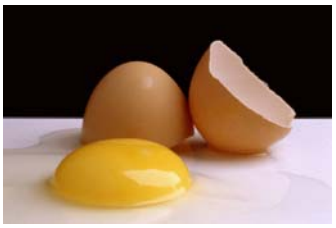
Make a Cell Membrane

OBJECTIVES



1. Demonstrate that collection of interconnected cells forms biological tissue
2. Demonstrate properties of cell membrane and phospholipid layer
3. Introduce concepts of hydrophilic and hydrophobic properties

BACKGROUND INFORMATION

The flexible plasma membrane forms the outside barrier to the cell, separating the intracellular fluid within cells and the extacellular fluid outside cells. The unique structure of the cell membrane allows it to play a dynamic role in many cellular activities.

The plasma membrane is an exceedingly thin structure (7-10nm) composed of a double layer, or bilayer of lipid of proteins and lipids (approx. 60% protein and 40% lipids). The proteins in the cell are mainly a type of protein called stromatin, an insoluble structural protein having elastic properties. The lipids are approx 65% phospholipids, 25% cholesterol and 10% other lipids.
The properties of the cell membrane allows it:

- to act as a barrier between the cell and its environment, allowing a complex organized system to exist inside the cell.
- permit the passage of selected substances into and out of the cell.
- flex, bend and flow to allow the cell to change shape.

Phospholipids and cholesterol form membranes due to the structure of the phospolipids. They have a polar head and a nonpolar tail. The polar head is charged and attracted to water (hydrophilic), the main constituent of intracellular and extracellular fluids, and so they lie on both the inner and outer surfaces of the membrane. The nonpolar tails avoid water (hydrophobic) and so line up facing the centre of the membrane (figure 1). The self-orientating properties of phospholipids encourages biological membranes to self-assemble into closed, generally spherical structures and to researl themselves quickly when torn.

Polar forces between water molecules pull them together as if they are attracted together like magnets, providing a force which squeezes the nonpolar (hydrophobic, like they are afraid of water) oil out of solution. That is why oil and water do not mix. Oil is less dense so it heads towards the top. If oil were heavier than water then it would form a layer at the bottom.

ACTIVITY

In this activity the oil represents the lipids contained in a plasma membrane and the egg yolk represents the proteins and cholesterol. These both join together to form a cell membrane due to the polar heads being attracted to water and the tails attracted to non-polar oil. The water represents the intracellular and extracellular fluid.

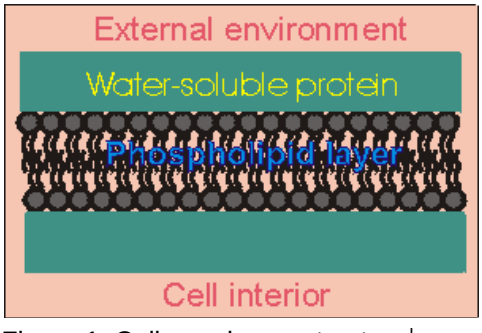


Figure 1: Cell membrane structure[1]

Make a Cell Membrane

WHAT YOU NEED

- 125 Ml flask with stopper, or suitable jar with lid
- 25mL cooking oil
- Egg-dish, container for egg
- Eyedropper
- Water
- Iron filings

WHAT TO DO

1. Add 100mL of water to the flask or jar then add 25mL oil to the water
2. Cover then shake for a second or two. Mixture should at first appear milky but quickly start separating
3. While you are waiting for the oil and water to separate, crack open your egg into the egg dish. Notice that the egg yolk is a single giant cell. The yellow yolk contains among other fats and oily compounds, phospholipid molecules (can be used as soap) that form strong flexible cell membranes.
4. Now use the eyedropper to draw up a drop of egg yolk and add to your water/oil solution. **Be careful to only add one drop!** Adding too much can cause the oil to form such small droplets it becomes a colloid, like milk.
5. The drop of yolk will fall through the oil but float on the water so you can see it stuck in the middle. Shake for a second or two like before.
6. Now watch what happens to the oil layer this time. It should soon look like a giant piece of tissue, like you're looking at cells under a microscope, but in this case, you see them with your own eyes! The less dense ones which contain only oil and have a phospholipid monolayer around them, go to the top. The smaller phospholipid bilayer vesicles which are even much more like living cells and contain water inside would be at the bottom of the layer, with some moving in the thermal convection currents of the water.
7. Sprinkle a small amount of iron filings into the solution
8. As the particles pass through the oil-membrane-water interface (shake a little if they get stuck) they are first coated with oil, then pick up a membrane, and after passing into the water quickly sink to the bottom where they will stay.

QUESTIONS / ANSWERS

1. Why did we use oil and egg yolk to simulate formation of cell membrane?
2. How do you think the water gets trapped inside the “cells”?
3. How do you think a cell membrane could get damaged?

Make a Cell Membrane

CURRICULUM

Essential Learnings Year 5:
Structures of living things have particular functions.

Essential Learnings Year 7:
Cells are the basic unit of all living things and perform functions that are needed to sustain and reproduce life.

Essential Learnings Year 9
Complex organisms depend on interacting body systems to meet their needs internally and with respect to their environment.

Science21
LS1: The cell is the lowest form of organisation that can perform all activities required for life.
More complex organisation of cells involves tissues, organs and organ systems

REFERENCES

1. Anon. 2008. Models of the plasma membrane. http://www.hillstrath.on.ca/moffatt/bio3a/cellbio/phase1.htm. (accessed 18/04/08).

2. Gaulin, G. 2008. Self-Assembly Of Real Cell Membranes Experiment. http://www.lessonplanspage.com/ScienceSelfAssemblyOfRealCellMembranesOriginOfLifeExperiment68.htm (accessed 1/04/08)

3. Marieb, E.N. 2004. Human Anatomy & Physiology. Pearson Benjamin Cummings:San Francisco.