

CELL MEMBRANE THOUGHT EXPERIMENT

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Background

This activity is a simple series of thought experiments that provide an opportunity for students to spontaneously form (through drawings) a cell membrane using their knowledge of molecules having both hydrophilic and hydrophobic components (amphipathic).

Materials

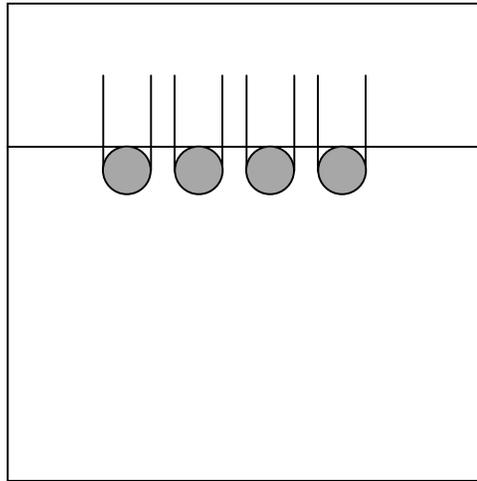
Paper and pencils

Procedure

Lipid Surface Monolayer

1. I direct students to draw a to scale 600ml beaker, and fill it 2/3 full of water. As they do so, I often walk around the room and make comments about those students who have accidentally knocked their beakers (noticeable by the waves in their water). I also comment on the fact that some make 2-D beaker while others draw theirs in perspective, and some draw graduations and fill it to exactly 2/3 full of water (just a way to help waste time while were waiting for all to finish drawing).
2. Then, I draw a simplified phospholipid on the board (a circular head and two line tail), and label the head hydrophilic and the tail hydrophobic. I do not label the molecule "phospholipid". At this point, I ask them to share what they know about the roots of the words so that we develop meanings for these two terms.
3. Finally, I tell the students that I will be walking around the room passing out 5 to 10 of these molecules, and that they are to imagine and draw how these molecules would arrange themselves if they were dropped from above their beaker of water.

Most students quickly draw something that looks like the following, a surface monolayer of the molecules. Some will have the heads just touching the water, and some might even draw a few totally submerged thinking that they will drop into the water (disregarding the focus on the hydrophilic and hydrophobic characteristics of the molecule). Most students can be easily steered in the right direction by asking a few questions.



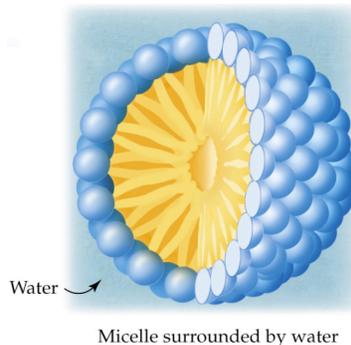
Lipid Micelle

1. For the second thought experiment students are asked to draw a second beaker 2/3 full of water.
2. When finished, students are given more imaginary molecules (verbally this time) and asked to represent how they would arrange themselves if they had to meet the criteria that they had to be submerged and surrounded by water. Since they really understand that their hydrophobic portions of the molecule don't like the water in the last thought experiment the majority of students immediately resist this and openly suggest that this is impossible.
3. At this point, I usually give them the hint that the molecules work together to solve the problem.

4. I walk around the room quickly looking for correct answers. When, I find them, I quickly turn over their paper (It is important that you have had the students rip out a piece of their notebook paper earlier so you can do so). Many students will still not be able to successfully form the correct structure show below.

Those that are correct will either draw a cross-section like the left half of the picture show, while others will draw a circle of spheres like the right half of the picture. Later I ask those that have drawn the cross-section if the hydrophobic tails are really exposed to the water and they all can quickly tell me that it is really a sphere and they have drawn it cut in half. For those that have drawn the sphere of heads I ask what it would look like if cut in half and similarly they all can easily tell me or draw it for me.

For those that still don't get it, I can often ask questions that get them to modify their drawings so that they use more molecules and soon see that the heads can shield the tails. Many never get it on by their selves but all easily understand it once they see it drawn on the board. I usually have the first student that finished correctly to come share their drawing and reasoning from the front of the class.

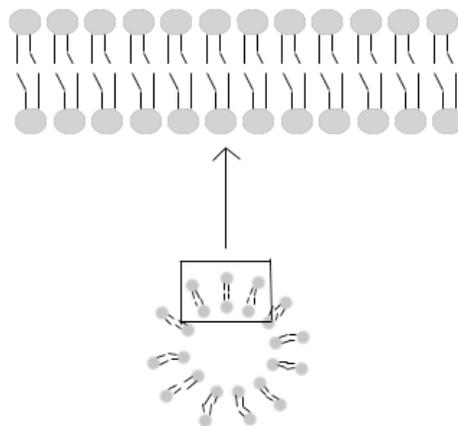


The Phospholipid Bilayer of a Cell Membrane

1. For the third thought experiment student are asked to draw their final beaker 2/3 full of water.
2. When finished, students are given more imaginary molecules (verbally this time too) and asked to represent how they would arrange themselves if they had to meet the criteria that they had to be submerged and surrounded by water, but also be able to contain water.

Many more students get this one. Knowing the answer to the previous question allows even those that never figured out the second thought experiment on their own to complete this one correctly.

3. For those that still can't figure it out, I may tell them that the answer is based off of the previous answer.
4. Once the majority of students figure it out, I have another successful volunteer come to the front of the room to draw their molecular arrangement and discuss the reasoning that led them to the answer.
5. At this point, I challenge the students to use their textbook to determine and label their drawing with the name of the molecules and the overall name of the structure represented in this last thought experiment. I may even tell them I am going to give extra credit for the first person to find such information (only to create excitement –I usually don't give them any or I'll tell them that its worth something insignificant when they ask after having found the names).



I reinforce this over the course of the unit on basic cell structure and function and they never forget this basic structure of the cell membrane and why it forms in the manner that it does!