

Science and Life

Hippos aren't fat, and they can't swim. A mouse can survive a fall from any height. There are salamanders one foot long that don't have lungs or gills. There are snakes that can see in complete darkness, and dolphins that can sense your heartbeat. And the animal with the largest brain relative to its body size is a fish—a fish with an amazing superpower. In this class, we'll talk about the laws of nature that explain how creatures live and breathe and move around, and the senses they use to understand their world.



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Different Visions

Our view of the world is defined by the range of our vision. There are properties of light that we can't sense, and wavelengths of light we can't see, that other creatures can. We'll explore the entire range of the electromagnetic spectrum and discuss creatures that use light we can't see to inform their view of the world.



Physics Principles

Properties of Light

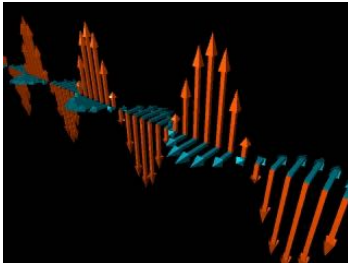
The Electromagnetic Spectrum



Light has a dual nature.

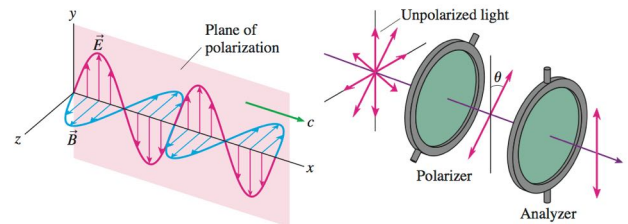


Light is an electromagnetic wave.



The orange arrows are electric fields: They push charges around.

