MCAT > CELLS

Cell membrane overview

Phospholipid structure

Cell membrane overview and fluid mosaic model

Cell membrane proteins

Cell membrane fluidity

Membrane dynamics

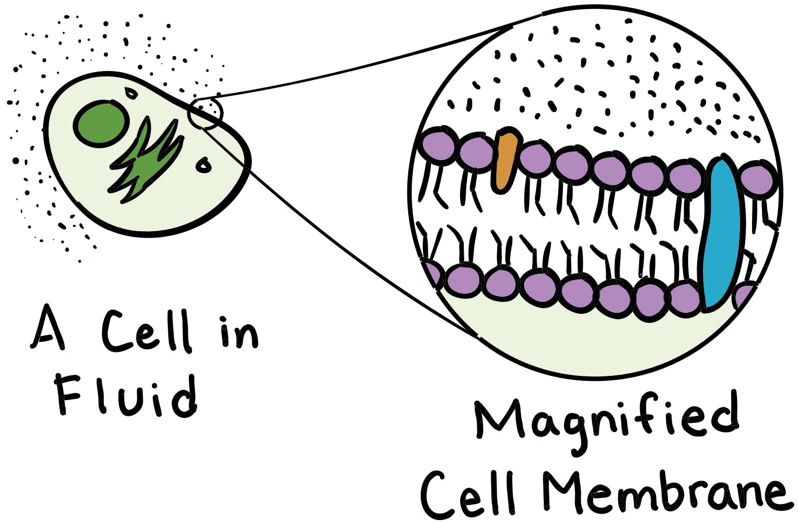
Fluid mosaic model: cell membranes article

Next tutorial
Cell-cell interactions

Fluid mosaic model: cell membranes article

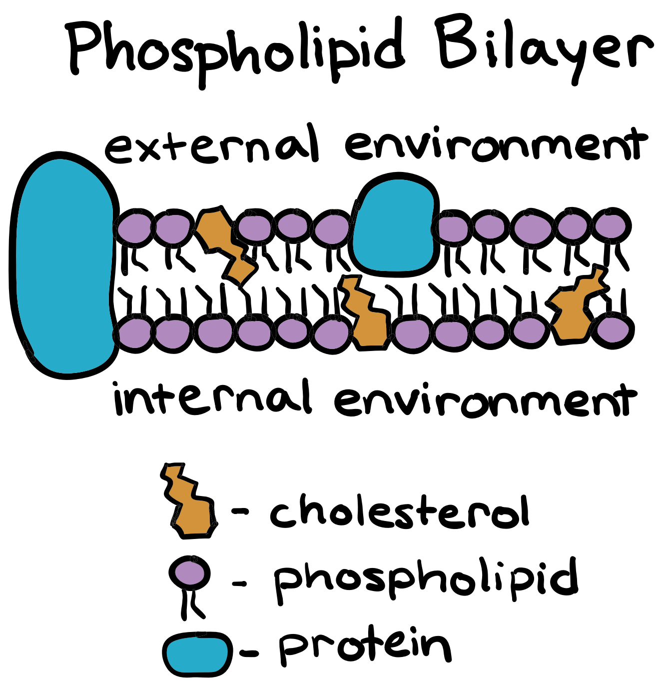
It may seem like the human body is made up of a chaotic mix of random parts, but that's not the case. The liquid nutrients, cell machinery, and blueprint information that make up the human body are tucked away inside individual cells, surrounded by a double layer of lipids.

The purpose of the cell membrane is to hold the different components of the cell together and to protect it from the environment outside the cell. The cell membrane also regulates what enters and exits the cell so that it doesn't lose too many nutrients, or take in too many ions. It also does a pretty good job of keeping harmful things out.



