

nano 

weww

nano and nature

## Introduction

How does the idea of self-cleaning clothes sound? Or a mobile phone screen that doesn't glare in the sun? Or even super efficient solar panels? This lesson looks at some nano materials that already exist in nature and how scientists are taking inspiration from these naturally occurring structures to create new, exciting materials and products. This lesson contains two activities and a web quest.

## ICT links

[www.youtube.com/watch?v=MFHcSrNRU5E](https://www.youtube.com/watch?v=MFHcSrNRU5E)

This is a 24 second video clip that could introduce the Lotus Effect.

[www.youtube.com/watch?v=IPM8OR6W6WE](https://www.youtube.com/watch?v=IPM8OR6W6WE)

This is a 4 minute 36 second video advertising a self-cleaning nano product.

[www.youtube.com/watch?v=o7enQj6Z9pM](https://www.youtube.com/watch?v=o7enQj6Z9pM)

This is a 3 minute 49 second video of an NBC News interview about the future, it shows self-cleaning nano products.

[www.youtube.com/watch?v=7is6r6zXFdc](https://www.youtube.com/watch?v=7is6r6zXFdc)

This is a 1 minute 4 second video advertisement showing chocolate sauce being poured on a shoe that is protected with a nano coating.

[www.youtube.com/watch?v=Fhthxn3wGaE&feature=c4-overview-vl&list=PL55E60D871E3B59E9](https://www.youtube.com/watch?v=Fhthxn3wGaE&feature=c4-overview-vl&list=PL55E60D871E3B59E9)

This is a 3 minute 7 second video of a secondary school teacher in CRANN carrying out the Lotus Effect activity.

## Curriculum links

### Science

**Strand:** Environmental awareness and care **Strand:** Unit Plant and animal life, **Strand:** Materials Strand Unit Properties and characteristics of materials

## WALT

- Investigate nano in nature
- Identify leaves that demonstrate the 'Lotus Effect'
- Classify leaves according to how they demonstrate the lotus effect
- Develop observation, prediction, analysing, recording and presentation skills
- Understand the links between nano in nature and new nano products
- Reflect on what we have learned

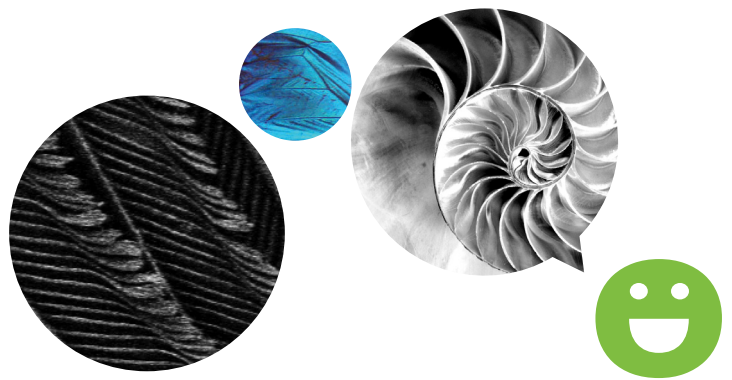
## Trigger questions for class discussion

These questions can be used before the activities to introduce the idea of self-cleaning surfaces and why they might be useful.

- **Why do we want surfaces to stay clean?** disease prevention, aesthetics, so we can work on them, so they operate properly e.g. a TV screen, solar panel
- **What do we use to clean surfaces?** water, soap, cloth, cleaning products
- **How do plants keep clean?** rely on rain water, but some have self-cleaning properties which we will explore in this lesson

## Useful resources

- [www.youtube.com/watch?v=nAg\\_FuG\\_4XE](https://www.youtube.com/watch?v=nAg_FuG_4XE)
- [www.popsci.com/science/article/2012-11/7-amazing-ways-nanotechnology-changing-world](http://www.popsci.com/science/article/2012-11/7-amazing-ways-nanotechnology-changing-world)
- <http://science.howstuffworks.com/nanotechnology3.htm>
- [www.sciencedaily.com/releases/2007/05/070523075416.htm](http://www.sciencedaily.com/releases/2007/05/070523075416.htm)
- [www.theguardian.com/nanotechnology-world/nanotechnology-in-everyday-life](http://www.theguardian.com/nanotechnology-world/nanotechnology-in-everyday-life)



## Journal suggestions

**Hippo sweat is a natural sun block because of the way it interacts with light on the nano-scale.**

- Write this on a journal page and draw a picture of a hippo sunbathing.
- Make a list of leaves that display the lotus effect. Print out or draw pictures of the leaves to accompany the list.