Polarization

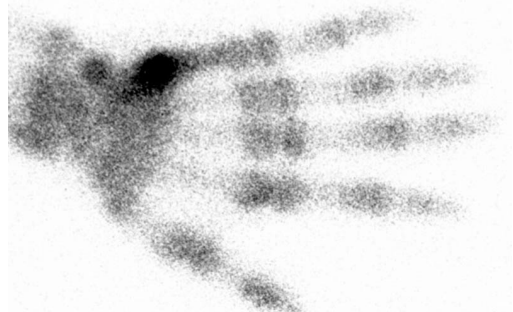


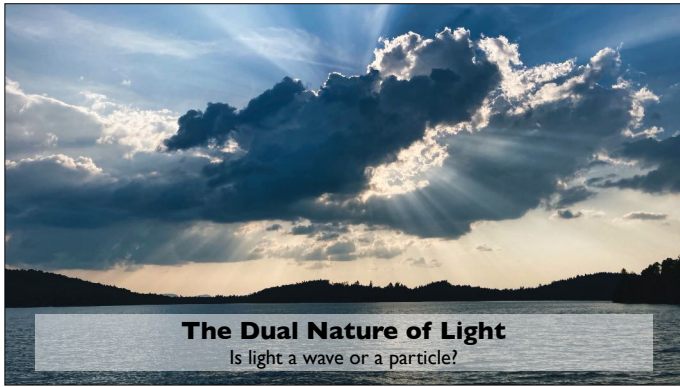
Playing with Polarizers

Check out: Polarized glasses, phone screens, reflections, computer screens



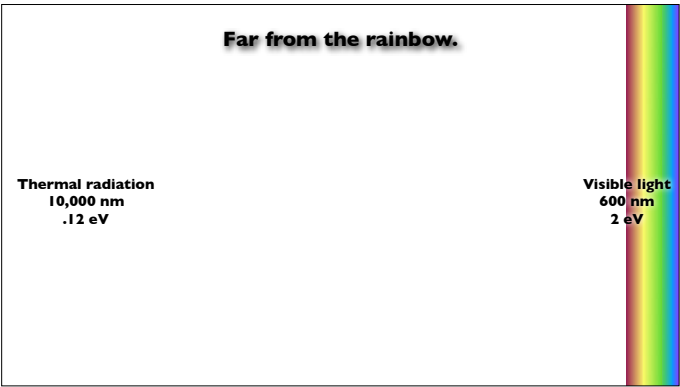
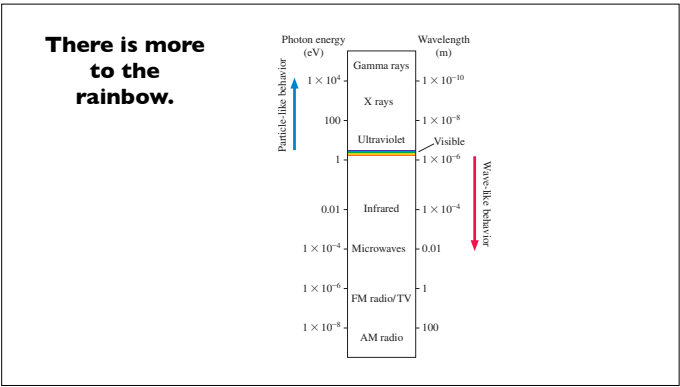
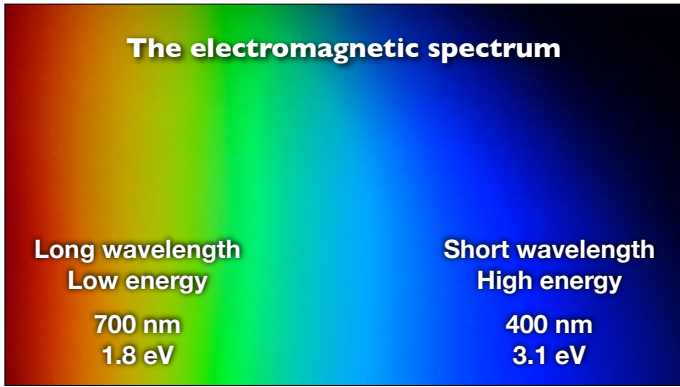
Electromagnetic waves are also **photons**:
Particles of light, with a certain amount of energy.





Writing with Light

Touch (gently!) different color flashlights to the glow-in-the-dark surface. Which colors leave trails?