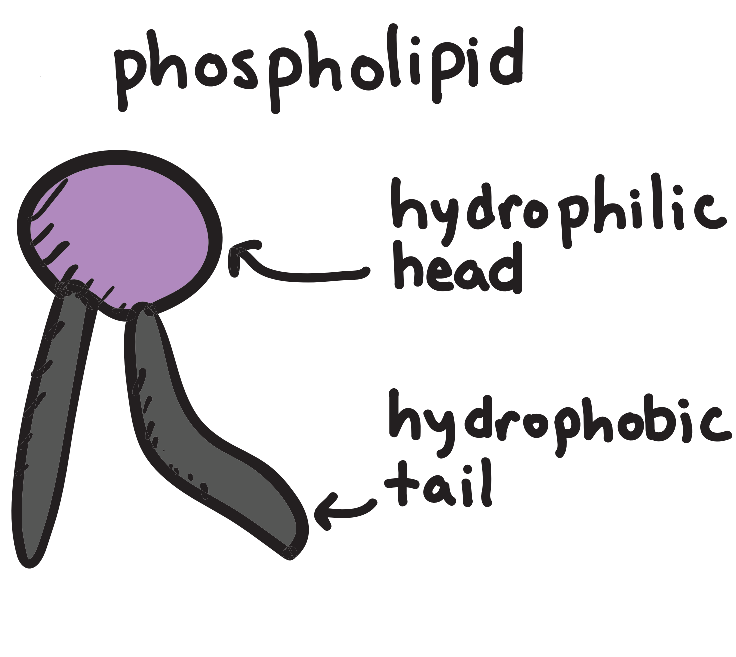
What's it made up of?

The cell membrane is primarily made up of three things: 1. Phospholipids 2. Cholesterol 3. Proteins



1) Phospholipids

There are two important parts of a phospholipid: the head and the two tails. The head is a phosphate molecule that is attracted to water (*hydrophilic*). The two tails are made up of fatty acids (chains of carbon atoms) that aren't compatible with, or repel, water (*hydrophobic*). The cell membrane is exposed to water mixed with electrolytes and other materials on the outside and the inside of the cell. When cellular membranes form, phospholipids assemble into two layers because of these hydrophilic and hydrophobic properties. The phosphate heads in each layer face the aqueous or watery environment on either side, and the tails hide away from the water between the layers of heads, because they are hydrophobic. Biologists call this neat assembling characteristic "self-assembly".



2) Cholesterol

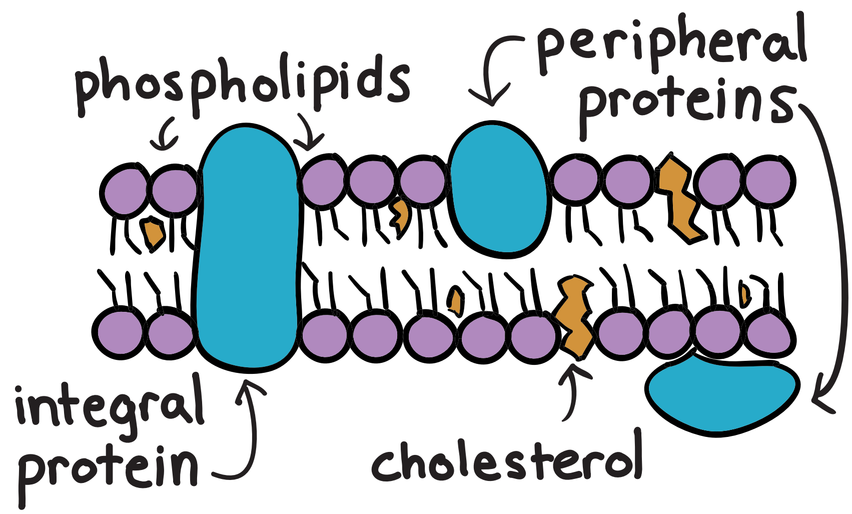
Cholesterol is a type of steroid which is helpful in regulating molecules entering and exiting the cell. We'll talk about this in more depth later, but for now remember it's part of the cell membrane.

3) Proteins

The cell is made up of two different types, or "classes", of proteins. *Integral proteins* are nestled into the phospholipid bilayer and stick out on either end. Integral proteins are helpful for transporting larger molecules, like glucose, across the cell membrane. They have regions, called "*polar*" and "*nonpolar*" regions, that correspond with the polarity of the phospholipid bilayer.

