LEARNING FROM NATURE'S BEST

Materials researchers are taking cues from specific plants and animals that make substances that could endow humans with superhero powers. By **Julie Gould.**

1 SUPER STRONG

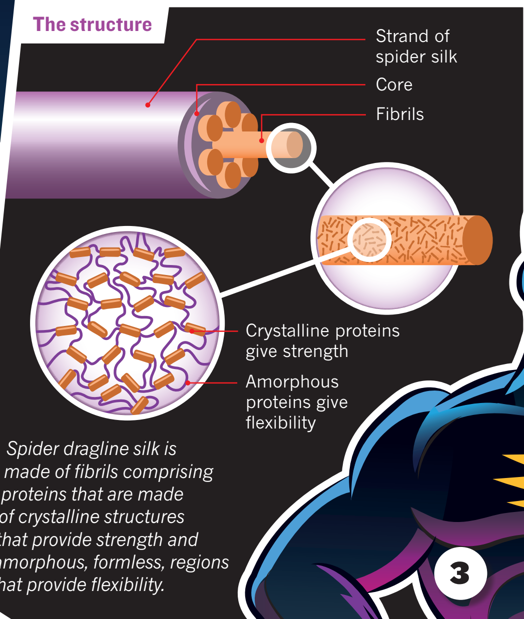
See page S4

The inspiration

Spiders can make up to seven different types of silk. The strongest is dragline silk, which is used for building webs[1].

Fact
Darwin's bark spider (Caerostris darwini) can spin silk threads[2] that can measure up to **25 m.**

The structure



Spider dragline silk is made of fibrils comprising proteins that are made of crystalline structures that provide strength and amorphous, formless, regions that provide flexibility.

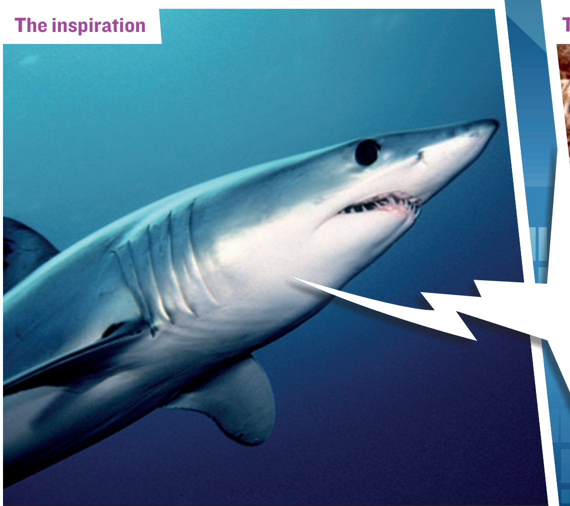
The application

Infusing metal into spider silk increases its toughness tenfold[3]. The resulting thread could be used in artificial tendons.

2 SUPER FAST

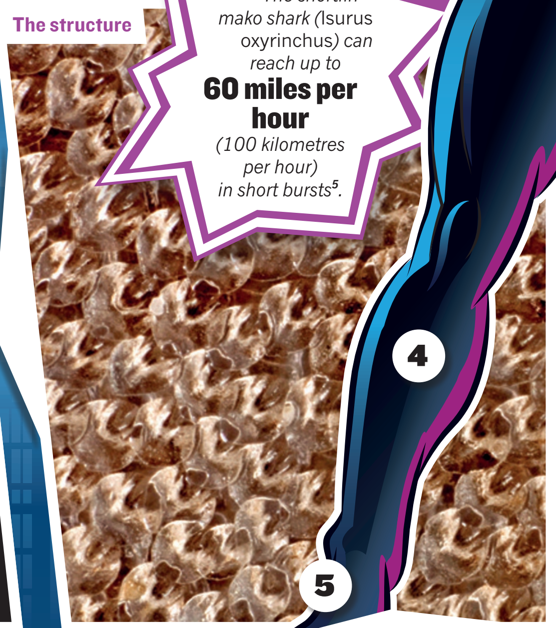
See page S10

The inspiration



Shark skin is made up of tooth-like V-shaped scales called dermal denticles that ***align parallel*** *to the direction of local water flow to reduce drag[4].*

The structure



Fact
The shortfin mako shark (Isurus oxyrinchus) can reach up to **60 miles per hour** *(100 kilometres per hour) in short bursts[5].*

