

The Shape of Wings

investigating the wings of
the monarch butterfly



The monarch butterfly may be the most famous orange-colored creature in the animal kingdom. Its color, while beautiful, is also very important because it helps the monarch to survive. **How does color help animals to survive?**



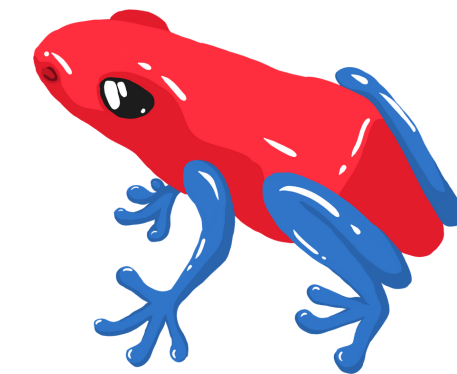
Camouflage

"You can't see me!"



Mimicry

"I'm a leaf!"



Warning

"I'm dangerous!"

How do you think the color orange protects monarch butterflies from predators?
Here's a hint: their main predators are birds.

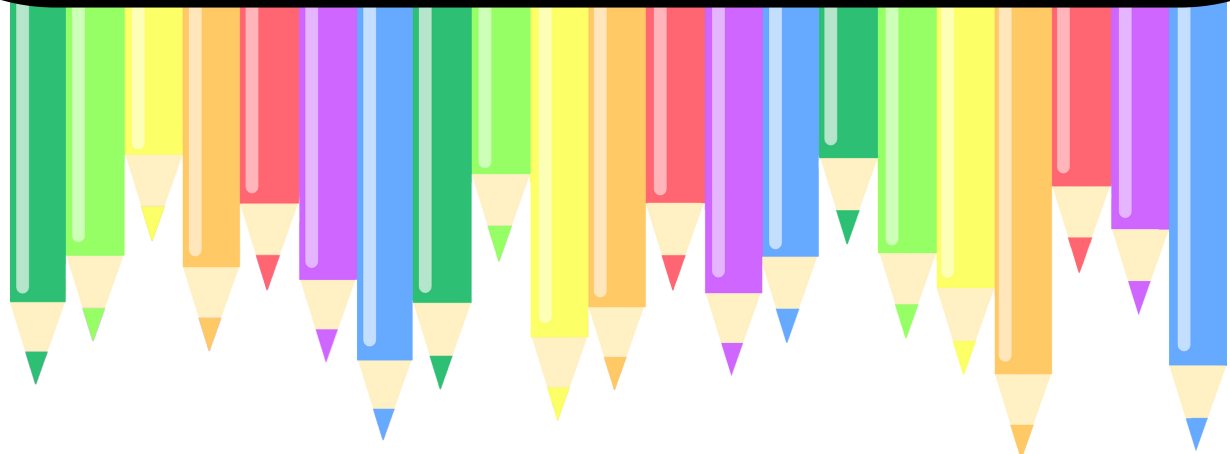


Monarchs use their orange color as a **warning** to say "Don't eat me, I will make you sick!". This warning is a truthful signal- monarch butterflies are toxic and cause animals that eat them to be sick!

Scientists have found birds that eat a monarch once will never eat a monarch again, because they remember how sick they felt before. They won't be making that mistake again!



Think about it...
What do different colors remind you of?



A monarch's wings not only protect them from predators, but they also take them places. Each day monarchs fly from flower to flower, eating nectar.

