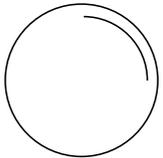


Cell Membrane Bubble Lab

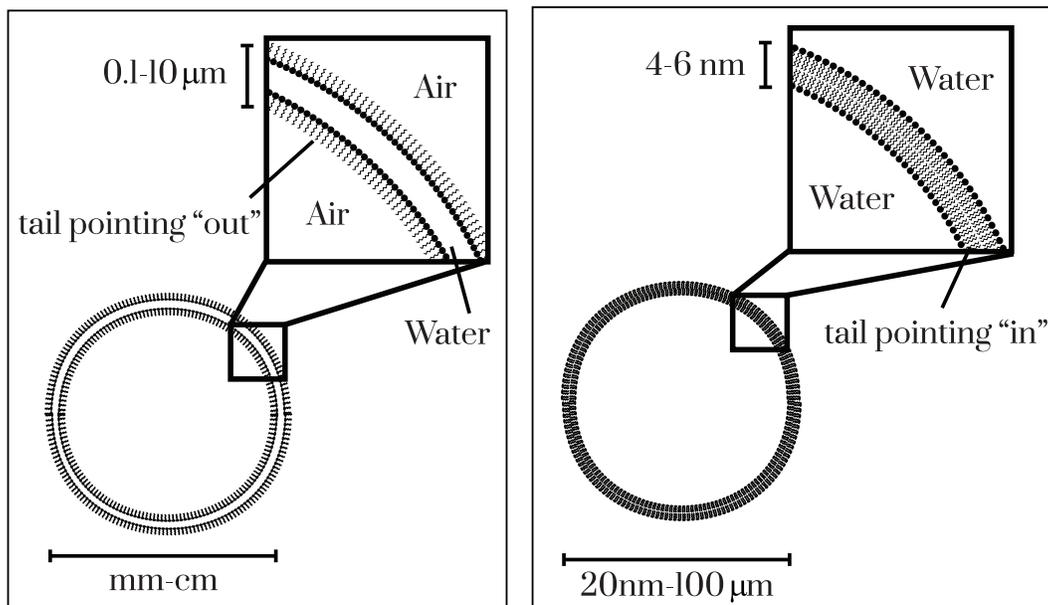


Background

Bubbles make a great stand in for cell membranes. They're fluid, flexible, and can self-repair. Bubbles and cell membranes are alike because their parts are so similar. If you could zoom down on a cell membrane, you'd see that much of the membrane is a double layer of little molecules called phospholipids. Phospholipids have a love-hate relationship with water. One end, the "head," is attracted to water, and the other end, the "tail," is repelled by water. Place phospholipids in water and they quickly form a double layer with the heads facing out on both sides.

A soap molecule has the same split personality. The "head" of a soap molecule is charged (ionic) and attracts to water molecules, which have regions of positive and negative charge (polar). The hydrocarbon tail of the soap molecule is not charged and is repelled by water's polarity. This explains why we use soap to clean. The hydrocarbon tail of soap mixes with and dissolves in other hydrocarbons, like oils and fats, while the head region grabs a hold of passing water molecules and follows them down the drain. The surface of a bubble has three layers. The middle layer is a thin film of water. On both sides of this film is a layer of soap molecules with hydrophilic heads oriented toward the water film and hydrophobic tails pointing away.

The diagram below (**Fig. 1**) offers a nice depiction of this comparison.



Soap Bubble

Lipid Vesicle

Fig. 1

Set Up

1. Create the bubble solution by mixing the water, soap, and corn syrup in the 1000ml beaker.
2. Create a bubble frame by using the following instructions.

Method One

- a. Bend 4 straws at elbows.
- b. Flatten the shorter ends of straws and fold flattened surface in the middle
- c. Connect straws together by inserting short ends into long ends to create a square

Method Two

- a. Cut two straws in 5 ½ inch lengths.
- b. Run a 30 inch string through all two straws.
- c. Tightly tie ends of string together to create a frame. (See image below)
- d. Cut off loose ends of string.

3. Create a ring of thread by tying a loop about two fingers wide.
4. Cut off the loose ends.
5. Place bubble frame into shallow tray
6. Add bubble solution to slightly cover bubble frame.

Materials

- **3 tbsp baking soda**
- **3 gallons of water**
- **24 oz. dish soap**
- **1 tbsp J-Lube**
- **4 bendable straws**
- **Spool of cotten thread**
- **1 clean straw**
- **Shallow tray (cafeteria trays work well)**



Procedure

Cell Concept 1 – Membranes are Fluid and Flexible

Cell membranes are not static, they bend and flex in order to adapt to changing conditions.

1. Lift bubble frame out of solution so that a thin film spans across frame.
2. Tilt the frame back and forth and observe the surface of the film.
3. Notice the swirl of color as the light reflects off the film. Molecules in the cell membrane move about in a similar fashion.
4. Hold the frame by the edges and rotate the sides in opposite directions. Notice the elasticity of the film.
5. Hold the bubble film parallel to the floor and gently move the frame up and down until the surface begins to bounce up and down.
6. **Like the bubble film, membranes can flex without breaking.**
7. Take a dropper fill it with water and drop drops on the film.

