Fascinating Education Script
Fascinating Biology Lessons

Lesson 3: The Cell Membrane

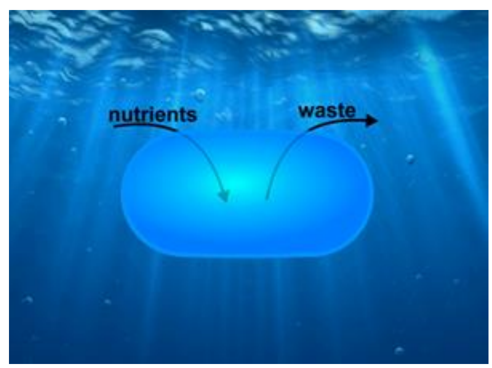
Slide 1: Introduction

Slide 2: The waterproof cell membrane

All life requires water. The interior of all organisms is watery, so there is no such thing as an organism living without water.

The earth formed about 4.5 billion years ago. It took a billion years for the earth to cool off and for the oceans to form.

For life to begin there had to be a private, protected chamber where simple molecules could begin forming the complex molecules of life. A waterproof membrane was the ideal solution to keep promising molecules from being washed away into the vast reaches of the ocean.



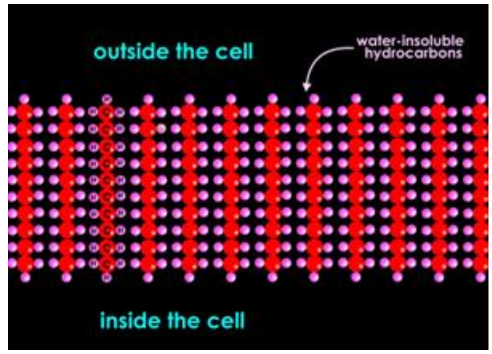
Non-polar lipids are the ideal candidates for cell membranes, except for one thing. The cell wants to keep the ocean out but at the same time allow the ocean in, because life inside a cell membrane needs the ocean's water and the nutrients dissolved in the ocean water -- nutrients like sodium, potassium, calcium, magnesium, nitrogen, sulfur, chlorine, and phosphate, and any molecules that might harbor energy in their chemical bonds.

And if the inside of the cell is watery, the cell needs to be able to discharge water-soluble waste back out through the cell membrane.

Slide 3: Allowing water to pass through the cell membrane

The solution to this problem was to make the cell membrane out of waterproof non-polar lipids, but coat the outside of the lipid membrane with water-soluble polar molecules.

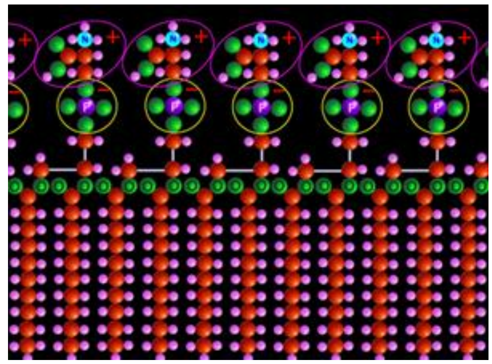
The first step is to make one end of the hydrocarbons polar by adding two oxygen atoms and turning the hydrocarbons into fatty acids.



The next step is to link every two fatty acids together with a glycerol molecule.

Then attach a negative phosphate molecule to that.

On top of the phosphate, attach a positive serine molecule.



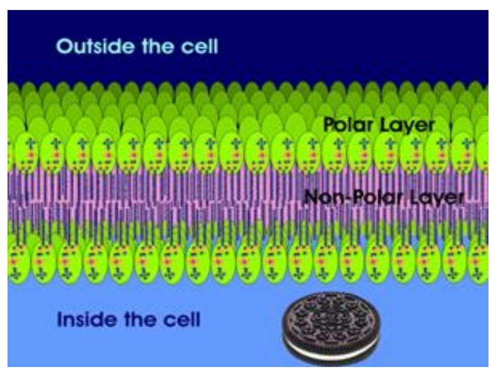
Or instead of serine, you could attach choline or ethanolamine. All of these are types of phospholipids.

With the charged phosphate and serine molecules on the surface of the cell membrane, the cell membrane can now interact with the water surrounding the cell.