Polar and nonpolar refer to the concentration of electrons on a molecule. Polar means the electrons are not evenly distributed, making one side of the molecule more positively charged or negatively charged than another side. Nonpolar means the electrons are evenly distributed, so the molecule is evenly charged across the surface.

The other class of protein is called *peripheral proteins*, which don't extend across the membrane. They can be attached to the ends of integral proteins, or not, and help with transport or communication.

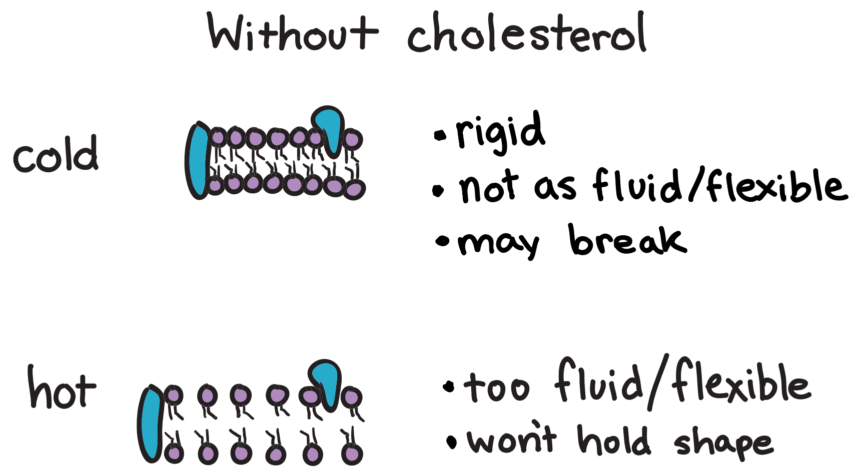


What makes the cell membrane fluid?

The fluid mosaic model of the cell membrane is how scientists describe what the cell membrane looks and functions like, because it is made up of a bunch of different molecules that are distributed across the membrane. If you were to look at a cell membrane using a microscope, you would see a pattern of different types of molecules put together, also known as a *mosaic*. These molecules are constantly moving in two dimensions, in a *fluid* fashion, similar to icebergs floating in the ocean. The movement of the mosaic of molecules makes it impossible to form a completely impenetrable barrier.

There are 3 main factors that influence cell membrane fluidity:

1. Temperature: The temperature will affect how the phospholipids move and how close together they are found. When it's cold they are found closer together and when it's hot they move farther apart.

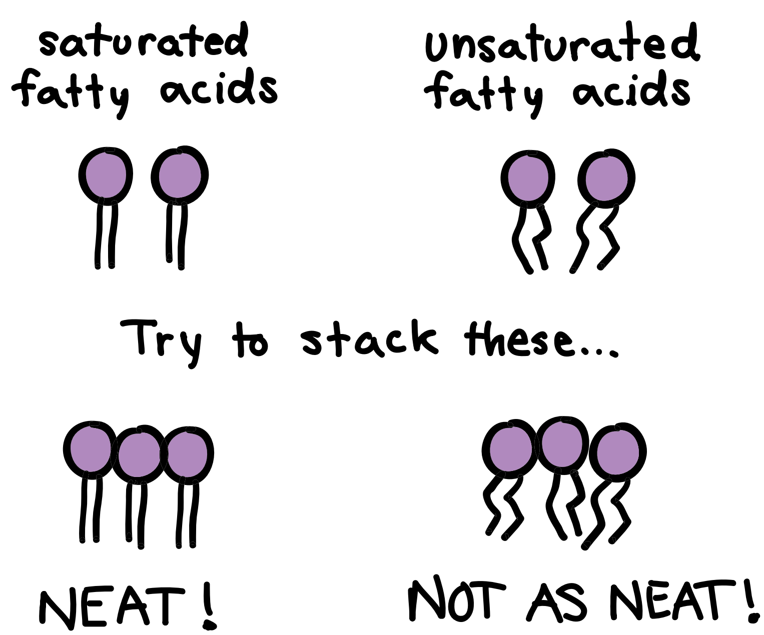


2. Cholesterol: The cholesterol molecules are randomly distributed across the phospholipid bilayer, helping the bilayer stay fluid in different environmental conditions. The cholesterol holds the phospholipids together so that they don't separate too far, letting unwanted substances in, or compact too tightly, restricting movement across the membrane. Without cholesterol, the phospholipids in your cells will start to get closer together when exposed to cold, making it more difficult for small molecules, like gases to squeeze in between the phospholipids like they normally do. Without cholesterol, the phospholipids start to separate from each other, leaving large gaps.