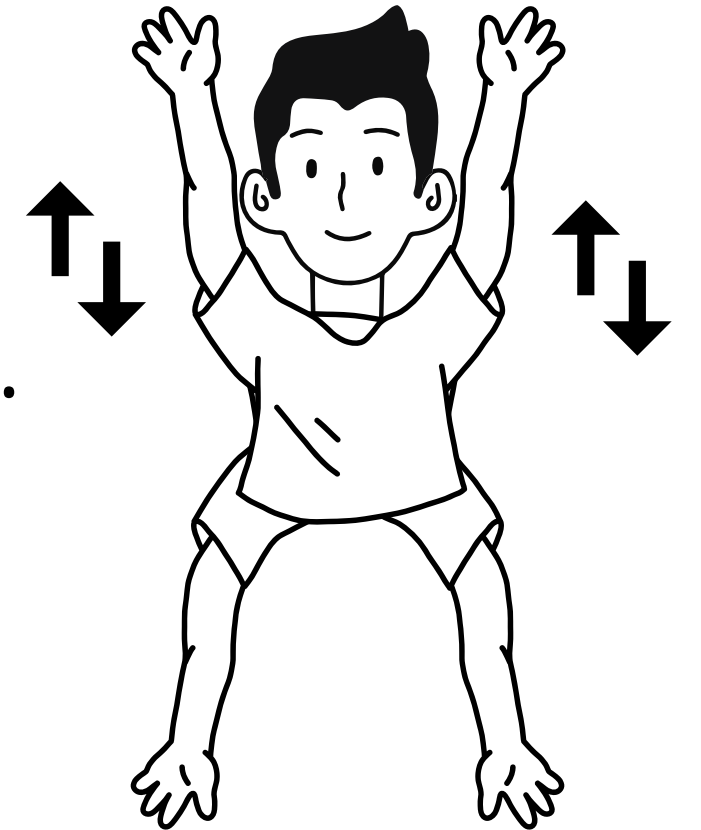


Twice a year monarch butterflies embark on a great migration, flying hundreds of miles between the U.S. and Canada to Mexico and back. They make this journey in just weeks. Could you run to Mexico that fast?

So, how do monarchs do it?

The shape and function of the monarch's wings help it make the long migration. First, how do wings work? They flap up and down. Practice with your arms! Can you feel the air on your hands as you flap?

When the monarch's wings go up, the air in between its wings is squeezed out with such force that it thrusts the butterfly forward. The butterfly is able to fly farther while using less energy!



Fun Fact!
The Peregrine Falcon,
the world's fastest
bird, inspired the
design of the swift B2
bomber!



Engineers have always been inspired by the amazing skills that animals have...

