

3) **Create a handle for the frame** by threading the shorter string through one of the straws and tying the ends together. An easy way to get the string through the straw is to tie it to the string loop you made in the previous step, and then pull the loop to bring the tied end through one of the straws. Then untie the knot and make the handle. The frame and handle should look something like the drawing in Figure 1.

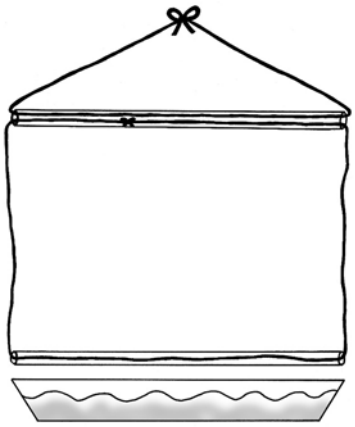


Figure 1: The bubble film apparatus

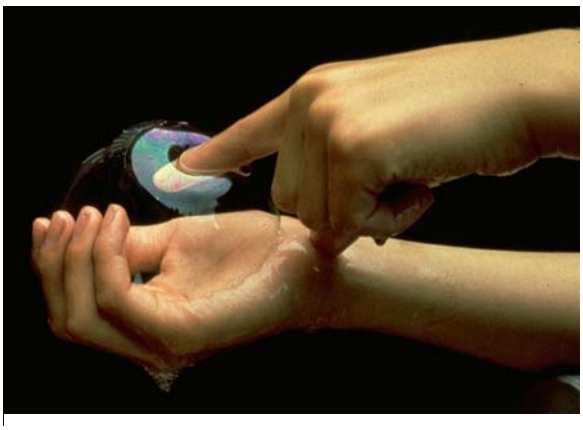
4) **Fill the pie pan with the soap solution**, at least 3/4 inch (2 cm) deep.

5) **Shape the bubble frame into a rectangle** (as shown in Figure 1). Holding the frame by the handle, immerse the entire frame in the bubble solution.

6) **Lift the frame up by the handle** until the bottom of the frame is slightly out of the bubble solution and the half-straws are parallel to the table top. You should have a rectangular soap film between the two half-straws. If there isn't a soap film, try immersing and lifting the frame again.

7) **Hold the soap film in front of a piece of black construction paper** or other black material. Carefully observe the surface of the film. Blow gently on the film and watch what happens.

8) **Wet your finger in the bubble solution.** Gently poke it through the soap film. What happens? Can you move your finger around



Students can try putting wet, then dry fingers through a bubble film.

in the film? Now wet your finger in plain water and poke it into the film. What happens?

9) **Try gently poking** a dry finger through the soap film. What happens?

10) **Make a new film on the frame.** Roll a film can (with the top and bottom removed) in the bubble solution to coat the surfaces of the can. Grasp the film can near one end and remove it from the solution. If films have formed across the openings of the can, pop them. Insert one end of the film can through the soap film on the frame. If the film pops, make another and try again.

A young museum visitor puts his hand through the "Soap Film Painting" exhibit. The exhibit is a large-scale version of Cellular Soap Opera.

11) **When you successfully insert** a bubble solution-coated film can through the soap film, hold the can in this position and have your partner or someone else pass an object (such as a pencil) through the openings in the can, from one side of the film to the other. Can you move the film can around in the soap film?

12) **Try putting a dry film can** through the soap film.

Group Name: _____

Group Members: _____

Cellular Soap Opera Observation Worksheet: *What happened?*

Step in instructions:	Questions: Be sure to give observations in addition to explanations!
7	What happened when you gently blew on the soap film surface?
8	What happened when you gently poked through the soap film? Can you move your finger around in the film? What happened when you poked your wet finger into the film?
9	What happened when you gently poked a dry finger through the soap film?
11	Can you move the film can around in the soap film?
12	What happened when you put a dry film can through the soap film?

Group Name: _____

Group Members: _____

More exploration questions:

1. Coat a finger with a different type of fluid (for example, vegetable oil or rubbing alcohol) and see if you can penetrate the film without popping it. Try it several times with different fluids. What do the fluids that work seem to have in common?

2. Wet your finger again in the soap solution and put your finger in the bubble. What happens to the bubble when you pull your finger out? What does this imply about cell membranes?

3. Cells of humans and many other organisms have a nucleus wrapped in a membrane floating inside the cell—a sort of bubble inside a bubble. How could this have evolved? Can you make a soap bubble using bubble solution and straw and pass that bubble through the soap film like you did with the film can?