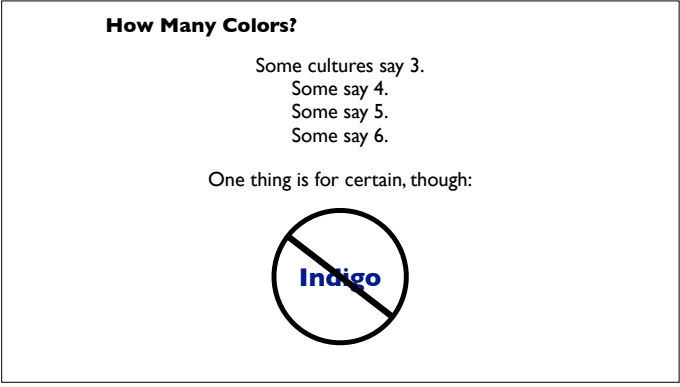
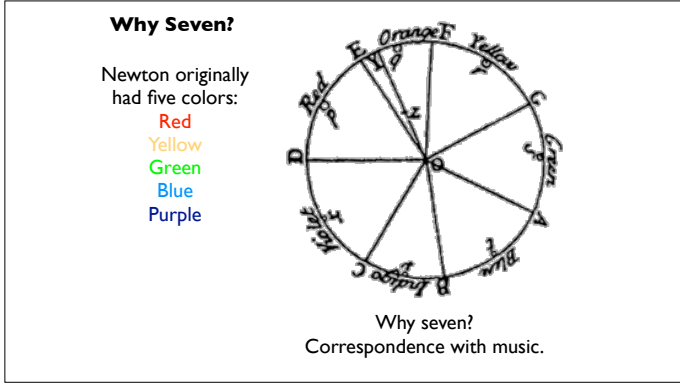
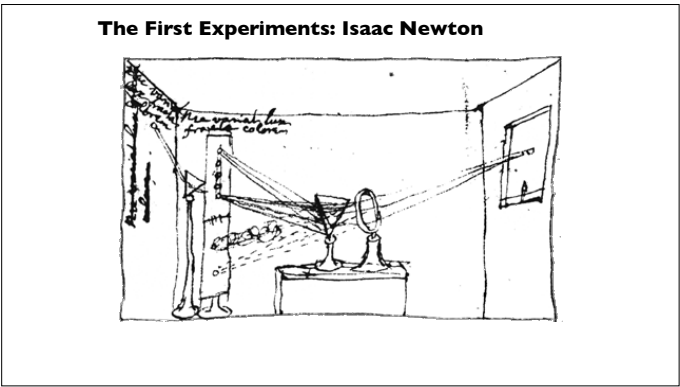
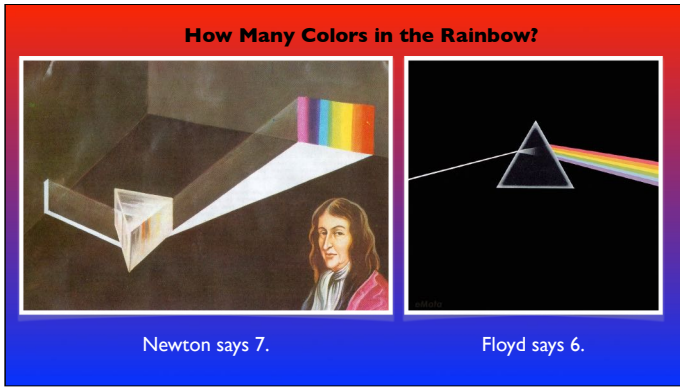
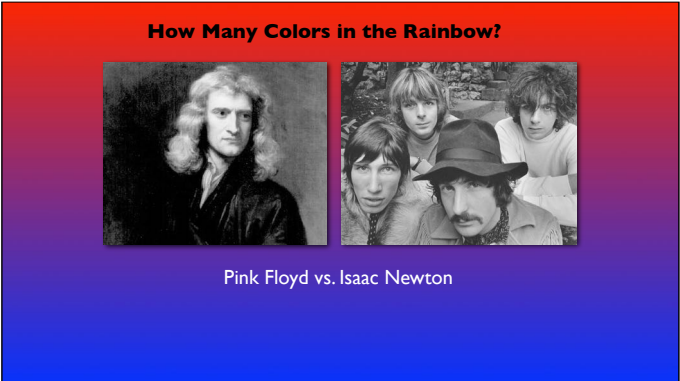
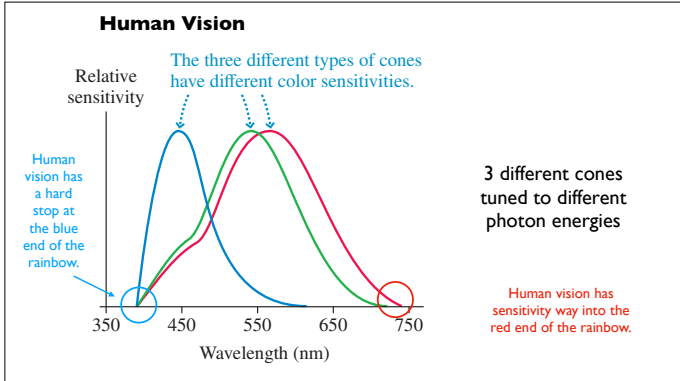
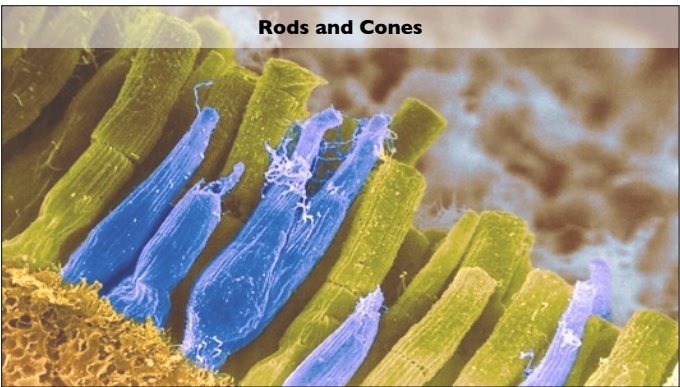
Fluorescence