## Cross curricular links

### Art

Construction, drawing

## More useful resources

- **Nano and transport:** [www.nanolandbaltic.com/en/nano-solutions/transport](http://www.nanolandbaltic.com/en/nano-solutions/transport)
- **Nano Magazine: Editorial on transport:** [www.nano-magazine.com/news/2019/7/18/supercar-features-graphene-enhanced-composites?rq=transport](http://www.nano-magazine.com/news/2019/7/18/supercar-features-graphene-enhanced-composites?rq=transport)
- **Overview** [www.azonano.com/article.aspx?ArticleID=4826](http://www.azonano.com/article.aspx?ArticleID=4826)
- **Nanotechnology Makes Cars Shinier, Safer, More Fuel Efficient:** [www.dummies.com/how-to/content/nanotechnology-makes-cars-shinier-safer-more-fuel.html](http://www.dummies.com/how-to/content/nanotechnology-makes-cars-shinier-safer-more-fuel.html)

## Background Information

**Nature is full of nano materials;** our teeth, sea salt in the air, particles from volcanoes, patterns on seashells, patterns and colours on butterfly wings, the shape and texture of bird feathers and gecko feet. Studying how nano scale features in nature work can lead to the development of new 'smart' materials, such as self-cleaning windows or clothes.

An example of a naturally occurring self-cleaning surface is the lotus flower. It is a river flower and is revered in Asian religions such as Hinduism and Buddhism as it is a striking white flower that stays dirt free even after being submerged in muddy river water. This remarkable property of the lotus is not purely for cosmetic purposes, it prevents organisms gaining a foothold on the surface of the plant which helps them avoid infection.

A waxy surface and a rough nanoscale coating on the plant surface make it self-cleaning. This condition is known as super hydrophobicity. Water that comes in contact with the surface of the lotus flower beads up, and rolls off, collecting dirt and dust along the way.

This lotus effect has been applied in materials today, mainly in the manufacture of waterproof and self-cleaning clothing e.g. raingear, self-cleaning windows in high-rise buildings, green houses, solar panels, windscreens and outdoor paints. We can also find self-cleaning materials in hospitals, nurseries and other buildings where the spread of germs and disease needs to be controlled. Using self-cleaning materials in transport is also very beneficial as clean surfaces on aeroplanes, ships and vehicles make them more fuel efficient (see More useful resources section).

## Interesting Nature Facts

- Hippo sweat is a natural sun block – it contains compounds that absorb light in the 200–600 nanometre range, this protects the hippo's skin like sunscreen.
- Gecko lizards can walk on walls and ceilings because they have nano structures on their feet which allow them to grip to any surface. This discovery has inspired scientists to create super strong tape for sticking heavy objects to surfaces.
- Nano materials are used to make water filters to produce clean drinking water. Because the nano scale is so small, filters made at this size can not only filter dirt out of water but also bacteria, fungi and salt. This enables people who can only access dirty or contaminated water to have clean drinking water.

# Activity 1

## Webquest



**Research how a gecko sticks to a wall or a ceiling and**

**write about it in your own words.**

Handwriting practice area for the gecko research task, consisting of 20 horizontal light blue lines.



**Research how a lotus flower stays clean and write**

**about it in your own words.**

Handwriting practice area for the lotus flower research task, consisting of 20 horizontal light blue lines.

## Activity 2

# Investigating properties of materials: The lotus effect

### This experiment aims to investigate the lotus effect

The leaves of the lotus flower are highly water repellent due to the presence of nano size bumps on the petals of the lotus flower. When the petals of the lotus flower get wet, water particles roll over the petal surface, rather than adhering and wetting it. This is known as the 'lotus effect' and can be found in other plants and on the wings of certain insects. This effect has applications for waterproof clothing e.g. raingear, and self-cleaning windows. The lotus effect can be best observed on plants by pouring or spraying small amounts of water on the plant surface and watching how the water behaves when it comes in contact with the surface of the petal/leaves of the plant.