3. Saturated and unsaturated fatty acids: Fatty acids are what make up the phospholipid tails. Saturated fatty acids are chains of carbon atoms that have single bonds between them. This makes them straight and easy to pack tightly. Unsaturated fats are chains of carbon atoms that have some double bonds between them. Double bonds create kinks in the chain, making them not as easy to pack tightly. There are two possible kinks that can occur:

    1. *Cis-unsaturated fats*, where both sides of the chain remain on the same side
    2. *Trans-unsaturated fats*, where the sides of the chain are opposite from each other

The kinked shape of cis-unsaturated fats make it more difficult to pack tightly.



This plays a role in membrane fluidity, because the kinks increase the space in between the phospholipids, making them harder to freeze at lower temperatures. Also, some molecules, like CO_2 and O_2, require small spaces between the phospholipids so that they can cross the membrane quickly and easily.

What can go through the cell membrane?

Phospholipids are attracted to each other, but they are also constantly in motion and bounce around a little off of each other. The spaces created by the membrane's fluidity are incredibly small, so it is still an effective barrier. For this reason, and the ability of proteins to help with transport across the membrane, cell membranes are called *semi-permeable*.

There are 5 broad categories of molecules found in the cellular environment. Some of these molecules can cross the membrane and some of them need the help of other molecules or processes. One way of distinguishing between these categories of molecules is based on how they react with water. Molecules that are hydrophilic (water loving) are capable of forming bonds with water and other hydrophilic molecules. They are called polar molecules. The opposite can be said for molecules that are hydrophobic (water fearing), they are called nonpolar molecules. Here are the 5 types:

1. Small, nonpolar molecules (ex: oxygen and carbon dioxide) can pass through the lipid bilayer and do so by squeezing through the phospholipid bilayers. They don't need proteins for transport and can diffuse across quickly.
2. Small, polar molecules (ex: water): This is a little more difficult than the molecule type above. Recall that the interior of the phospholipid bilayer is made up of the hydrophobic tails. It won't be easy for the water molecules to cross, but they can cross without the help of proteins. This is a somewhat slower process.
3. Large, nonpolar molecules (ex: carbon rings): These rings can pass through but it is also slow process.
4. Large, polar molecules (ex: simple sugar - glucose) and ions: The charge of an ion, and the size and charge of large polar molecules, makes it too difficult to pass through the nonpolar region of the phospholipid membrane without help.

Consider the following:

What happens when there is a problem with the cell membrane's ability to uptake/export important molecules or communicate? There are many diseases associated with problems in the ability of the phospholipid bilayer to perform these functions. One of these is Alzheimer's disease, characterized by brain shrinkage and memory loss. One idea explaining why Alzheimer's disease occurs is the forming of plaque sticking to the phospholipid bilayer of the brain neurons. These plaques block communication between the brain neurons, eventually leading to neuron death and in turn causing the symptoms of Alzheimer’s, such as poor short-term memory.

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I have noticed that there is a writing new folder in every subject (like the one here) so does this cover every thing in this topic, so can i just read it without watching the videos?

• 11 votes • 1 comment • Flag

3 years ago by Norman

One way that could be helpful would be to offer a quick summary of what is above, and then after watching the videos, go through and answer the questions.

8 votes • Comment • Flag

3 years ago by M. R. Wiggins

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The article says the cell membrane has 2 types of proteins but it's missing the lipid bound protein (in-between the two phospholipid leaflets) mentioned in the "cell membrane proteins" video.

The article says there are 5 types of molecules but only 4 are listed.

The article says "The kinked shape of cis-unsaturated fats make it more difficult to pack tightly." What about trans-unsaturated fats?

7 votes • 1 comment • Flag 3 years ago by ff142

I think lipid bound proteins are excluded because they do not play a role in transport or signaling.