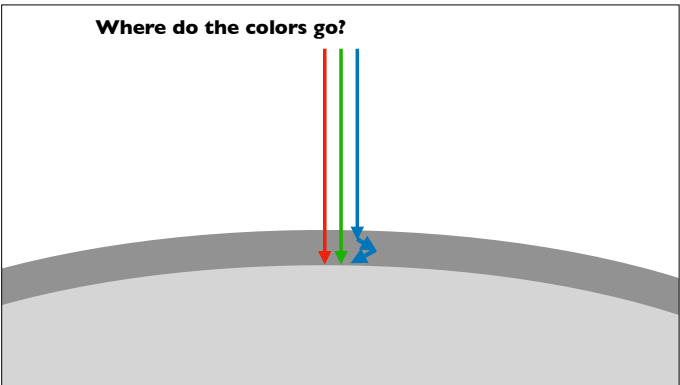
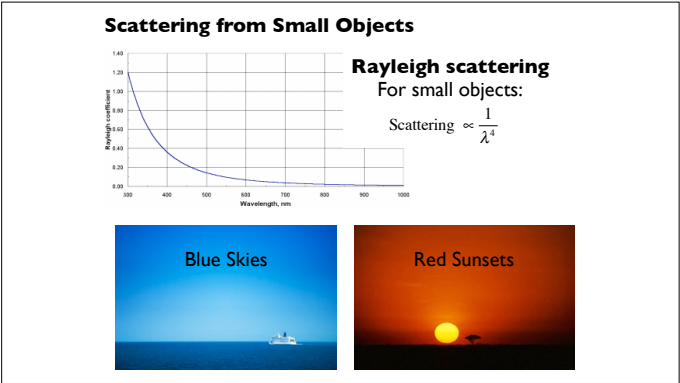
Something that needs high energy photons.

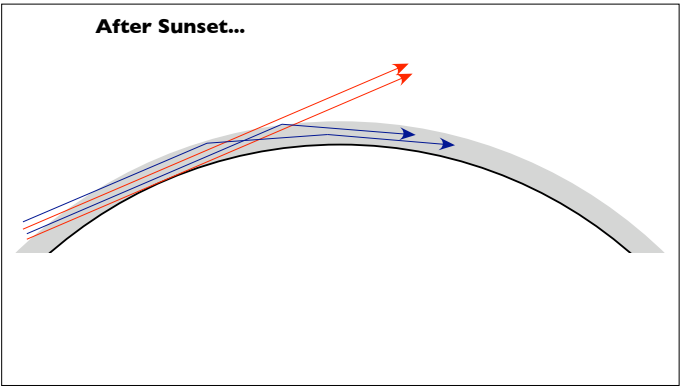
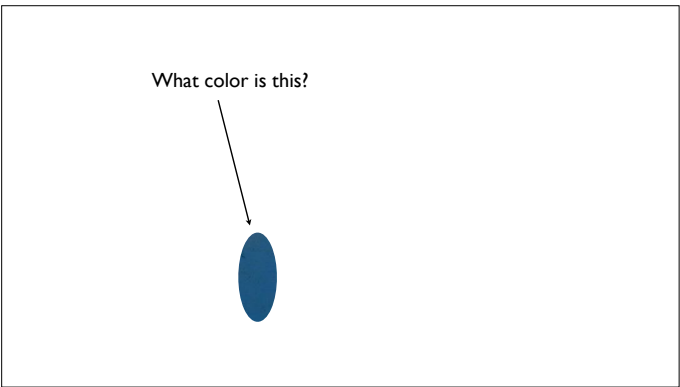
The molecules can absorb light over a range of wavelengths. This makes an *absorption band*.