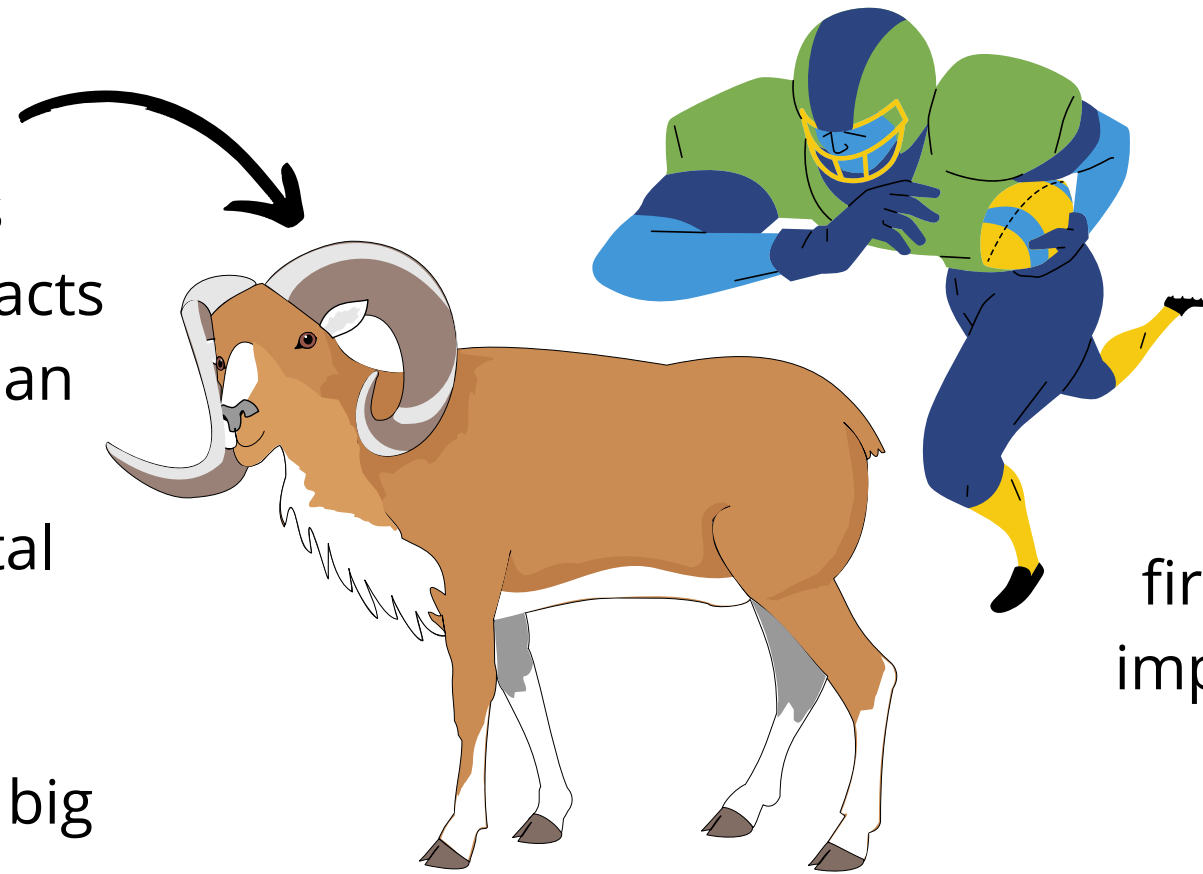


Researchers at MIT were inspired by sea otters to create a wetsuit that functions like their fur. The suit keeps the wearer warm by trapping air bubbles. [1]

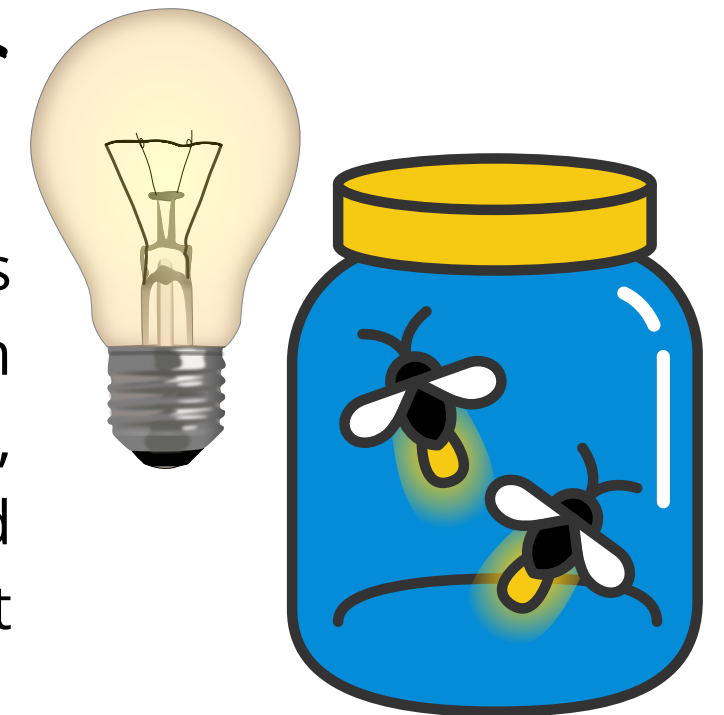


A team from Stanford University found that hummingbirds are more efficient at hovering than helicopters. As technology improves, we will surely look to the hummingbird for inspiration. [2]

Male big horned sheep intentionally hit their heads together, withstanding impacts that are 10 times greater than two football players. The Cincinnati Children's Hospital Medical Center is experimenting with safety equipment inspired by the big horned sheep. [3]



Penn State University is creating LEDs made with firefly-mimicking structures, improving the efficiency and sustainability of the light source. [4]



What animals will inspire **you** to create the next great invention?



[1] Nasto, A., Regli, M., Brun, P.-T., Alvarado, J., Clanet, C., & Hosoi, A. E. (2016). Air entrainment in hairy surfaces. *Physical Review Fluids*, 1(3).

[2] Kruyt, J. W., Quicazán-Rubio, E. M., van Heijst, G. J. F., Altshuler, D. L., & Lentink, D. (2014). Hummingbird wing efficacy depends on aspect ratio and compares with helicopter rotors. *Journal of The Royal Society Interface*, 11(99), 20140585.

[3] Cincinnati Children's Hospital Medical Center. (2016, June 15). Research shows promising results for a device designed to protect athletes from sports-related brain injuries: Experimental neck collar inspired by woodpeckers and bighorn sheep. *ScienceDaily*.

[4] Shizhuo Yin, Chang Jiang C, Wenbin Zhu, Ju-Hung Chao and Annan Shang, 2019, "Ultrahigh light extraction efficiency light emitting diodes by harnessing asymmetric obtuse angle microstructured surfaces", *Optik*, 182, pp. 400