### Equipment

- Broccoli/ brussels sprouts/cabbage/ kale/ tulip/ turnip greens and water lily (these plants demonstrate different levels of the lotus effect)
- A sample of different leaves from the garden/park/different vegetable leaves that need to be tested for the lotus effect
- Water, honey, tissue paper, basin, beakers or droppers



### Teaching Tips for Activity

- The children could plan their investigation using investigation sheets in groups of three or four.
- They should be encouraged to discuss, examine, predict and plan as much of their investigation as possible, before they take any resources to begin their investigation (planning and recording are very important skills in science).
- This 24 second video of the Lotus Effect [www.youtube.com/watch?v=MFHcSrNRU5E](http://www.youtube.com/watch?v=MFHcSrNRU5E) could be shown to the children to illustrate to them what the lotus effect looks like, however, they should be reminded that there are different levels of the lotus effect. Some plants clearly demonstrate the effect while others just show signs of it.
- The children should be encouraged to record their results/observations when they have conducted their test.
- The children could collect some leaves themselves for this investigation
- This link will take you to a video of a secondary school teacher in the CRANN institute carrying out the "Lotus Effect" activity: <http://www.youtube.com/watch?v=Fhthxn3wGaE&feature=c4-overview-1&list=PL55E60D871E3B59E9>

**Note:** Sweetheart and York cabbage work very well as self-cleaning examples. When the children are conducting this activity ensure that they are gentle with the leaves as rubbing the surface of hydrophobic leaves can alter their effectiveness.



## Activity 2

# Investigating properties of materials: The lotus effect



## Key Questions

- Which leaves do you think will demonstrate the lotus effect best?
- Why do you think that water rolls off certain leaves?
- How does it roll off? (Little beads)

## Advanced

- What could nanoscientists learn from the lotus leaf?

Measuring, recording and presenting :

The children are encouraged to come up with their own ideas on how to measure, record and present. If they have trouble with this, the following are suggestions that teachers could use as prompts:

- The children could use observations to measure
- They could hold each leaf over a measuring beaker and measure in millilitres how much water runs off the leaves
- The children could take videos or photographs of their inquiries
- They could draw their observations
- The children could have a scale rating system and assign a mark between 1–10 on how hydrophobic/self-cleaning they rate a leaf from observations
- The children could present their findings in a presentation style of their own choosing, for example, use the leaves to make a chart, oral presentation, photographic presentation, PowerPoint/video presentation etc.



## Extension Activities

- Can you find any leaves in your garden/ the park/your vegetable cupboard that demonstrate the lotus effect?
- Is it possible for any liquid to remain on a leaf that demonstrates the lotus effect?
- **Make a lotus flower:** Make your very own lotus flower out of paper.  
**Materials:** Paper – works best with paper that is a little flexible.  
**Method:** Video of this experiment can be found here: [www.origami-fun.com/origami-lotus.html](http://www.origami-fun.com/origami-lotus.html) Instructions can also be found on this website

## Investigation worksheet

We are investigating if our leaves demonstrate signs of the lotus effect. Lotus flowers are hydrophobic, which means 'water-fearing'. They do not allow water to rest on their leaves. When water falls on a lotus flower, it forms into small little spheres, like little beads, and it rolls off the leaves. Lotus flowers are also self-cleaning, if they get dirty, the little beads of water pull dirt off the leaves. Nanoscientists have investigated how the lotus flower can stay dry and clean and they have applied what they have learned to new waterproof and self-cleaning products, for example, some rain gear now uses nanomaterials to keep them dry.

<b>Names of leaves:</b>	<ul style="list-style-type: none"> <li>• Choose some leaves to examine.</li> </ul>
	<ul style="list-style-type: none"> <li>• Name the leaves or label them A, B, C, D, E, etc.</li> </ul>
	<ul style="list-style-type: none"> <li>• Predict which leaves you expect will be hydrophobic and self-cleaning.</li> </ul>
<b>1. Which leaves do we predict will be hydrophobic and self-cleaning?</b>	<b>6. Plan as a group how much water you will pour/spray onto each leaf, how you will measure, record and present your results.</b>
<b>2. Which leaves do we predict will NOT be hydrophobic and self-cleaning?</b>	
<b>3. Which leaf will be the most hydrophobic?</b>	<b>7. How will we measure our findings?</b>
<b>4. Which leaf will be the best at self-cleaning?</b>	
<b>5. What other flowers or leaves would your group like to test for the lotus effect?</b>	<b>8. How will we record our findings?</b>

# Investigation worksheet

## Our results

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## How are we working like scientists?

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## What did we learn?

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