Lotus Effect Activity

Instructors Notes

Audience: JH or HS Students
Standards:

- **Grade 5 – properties of water**
- **Grade 7 - Investigation and experimentation**
- **Grade 8 - structure of matter (3d,e) (water H bonding)**
- **Grade 8 - investigation and experimentation 9a**
- **Grades 9-12 - chemical bonds 2d, and especially h (h-bonding)**

Time Frame: Set-up 20-30 minutes; activity 45-60 minutes; Cleanup 10-15 minutes
Materials:

- **Nasturtium leaves (*or other lotus effect leaves such as kale, brocolli,turnip greens, collard greens, water lily leaves, rose petals or cabbage*)**
- **Other normal leaves from house plants or vegetables**
- **Spray bottle w H_2O**
- **Container of H_2O**
- **Empty container**
- **Pipettes**
- **Ruler with mm spacing**
- **Honey (ketchup and chocolate syrup also ok)**
- **Protractor**
- **Paper towels for cleanup purposes**

Suggestions:
Label the different piles of leaves so that students can refer to them by name during the assignment.
Only very small volumes of water (and honey/ketchup/syrup) are needed for this activity to be successful – mention this to your students before the activity starts. Drops, and not streams of water are used in most of the activities! Leaves can be held over the empty container to minimize cleanup.
A protractor is suggested but not necessary.
Honey is great for testing the self-cleaning effect of the leaves as it sticks very well to the reference (non-lotus) leaves. Ketchup and syrup are satisfactory (other materials may work well too).
Rubbing the surface of the lotus leaves should destroy some of the nanoscale bumps and reduce the lotus effect – it will not eliminate it however.
The last page (video viewing and associated questions is optional but recommended).
Incorporate demonstrations of Lotus effect fabrics or other surfaces if possible!

Lotus Effect Activity

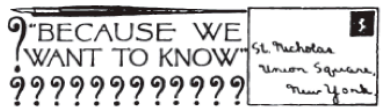
The following passage was taken from an issue of St. Nicholas Magazine "Nature and Science for Young Folks" published around 100 years ago (1913).

WHY A NASTURTIUM LEAF LOOKS SILVERY UNDER WATER

VILLA FONTANELLE, P. OVILE, SIENA, ITALY.

DEAR ST. NICHOLAS: Will you please tell me why, putting a nasturtium leaf under the water, it looks as if it was of silver? EGLE BOSSI.

The nasturtium leaf is covered with a finely distributed, waxy substance which will not permit water to wet the leaf. Hence, when immersed, the water cannot touch the leaf and drive off the air surrounding it, and a thin layer of air remains between the leaf and the water. It is the reflection and refraction of light from this layer of air that give the silvery appearance. It has been supposed by some authorities that the presence of this non-wettable layer has the advantage of preventing the raindrops which fall on the leaf from remaining there, and thus blocking up the stomata, or breathing-pores.—W. F. G.



Using the materials provided can you duplicate the observations of Egle Bossi? (Submerge the leaves into a container of water). Which leaves demonstrate this effect? Record any other observations you make below. (for example is there a certain angle that you must hold the leaves relative to your eyes to see the silvery coating?)

Use the spray bottle to spray water droplets onto the leaves. Do it over the empty container to minimize cleanup. What happens?

Use the pipette to drip droplets of similar volume onto the surface of the various leaves. Draw the shape of the drops as viewed from the side for each type of leaf. Which leaves have water droplets that are most spherical (most like a globe)?

Place the leaves flat on the table. Use the pipette to drip droplets of similar volume onto the surface of the leaves. Slowly lift one side of each leaf (do one at a time) and observe how much you have to tilt each leaf to get the water to roll off. Record your observations below (optional - use a protractor to more precisely determine the angle).

Place a droplet of honey (or ketchup or syrup) on the surface of the different leaves, then try to wash the honey off into the empty container. Which leaf cleans up more easily?

Rub the hydrophobic (hydro = water, phobic = "afraid of") leaf (the leaf with the most spherical water droplets), but not so hard as to tear it. Repeat the above experiments. What happens?

Your experiments in this activity are exploring the "Lotus Effect" – the hydrophobic / water repellent property seen in some plants and insects and most famously in the lotus leaf. What are some possible advantages to having surfaces with this hydrophobic effect to plants and insects?

The Lotus Effect was not fully explained until the scanning electron microscope was introduced in the 1970's. (WATCH ACCOMPANYING MRL UCSB VIDEO IF POSSIBLE!)

Based on the microscope images of the lotus leaves and Luis' material which surface do you think is more hydrophobic? Which material has a more ordered microstructure? What do you think would happen if honey or chocolate syrup was placed on Luis' material?

Draw the surface of the hydrophobic leaf at the nanoscale.

Do you agree with the conclusions of "W.F.G." (the initials of the expert author from 1913)? Could that silver appearance be from a layer of air? Why might the water droplets be a different shape on the different surfaces?