The reconstruction of a single lens microscope. Reviving the Leeuwenhoek's microscope.

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ABSTRACT

Antonie Van Leeuwenhoek (1632-1723), is considered the father of microscopy and microbiology, due to the development and improvement of the first microscopes that made possible the discovery of microscopic organisms and great advances in the field of biology. The A. van Leeuwenhoek's microscope is a deceptively simple device that contains a single spherical lens housed in a metal plate, an specimen pin, where a capillary glass that contains the sample dissolved in water is inserted, and a series of associated screws that allow to position the capillary in the focal distance for the observation of the sample. Thus, we present the following protocol that includes the steps to elaborate an spherical lens of great power of magnification, and the steps to make simple tissue samples for visualization. The following protocol aims to show a simple, easily accessible, low cost, and effective, for the observation of microscopic samples, possible to perform anywhere, without depending on a laboratory or complex tools for its development.

EXTERNAL LINK

https://backyardbrains.com/experiments/Leeuwenhoek

Document body

BEFORE TO START:

You need:

1. A high temperature flame- it can be a bunsten lighter or a camping torch (propane/isobutene mix).
2. Solid glass filament, like borosilicate glass filament, crystal glass or soda lime glass.
3. Basic Needle noise pliers, like typical laboratory pliers or forceps.
4. Plain glass slide
5. Onion
6. Cotton swab
7. Methylene blue
8. Digital gauge (like a Vernier caliper).

PROTOCOL:

How to fabricate the ball lenses:

1. Turn on the flame. Respect it.
2. Take a filament of glass, hold it over the flame and pull the filament apart until you get two thin points. It is better to use solid glass filament spite hollow glass, because this prevent the formation of bubbles inside the molten glass.
3. Take one half of your now two glass pieces, and push the tapered end into the flame until it forms a small spheroid end.
4. With your forceps, break off the spherical end over a flame.
5. Take the piece of glass extracted with the tips of the clamp, and put this in the flame, specifically in the zone of the blue flame, of higher temperature. When the glass begins to melt and the flame acquires an orange color, you can open the clamp ensuring that the lens is attached to one end of the tip of the clamp.
6. With patience, as the glass melts it acquires the spherical shape. This lens it should be as round as possible and without any bubbles and minimal embedded black carbon residue (because the clamp burns).
7. To ensure a better observation, try that the diameter of the spheres will be equal to or greater than 2 mm. With this diameter you can have a suitable focal distance for microscopy observation.
8. After you obtain a sphere, release it from the tip of the clamp (for example by using another clamp) and then take the sphere again with the tip of the clamp from another position. This will allow you to decrease the deformation on the surface of the lens due to the contact with the clamp. It is recommended to repeat this step 3-4 times, to decrease lens aberrations.
9. Once formed and cooled, please the sphere in a small hole in a support (we recommend our 3D print, or a piece of strong paperboard). If the glass sphere doesn't fit in the hole, use a small scissor blade to enlarge the hole, until the sphere is adjusted. Try that the hole

doesn't be too big so that the sphere does not come out.
10. Now prepare a slide sample or look for a pre-prepared slide sample.

Cheking the focal distance:

1. First, using digital gauge or a milimetrical precise measure tool (i.e. vernier caliper), measure the spherical lens, and write the measurement in some paper to remember it.
2. You can calculate the Effective Focal Lenght (EFL) of your spherical lens with the following equation: **(1) EFL = nD/4(n - 1)**, where **n:** refractive index of the material of your lens (i.e. typical glass has an n= 1.52) and **D:** diameter of your spherical lens.
3. You can calculate the magnification of your spherical lens as follow: **(1) M = 250 mm/EFL**, where M: magnification of your spherical lens, and EFL : Effective focal length.
4. 250 mm is a convention, because the focusing average of a healthy eye has a minimum distance of about 250 mm, and is considered that a magnifier is any positive lens with a focal length of less than 250 mm. In this way the approximate magnification M by lens is calculated by dividing 250 by the focal length.

Prepare a simple slide:

Onion slide.

1. Hunt or by an onion
2. Remove the outer dark skin. Cut the onion in half.
3. With a tweezer, take a bit of clear onion skin. This skin layer is only one cell layer thick!
4. Place the onion sample on a glass slide. You are now ready to look at it with your microscope.

Skin cheek cells.

1. With a tooth pick, scrape the inside of your cheek for a minute.
2. Rub toothpick on a drop of water in the middle of a glass side.
3. Apply a drop of methylene blue over the fixed area. Remain 5 minutes.
4. Remove the methylene blue with water.
5. Soak up the excess.
6. You are now ready to look at it with your microscope.

- **Using your ball lens to view the sample**

1. Place the holder with your embedded glass sphere up to your eye, as if you are looking through the lens.
2. Turn on alamp and look at the lamp through the microscope. You need a light source.
3. Bring your slide up to the other end of the ball lens. Note that generally the focal length is very short, 0.3-1.00 mm away from the lens (you can calculate it before using the equation 1).