

NATURES INSPIRATION'S

OVERVIEW

DURATION: 40 minutes

TARGET AUDIENCE: Year 7+

The surface structure of a material has a great bearing on its behaviour and the way in which it interacts with its surroundings. Biomimetics is a field of science that takes inspirations from nature and natural surfaces in order to create functional materials. The aim of this activity is to demonstrate some of the surfaces that have evolved and developed in nature and to showcase examples of biomimetic surfaces that scientists have developed based on nature.

EQUIPMENT

- Velcro
- Burdock Burrs
- Felt/wool
- Acrylic sheet
- Lotus leaf
- Waterproof material (eg. swimwear)
- Hydrophobic soil
- Magic sand
- Super hydrophobic coating spray
- Water droppers (pipettes)
- Water
- Duplo blocks
- Toy gecko/taxidermy gecko
- Gecko pad (for mobile phones)
- Perspex sheet
- Morpho butterfly
- Sample of morphotex fabric
- Handheld microscopes
- Laptop
- Water guns
- Petri dishes x8
- Laminated SEM images of materials
- Sample description cards

METHODOLOGY

1. Place one of each sample of natural materials and its artificial analogues into a petri dish.
2. Ask participants to read the description cards and match them to each of the materials samples in front of them.
3. For each of the natural materials matched, demonstrate its properties:
 - a. Challenge the student to try and get the lotus leaf wet with a water gun
 - b. Showcase the toy gecko
 - c. Use the yarn on the burdock burs to show how the stick, the student can try to shake it off and see the firm grip
 - d. Make a small mound of hydrophobic soil and ask the student to put water droplets onto the mound with a pipette, challenging them to make the soil wet
4. For each of the synthetic materials matched, look at the SEM images and compare them with the natural SEM images. Show the similar properties achieved due to the similar micro-structures.

To access a full equipment kit for the Natures Inspiration's activity contact info@royce.ac.uk



BACKGROUND SCIENCE

Natural surfaces are specially adapted to fit the needs of an organism in order to help them survive in their environment. The pairings of the natural and synthetics is as follows: Velcro/Burdock Burrs, lotus leaf/ superhydrophobic surfaces swim wear, gecko feet, gecko pads / morpho butterfly/ morphotex fabric and finally hydrophobic soil/ and magic sand.

The surface of burdock burs shows hundred of hooks that catch onto microscopic loops that are found in fur, hair and clothing, allowing the seeds to be dispersed by animals on which they get caught. This inspired the hook and loop mechanism of Velcro.

Gecko feet pads consist of approximately half a million microscopic setae (hair-like structures), with each of these hairs having hundreds of smaller projections called spatulae protruding from them. Due to the extremely small scale of the spatulae, adhesion forces (Van de Waals forces) are created between the toepads and walls, allowing suspension of the gecko on most surfaces. Gecko pads and gecko tape use a similar structure, wherein thousands of microscopic plastic pillars resembling the setae are attached to a flexible base, creating the same phenomenon.

The lotus leaf exhibits super hydrophobicity, meaning that it is very water repellent and self-cleaning. This is because of microstructures called tubules that cover the surface increasing the surface the water droplets must squeeze into. The water will simply bead up and roll off to minimize the droplets energy. The tubules are also made of non-polar wax which doesn't favour interactions with water which is a polar substance. Superhydrophobic surfaces are made by etching treatments, where lasers or plasma are used to bombard the surface and create rough structures that promote hydrophobicity.

Hydrophobic soil is created as a result of dry seasons and wildfires, where organic matter burns and is broken down into a waxy residue that is left on the soil. The residue can coat the particles of soil and create hydrophobic properties preventing water from penetrating into the ground. Magic sand is created by applying a special coating to sand particles to make them hydrophobic.



FOLLOW UP QUESTIONS

1. What other examples of natural surfaces and synthetic analogues can you think of?
2. What are the benefits of biomimetics?

SAFETY

Wash your hands after handling these materials and be careful not to ingest any of the materials by accident, such as the magic sand which can stay on your hands after touching. Don't look into the light produced by the hand held microscope.