Unfortunately, we still have a problem. The inside of the cell will also be filled with water, so the inside of the cell membrane needs a polar coating, too.

How would you solve that problem if only one side of a phospholipid is polar?

Of course, make the cell wall two layers thick by attaching a duplicate of the phospholipid layer, turned upside down, to the inside layer of the cell membrane. The cell membrane now has two layers of phospholipids but showing a polar face to the watery world outside the cell and inside the cell. That leaves the cell wall waterproof while permitting the water soluble molecules coating the outside and inside surfaces of the cell free to interact with polar molecules and ions in the surrounding ocean water and the cell's interior.



The result is a cell membrane looking like an Oreo cookie -- a waterproof lipid center sandwiched between two water-soluble layers, which scientists call a "lipid bilayer."

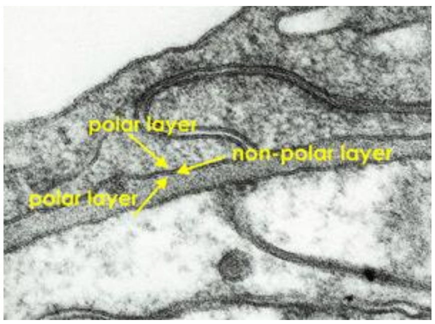
Polar molecules can't get through this membrane because they can't pass through the middle, non-polar layer.

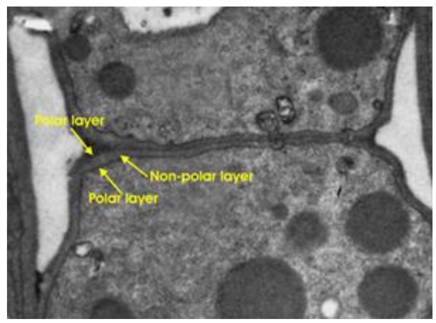
Non-polar molecules have an easier time getting through a lipid bilayer, because once they slip between the polar heads in the outer layer, they have no trouble crossing through the non-polar middle layer, and then slipping through the polar heads on the inner layer.

Slide 4: Microscopic view of a cell membrane

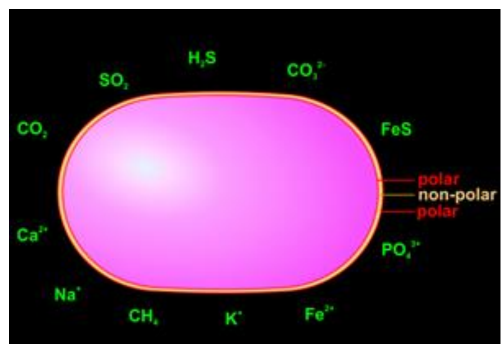
Here is an electron microscopic view of a cell membrane. Note the thick non-polar middle layer sandwiched between two thin polar layers.

Here is a better view of another cell membrane. Again, each membrane sandwiches an inner non-polar layer between two polar layers.





Slide 5: Getting nutrients through the cell membrane



As effective as a non-polar layer sandwiched between two polar layers is in protecting a cell from the outside, it raises the obvious problem of getting nutrients through the cell membrane into the cell. After all, how are polar nutrients going to enter the cell if they have to pass through a non-polar membrane, and how are non-polar nutrients like methane getting into the cell if they have to pass through a polar layer?

And let's not forget that today nutrients can range in size from tiny ions to medium-sized vitamins to large carbohydrates, lipids, proteins, and even nucleic acids.

That's just one problem. A more fundamental problem is coaxing a nutrient sitting comfortably outside the cell to enter the cell in the first place. Why should a nutrient outside a cell move into the cell? There has to be some force pushing or pulling a nutrient into the cell, especially when the nutrient has to get through an obstacle like a cell membrane.

We'll take up the subject of getting nutrients into the cell in the next lesson.

Slide 6: What you know so far

1. The cell membrane protects the water-soluble interior of the cell from water-soluble molecules outside the cell. The cell membrane is able to do this because it is made of non-polar molecules, making it waterproof.

2. To allow water-soluble molecules inside and outside the cell to interact with the non-polar, water-insoluble cell membrane, the cell membrane is coated on each side with a layer of polar molecules.

3. The cell membrane, then, has three layers: an outer polar layer, a middle non-polar layer, and an inner polar layer.