Cohesion and adhesion of water

Cohesion, adhesion, and surface tension of water and how they relate to hydrogen bonding.

Cohesion of water

Have you ever filled a glass of water to the very top and then slowly added a few more drops? Before it overflows, the water forms a dome-like shape above the rim of the glass. This dome-like shape forms due to the water molecules' cohesive properties, or their tendency to stick to one another. **Cohesion** refers to the attraction of molecules for other molecules of the same kind, and water molecules have strong cohesive forces thanks to their ability to form hydrogen bonds with one another.

Cohesive forces are responsible for **surface tension**, the tendency of a liquid's surface to resist rupture when placed under tension or stress. Water molecules at the surface (at the water-air interface) will form hydrogen bonds with their neighbors, just like water molecules deeper within the liquid. However, because they are exposed to air on one side, they will have fewer neighboring water molecules to bond with, and will form stronger bonds with the neighbors they do have. Surface tension causes water to form spherical droplets and allows it to support small objects, like a scrap of paper or a needle, if they are placed carefully on its surface.

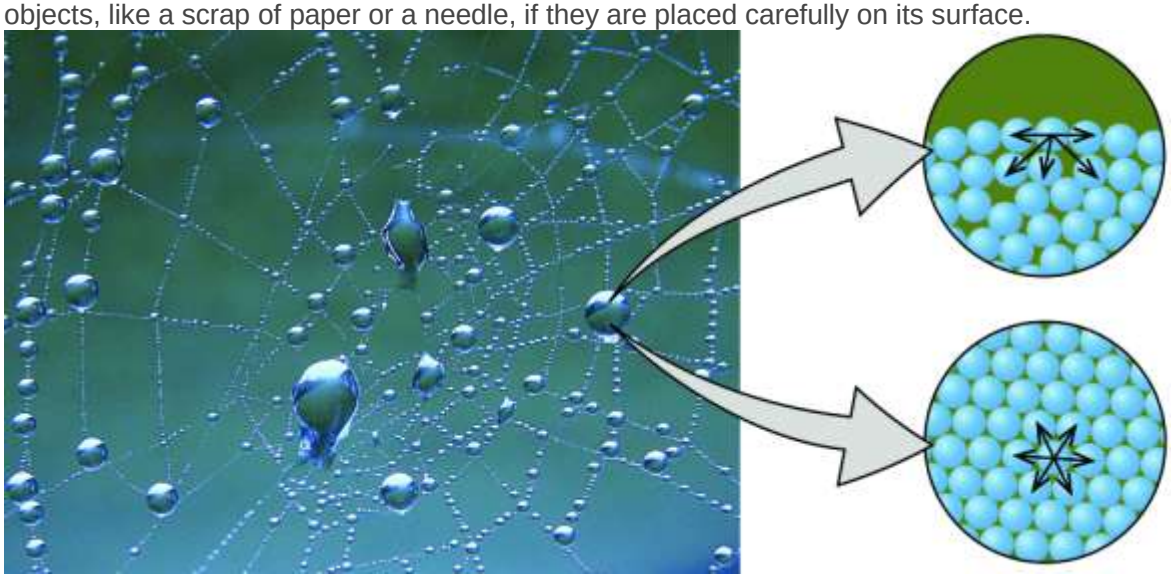

Illustration of surface tension in a water droplet suspended in a spider's web. Water molecules inside the center of the droplet have more neighboring water molecules to interact with than water molecules at the surface. Thus, the water molecules at the surface form stronger interactions with the neighbors they do have.

Image credit: "Properties of liquids: Figure 2," by OpenStax College (CC BY 4.0).

Adhesion of water

Water likes to stick to itself, but under certain circumstances, it actually prefers stick to other types of molecules. **Adhesion** is the attraction of molecules of one kind for molecules of a different kind, and it can be quite strong for water, especially with other molecules bearing positive or negative charges.

For instance, adhesion enables water to “climb” upwards through thin glass tubes (called capillary tubes) placed in a beaker of water. This upward motion against gravity, known as **capillary action**, depends on the attraction between water molecules and the glass walls of the tube (adhesion), as well as on interactions between water molecules (cohesion).

The water molecules are more strongly attracted to the glass than they are to other water molecules (because glass molecules are even more polar than water molecules). You can see this by looking at the image below: the water extends highest where it contacts the edges of the tube, and dips lowest in the middle. The curved surface formed by a liquid in a cylinder or tube is called a **meniscus**.

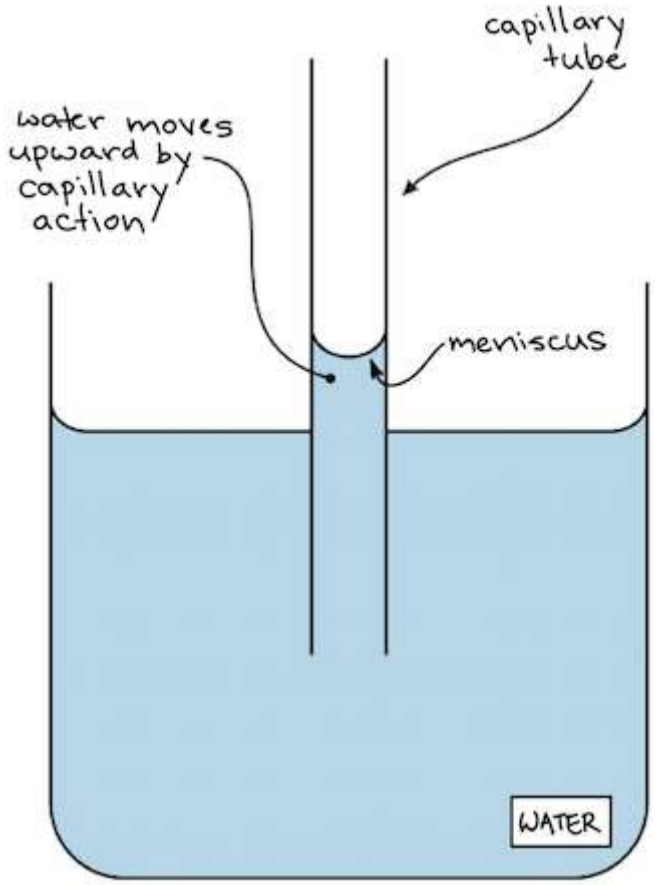

Illustration of water ascending a small tube via capillary action. The thin tube is inserted into a cup of water, and the water climbs up in the tube, reaching a higher level than it does in the cup. Also, the water extends the highest close to the sides of the tube, and dips down in the middle of the tube. This is because the water molecules are more strongly attracted to the sides of the tube than to each other. The curved surface of the water in the capillary tube is called the meniscus.

Image modified from "Water: Figure 5," by OpenStax College, Biology (CC BY 3.0). Modification of original work by Pearson-Scott Foresman, donated to the Wikimedia Foundation.

Why are cohesive and adhesive forces important for life? They play a role in many water-based processes in biology, including the movement of water to the tops of trees and the drainage of tears from tear ducts in the corners of your eyes[1]. A simple example of cohesion in action comes from the water strider (below), an insect that relies on surface tension to stay afloat on the surface of water.

Image of a water strider bug walking on the surface of water. This is possible thanks to the surface tension of the water.

Image credit: "Water: Figure 6, by OpenStax College, Biology (CC BY 3.0). Image by Tim Vickers.