In part 4 of the 5 types of molecules, there are two different categories lumped into one: large, polar; and ions.

Trans-unsaturated fats can pack more tightly than cis-unsaturated fats but less tightly than saturated fats.

8 votes • Comment • Flag 2 years ago by Jace Bradshaw

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I need to reference this into my essay, could I have the author name and the date published please? :)

2 votes • Comment • Flag 4 months ago by 318273

I also am using this information for an assignment, and was wondering who to credit to?? :)

2 votes • Comment • Flag 3 months ago by Chantilly Lace

How does phospholipid movement (flipping, flopping, scrambling) in the bilayer contribute to the survival of a cell?

2 votes • Comment • Flag about a year ago by fmroth

This is actually a super cool question, never thought of it. I can think of several possible answers:
1) Signaling: though these videos don't mention it much, there are many different kinds of phospholipids and they can be useful for signaling and telling other cells what type of cell this is. e.g. some phospholipid types are only on the outside membrane. One type of phospholipid, phosphatidylserine, is usually present more on the outside than inside. We know from observation that if it's... (more)

1 vote • Comment • Flag
17 days ago by Ank Agarwal

How exactly does the structure of a cell membrane supports its functions?

2 votes • Comment • Flag 3 years ago by jepas671

It does so by creating an electrochemical gradient that can than be used to drive ATP synthesis. This is one of the membranes most important functions. If the cells loses membrane integrity it will no longer be able to generate energy.

1 vote • Comment • Flag
about a year ago by StevenPiroso

Show all 2 answers • Answer this question

Do cell membrane apply force to hold the organelles

1 vote • Comment • Flag 2 years ago by Sid Sid

Organelles are held in place by the cytoskeleton, and the cytoskeleton pushes out on the cell membrane, holding it open in a globular shape.

3 votes • 1 comment • Flag
2 years ago by ♪♫ Viola ♬♪

How do lipid rafts affect membrane fluidity? I'd expect large protein aggregates in the membrane to decrease fluidity?

1 vote • Comment • Flag 2 years ago by King

Well, the lipid raft itself **does** have low membrane fluidity, but it moves around in the membrane, so I'd guess it might...maybe...have the same buffering effect on the membrane as a whole, like cholesterol.

2 votes • Comment • Flag
2 years ago by ♪♫ Viola ♬♪

The article asks what makes a cell membrane fluid and then talks about three points that influence the fluidity of the cell, one of them being cholesterol. Towards the end of the paragraph it says that without cholesterol, the phospholipids get closer together, then a sentence or two later it says that without cholesterol phospholipids get farther apart. Is this a typo, or will phospholipids do both depending on the environment and condition they are in?

1 vote • Comment • Flag
2 years ago by kdougherty42301

The key is temperature. Without cholesterol, the phospholipids will get closer together in a cold environment. The cholesterol acts as a kind of spacer to prevent them from getting too close. Conversely, in hot temperature, the phopholipids spread too far apart without cholesterol. The phospholipids want to be near the cholesterol molecules, causing them to be closer together.

2 votes • Comment • Flag
about a year ago by shaunacjones

Show all 2 answers • Answer this question

Do trans fatty acids tend to pack tightly together at room temperature, or are they more liquid (like unsaturated fatty acids) at room temperature?

1 vote • Comment • Flag 2 months ago by Aamir

How does nonpolar molecules move across the membrane ? Because in order to move through it they first encounter the hydrophillic part (or lypphobic) part of the plasma membrane, they need to first cross this barrier then only they can move.

1 vote • Comment • Flag
about a year ago by shreypatel0101

There are two principal methods discussed in the videos. 1) Random movement. sometimes phospholipids acquire enough energy to just move. This depends entirely on factors like temperature, whether there's cholesterol nearby, and whether the phospholipid has saturated or unsaturated tails. 2) Proteins can either actively or passively catalyze movement of a phospholipid across the membrane. Active proteins use ATP to catalyze the amount of energy that's required to move a molecule through a space… (more)

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17 days ago by Ank Agarwal

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‹ Membrane dynamics