Surface Tension and Movement: Molecules that Stick Together Stay Together!

What you need:

- Water
- Paper clips
- Dish soap
- Q-tip or fork
- Pepper

What to do: Surface of water as a film/skin

1. Add water to a small flat dish.

2. Gently add paperclips to the water so that they float. You can do this by dropping it slowly in the dish or by adding it from the side. Look carefully at the paper clip and how the water warps around it.
   Note: For best effect add no more than four paper clips

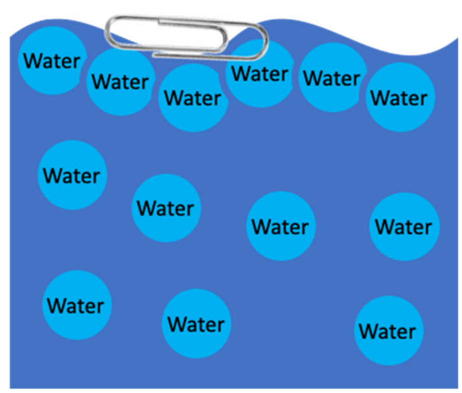
3. Add a drop of dish soap or use a Q-tip/fork that's dipped in dish soap. What happened?

4. Try adding more paper clips to the dish. Do any of them float anymore?

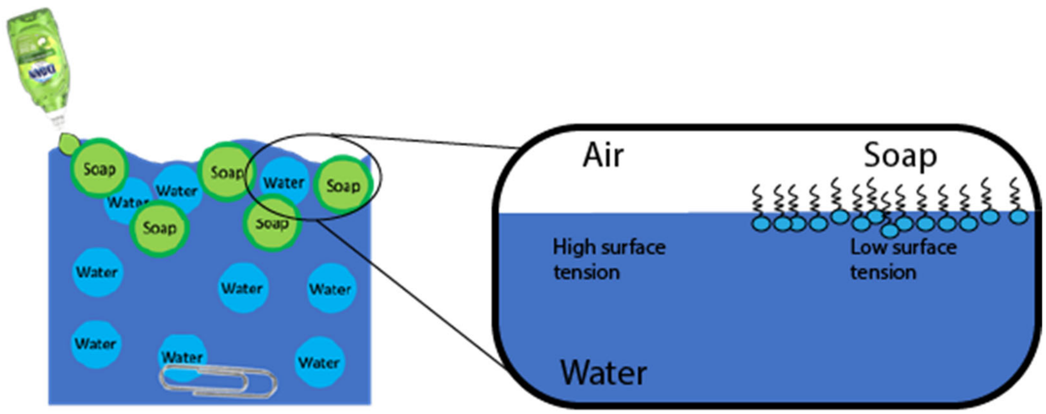
What's happening?

Water is a unique liquid because of what water is made of. Water is made of molecules, basically just the smallest unit of water, that are really attracted to each other. The molecules that make up water want to limit contact with anything besides water itself. We call this force of attraction between water and air "surface tension." At the surface, the water molecules are even more attracted to each other because they want to stay away from the air. This layer of water molecules is similar to plastic wrap that's tightly stretched across a surface. This "skin" allows some materials to float on the surface but not penetrate through the skin. The surface tension of water is so high that it allows certain light objects to stay completely afloat! All liquids have their own unique surface tension depending on the strength of their interaction with each other.

Surface Tension



In this demo, we are using paper clips. Paper clips are made of metal and are much heavier than water, meaning they should sink. Because of that surface tension "skin" though, the paper clips can actually float! But when you add dish soap, the molecules of soap and water mix together at the surface. This disrupts the "skin" so that nothing can float on it like before. This severely lowers the surface tension to the point where nothing can float anymore. We will learn more about how we can use soap to change the behavior of water in the next activity.



What to do: Riding the waves of surface tension

1. On a clean flat dish, add water.

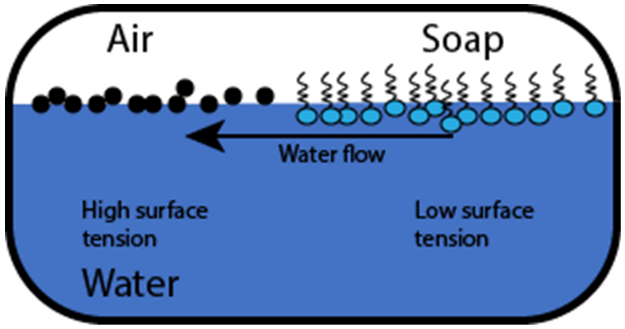
2. Drop some pepper on the surface evenly. The water does not need to be completely covered.

3. In the corner of the dish, add soap with a Q-tip/fork that has been dipped in dish soap. What happened?

4. Try adding soap again! Does anything happen?

What's happening?

Compared to the previous activity where we used paper clips that were heavier than water, in this demo, we are using pepper. Pepper is lighter than water so it will float. This means we can see how the surface tension changes on the surface! We learned before that adding soap lowers the surface tension. When you add soap to the middle or corner of your dish, you immediately lower the surface tension in that spot. Now you are creating an area of low surface tension near the soap and an area of high surface tension away from the soap. This difference in surface tension pushes the water towards higher surface tension. Imagine playing tug of war with a friend and suddenly your friend loosens their grip on the rope, we would fall backwards. Similarly, water will move away from the soap and by doing so, carry the pepper with it.