Cell Concept 2 – Membranes Can Self-Repair

Attraction between phospholipids allows cell membranes to repair small breaks in the bilayer.

1. Lift bubble frame out of solution so that a thin film spans across frame.
2. Cover the surface of your finger or extra straw in bubble solution.
3. Slowly push finger or straw through film. Film should allow finger to pass with out breaking.
4. Remove finger from film. Film should repair itself.
5. Try the same procedure with your entire hand.
6. **Like the bubble layer, cell membranes can spontaneously repair small tears in the lipid bilayer.**

Cell Concept 3 – Eukaryotic Cells Feature Membrane Bound Organelles

The membranes surrounding organelles in Eukaryotic cells feature a phospholipid bilayer like the one found in the outer “plasma” membrane.

1. Place the tip of a clean straw into the bubble solution in the tray.
2. Gently blow on the other end of the straw to create a bubble.
3. Slowly lift the tip of the straw out of the liquid while continuing to fill the bubble with air.
4. Allow the bubble to grow to a size of about 6” wide.
5. Return the tip of the straw back into the bubble solution and try to create a smaller bubble inside the larger bubble.
6. Notice how the smaller bubble creates a compartment of air that is contained within but separated from the air of the larger bubble.
7. **In a similar fashion, Eukaryotic cells feature membrane bound organelles that create specialized compartments within a single cell. The primary structure of the outer cell membrane as well as the membranes that enclose organelles is a double layer of phospholipids known as a phospholipid bilayer.**

Cell Concept 4 – Membrane Proteins Perform Special Functions

Some specialized proteins embed within the lipid bilayer, giving the membrane unique properties. Channel proteins are one example. They form a passageway for large or electrically charged molecules to pass through the membrane.

1. Lift bubble frame out of solution so that a thin film spans across frame.
2. Hold the frame parallel to the tray.
3. Gently lay loop of thread onto film surface.
4. Use a pencil or pen to break the bubble film that is inside the loop of thread.
5. Loop of thread should rapidly expand into the shape of a circle.
6. Insert pencil or finger into middle of thread loop.
7. Drop an object (dice/rock/paperclip) across film.
8. **Membrane proteins can also drift across the lipid bilayer.**

Cell Concept 5 – Gap Junctions Aid Transport Between Animal Cells

Gap junctions form between neighboring animal cells, allowing their cytoplasm to connect directly. This provides a quick way to move material between two cells.

1. Place the tip of a clean straw into the bubble solution in the tray.
2. Gently blow on the other end of the straw to create a bubble.
3. Lift the straw out of the liquid and continue to blow air into the bubble.
4. Continue to gently blow air into the bubble as you slowly pull out the straw.
5. As the tip of the straw leaves the bubble, you should be able to briefly observe a small tunnel existing between the bubble and straw tip.
6. This tunnel is allowing air to freely move between the straw and the bubble without breaking the bubble film.
7. **In the same manner, gap junctions allow for the rapid transit of ions and small molecules between adjacent animal cell membranes.**

Cell Concept 6 – Many Bacteria Cells Reproduce Through Binary Fission

Some single-celled bacteria reproduce by splitting into two. This is known as binary fission.

1. Place the tip of a clean straw into the bubble solution in the tray.
2. Gently blow on the other end of the straw to create a bubble.
3. Lift the straw out of the liquid and continue to blow air into the bubble.
4. Increase the size of the bubble until it is about 6" wide.
5. Hold a piece of thread that is twice as long as the bubble and slide it underneath the bubble.
6. Lift the thread up through the bubble and the bubble should split into two.
7. **In binary fission, bacterial cells divide when a thin ring of proteins located at the cells midpoint contracts, effectively cleaving the cell in two.**

Cell Membrane Bubble Lab - Student Analysis

In this lab, soap bubbles were used to model several properties that are characteristic of cellular membranes. Below is a chart listing each of the "Cell Concepts" investigated in the Cell Membrane Bubble Lab. Complete the following steps for each cell concept from the lab.

1. Describe the cell concept, as you understand it, in your own words.
2. Describe how the soap bubble was used to model the cell concept.

Cell Concept 1 - Membranes are Fluid and Flexible
1.
2.

Cell Concept 2 - Membranes Can Self-Repair
1.
2.

Cell Concept 3 - Membrane Bound Organelles

1.

2.

Cell Concept 4 - Membrane Proteins

1.

2.

Cell Concept 5 - Gap Junctions

1.

2.

Cell Concept 6 - Binary Fission

1.

2.

CONCLUSION: (On a separate sheet of paper – with your observations)

1. Describe what you observed about the bubble membrane's "fluidity" and explain how this relates to the structure of the cell membrane. (1 pt)
2. What are the four major components of the cell membrane and how are they organized? Make sure you discuss polarity in your response. (2 pt)
3. Explain how the "self-sealing" bubble membrane helps to illustrate the passage of molecules through a cell membrane and the property of selective permeability. (1 pt)
4. Explain how selective permeability maintains homeostasis within a cell. In your answer, define homeostasis. (2 pts)