Science on a microscope slide

Demonstrating the existence of molecules with a basic compound microscope

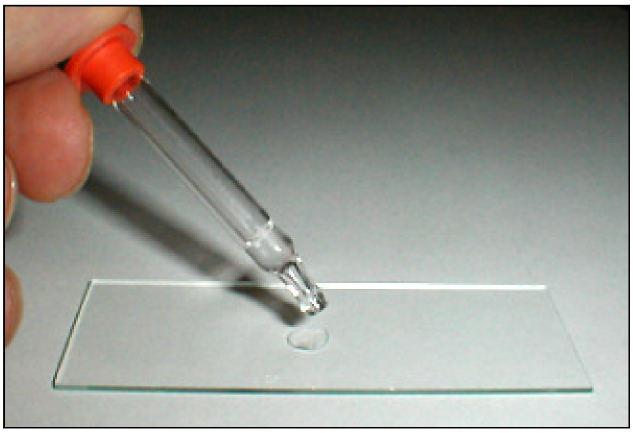
Some important scientific concepts can be easily demonstrated on a microscope slide when viewed with a student microscope.

The existence of molecules can be easily demonstrated using a basic compound microscope! You can't of course see the molecules themselves with an optical microscope, but it is possible to clearly see a direct effect of molecules. It's a phenomenom called Brownian motion and the demonstration has great historical significance. But explanations can come later, let's get on with the demo'!

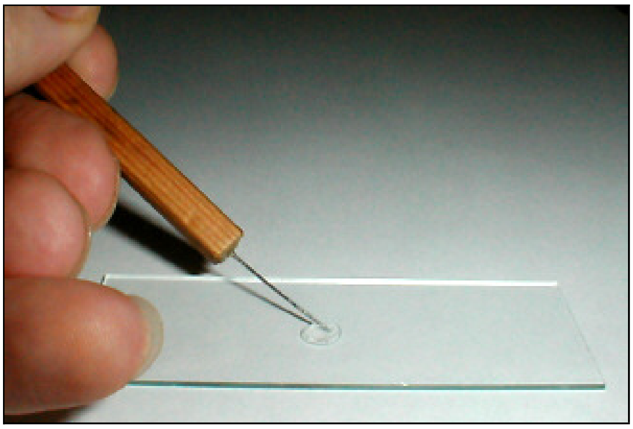
What do you need:

- a basic student compound microscope with an objective of at least 20x, preferably 40x and eyepiece ca. 10x. This type of microscope is widely available for typically less than $200. (A stereo microscope doesn't have a high enough magnification).
- a few drops of whole milk
- a few microscope slides and coverslips
- a piece of fine wire, or small needle (take care with sharp points)
- water, preferably distilled, or use boiled water or water defrosted from the ice compartment of the fridge
- a small amount of Vaseline®, petroleum jelly or similar (optional)

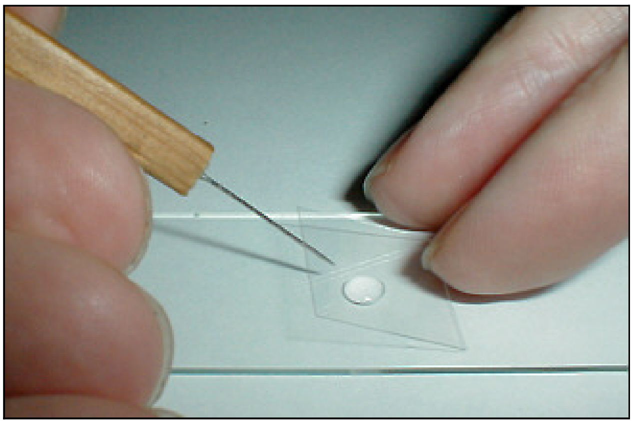
To prepare the slide:



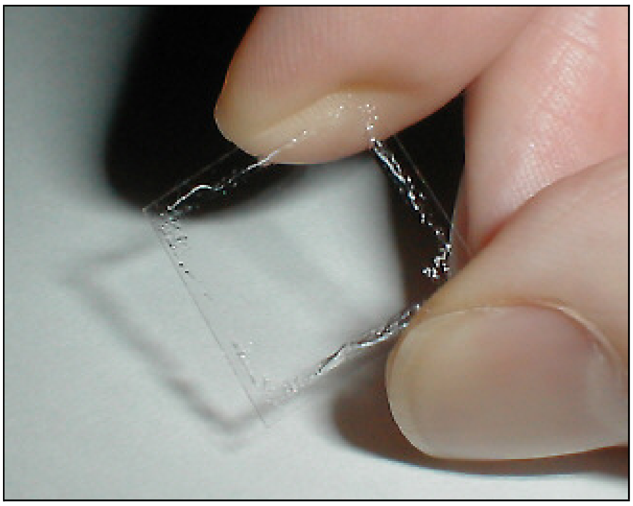
Place a small drop of water in the middle of the slide (use a dropper).



Dip the needle or wire in the milk, then dip and stir this wire in the water drop. (This ensures only very dilute milk is used.)



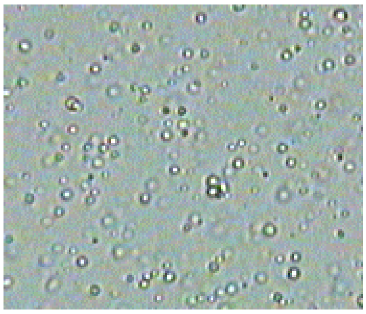
Gently lower the coverslip onto the diluted milk drop. Try not to make the drop too large, experiment a few times until there is little or no liquid creeping from the edges. Or mop up excess with a piece of tissue paper. (This is important to ensure you observe Brownian motion and not liquid movement caused by evaporation).



Optional: To make a slide that lasts longer, use a needle to lay a thin continuous line of Vaseline along the coverslip edges before lowering onto the slide. Also ensure the drop is quite small. Sealing the slide in this way minimises motion of the droplets caused by currents created by evaporation.

Viewing the slide:

Put the slide under your microscope, illuminate and focus in the normal way using a 10x objective until the tiny fat droplets in the milk come into focus. Change to the 20x and/or 40x objective and refocus.



Right: *Still from video using 40x objective. Notice that even in this very dilute milk, the drop density is high. Try using undiluted milk; you may find the fat droplet density is so high that the motion isn't so easy to demonstrate.*

What to look for: Initially the droplets may be moving across the field of view in the same direction. This is not Brownian motion; you are observing currents in the liquid before the liquid has reached a steady state under the coverslip. When the slide has settled for a few minutes, the fat droplets should no longer be moving across the field but should be noticeably jiggling, but not in any specific direction. This is Brownian motion. Study the motion of the droplets on your own slide - how does the motion of the smaller droplets differ to that in the larger droplets, why?

Why is this such an important demonstration? This motion is caused by water molecules (which are very much smaller than the fat droplets) randomly hitting the fat globules and making them jiggle. So you are observing a direct effect of water molecules. In the late 19th century and early 20th century, the existence of molecules was still in dispute and Brownian motion, when explained, was one of the first pieces of direct evidence for the existence of molecules.

Project ideas: *Try and estimate how large the fat droplets are in milk. How much larger are they approximately than the water molecules hitting them? When you work this out you will be surprised the fat droplets move by such bombardment! Try other finely divided material suspended in water. eg diluted Indian ink or talcum powder. If you have a video camera, try capturing your own sequence of Brownian motion. If you have an Intel Play QX3/QX5 video microscope, are you able to capture the motion? Read up on Robert Brown, the botanist after which the motion was named? What did he first observe the motion in?*

David Walker. 2008. Revised article first published by author in online 'Beyond' Magazine.