The reason why this only works once is because once the surface of the water is full of soap, we can no longer create a difference in surface tension. Adding more soap would no longer lower the surface tension any more as there is no longer free water - air surfaces. In the next activity we will look at the surface between two liquids, instead of the surface between liquid and air. This means you can have much more surface that allows you to keep seeing movement!

Interfacial tension demo

What you need:

- Q-tip or fork
- Water based food coloring
- Milk (2% and whole)
- Dish soap
- A small container or dish

What to do:

1. Add some milk to a small container or dish until it is approximately a ¼” deep.

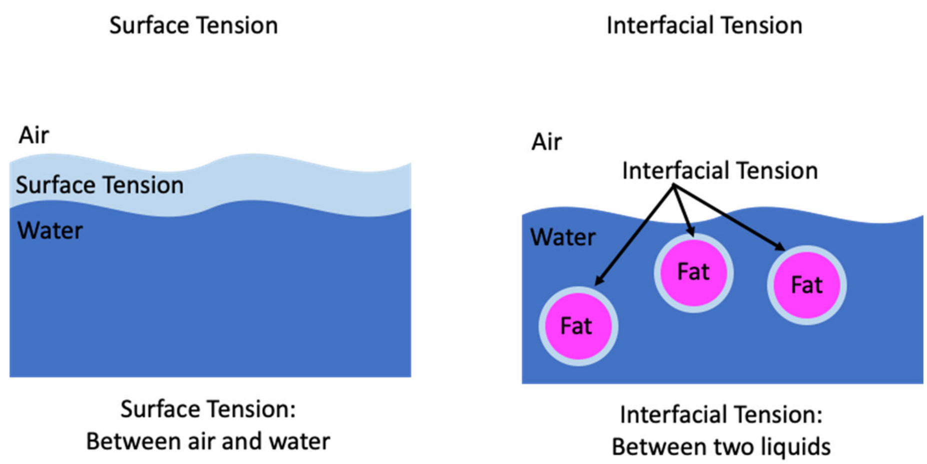
2. Add 3-4 drops of food coloring to the milk close to the center of the dish.

3. Dip one end of a Q-tip into the dish soap so there is a thin layer on the end.

4. Use the dish soap end of the Q-tip to tap the milk surface in the center of the food dye. What do you see happen?

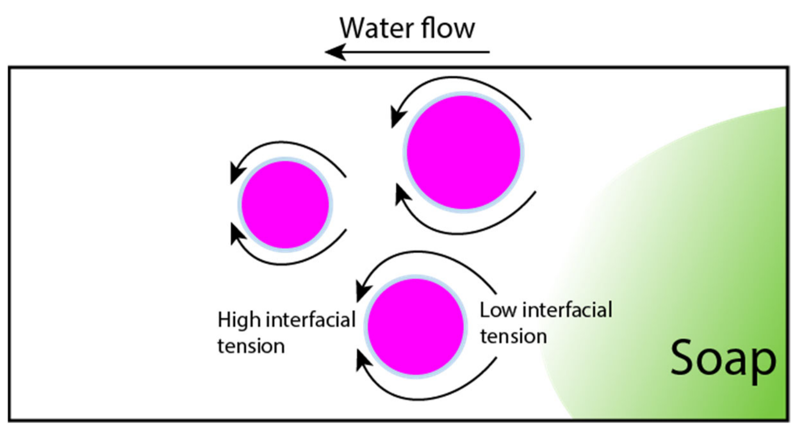
Clean-up:

1. Pour the milk mixture in the sink and wash the container with water.
2. The Q-tip can go in the trash.



What's happening?

Milk is composed of mostly water but includes many other things such as protein and fats. These fats and protein kind of act like oil. Remember that oil and water do not mix because oil is hydrophobic (water hating). These "oil" droplets do not like interacting with the water droplets. Therefore, there is interfacial tension between the two liquids. Interfacial tension is just a fancy word that means the surface tension between water and oil/fat (two liquids) instead of water and air (a liquid and a gas).



Just like in our previous demos, adding soap lowers the surface and interfacial tension. So, when the dish soap touches the milk, the interfacial tension is reduced and the water is pulled away from the dish soap in waves! We can see this happening as the food coloring moves through the milk. Compared to the surface tension demo, we will continue to see movement until all the fats mix with the soap. Remember that in this demo, we care about the surface between the fat and the water instead of the surface between the water and air. There is a lot more surface because of all the fats in milk so you will continue to see an explosion of color for a lot longer!

Activity extension questions:

What would happen if you use a different type of milk (skim, 1%, or watered-down milk etc.)? Try it!
Different types of milk have different fat contents. The extent the food coloring moves through the milk may vary. As the amount of fats determine how much "interface" there is in the milk, more fat will mean longer color explosions!

Does the movement of the colors change depending on where you put the dish soap in the milk?
Try touching the dish soap to the edge of the food coloring or the edge of the dish. Do you get more color movement when the dish soap is close to the food coloring or farther away?