The application

A swimsuit made from biomimetic shark skin could increase a human swimmer's speed by almost ***7%****, but the likelihood of it being allowed in competitive sport is slim[4].*

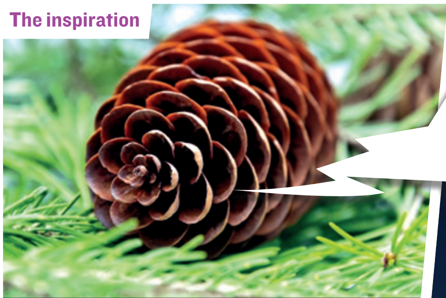
CARTOON MAN: SHUTTERSTOCK/LANA STEM; SPIDERWEB: THINKSTOCK; SHARK: MARK CONLIN/ALAMY; SHARK SCALES: PASCAL GOETGHELUCK/SPL

DESIGN BY **MOHAMED ASHOUR**/NATURE

References: 1. Römer, L. & Scheibel, T. *Prion* **2,** 154–161 (2008); 2. Gregorič, M. *et al. PLoS ONE* **6,** e26847 (2011); 3. Lee, S. M. *et al. Science* **324,** 488–492 (2009); 4. Wen, L. *et al. J. Experim. Biol.* **217,** 1656–1666 (2014); 5. Ebert, D. A. *et al. Sharks of the World: A Fully Illustrated Guide* 230 (Dolby, 2013);

3 SUPER DRY See page S10

The inspiration

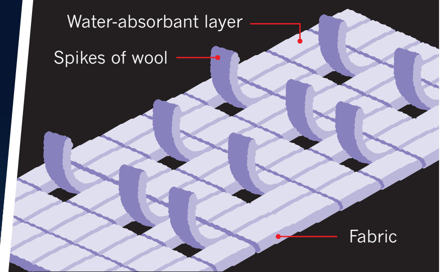


The scales of a pine cone are made up of two different layers, each reacting differently to changes in humidity. One layer elongates in damp conditions and the other works to resist this, causing the scales to bend. It is similar to the way a thermostat's bimetallic strip bends in response to changing temperature[6].

The structure

Fact
The cones of the knobcone pine (Pinus attenuata) only open their scales to drop seeds in the extreme heat of a **wildfire.**

The application



Researchers have developed smart materials with woollen spikes that are sensitive to relative humidity. The wool spikes open when the wearer sweats and close when the layer dries out.

4 SUPER CLEAN See page S7

The inspiration

The leaves of the lotus plant (Nelumbo spp.) have evolved an intricate structure consisting of papillae covered in a dense coating of wax tubules. Trapped air reduces the liquid-to-surface contact area, so water ***rolls off the surface*** *and collects dust particles on its way*[7].

The structure

Fact
By 2019, the global nanocoatings market is forecast to reach a value of US$14.2 billion.

The application

Synthetic materials with a hierarchical surface, such as those that mimic the lotus leaf, have ***gaps filled with a lubricant*** *so that the material is stain- as well as water-resistant*[8].

5 SUPER STICKY See page S7

The inspiration

Geckos (Hemidactylus spp.) can climb glass walls and hang from ceilings without a visible method of sticking to them. Researchers found that geckos can adhere to gravity-defying surfaces because of the electrostatic interaction between the molecules in their feet and the molecules on a surface[9].

The structure

Fact
Geckos' feet are so sticky that, in theory, they could support the weight of a **130 kg** *person hanging from the ceiling*[10].

The application

Hand pads, each covered in tiles with tiny silicon rubber hairs that ***mimic geckos' feet****, mean humans can scale walls like lizards. The more force applied to the pads, the stickier they become*[11].

PINE CONE: THINKSTOCK; CONE CLOSE-UP: JULIAN VINCENT, UNIV. OXFORD; LOTUS LEAF: BLICKWINKEL/ALAMY; LOTUS CLOSE-UP: EYE OF SCIENCE/SPL; DROPLET: J. ADAM FENSTER / UNIV. ROCHESTER; GECKO: BOSTON GLOBE/GETTY IMAGES; GECKO CLOSE-UP: MATT REINBOLD; CLIMBING MAN: ERIC EASON, STANFORD UNIV.

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