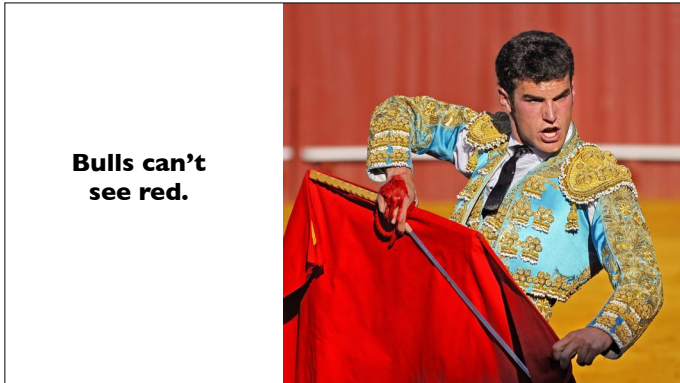
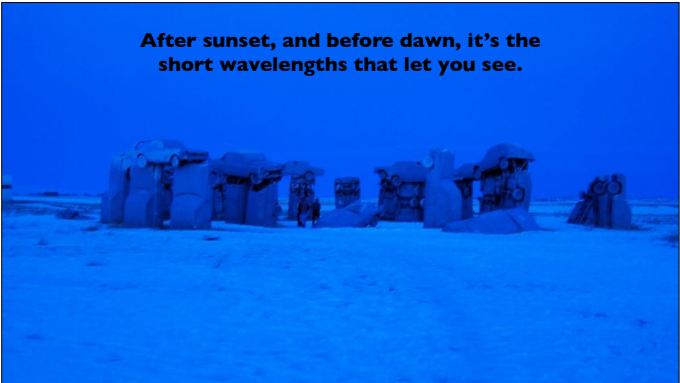
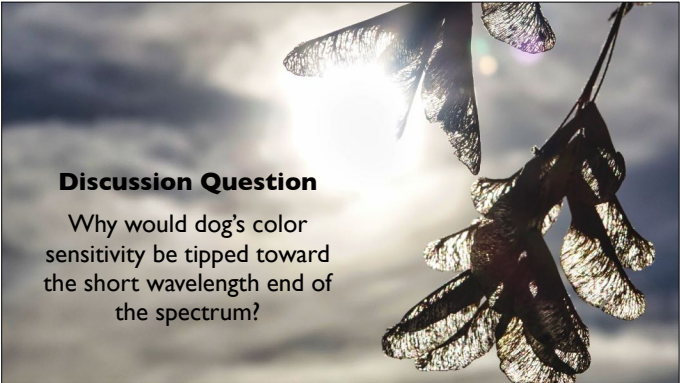
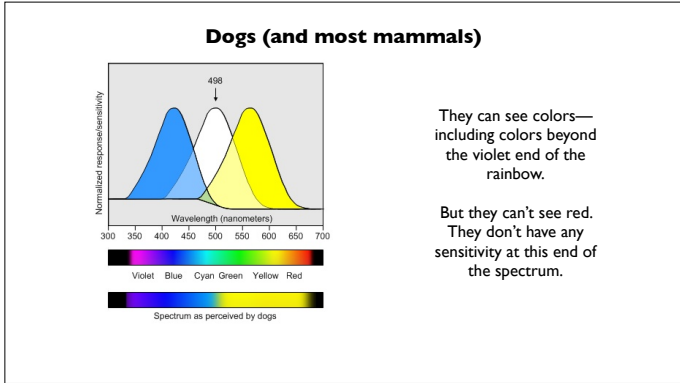
The molecules rapidly transform some of the absorbed energy into molecular vibrations, causing the molecules to fall to the bottom edge of the excited band.

Quantum jumps back to the lower band have less energy than the original jumps up. Thus the *emission band* is at longer wavelength than the absorption band. This is *fluorescence*.

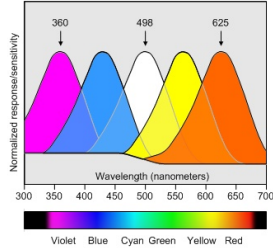








Chickens



Much better color vision than you. Can see into the ultraviolet.

Discussion Question

Why might you expect to see chickens to have much better color vision than dogs?



Urine is fluorescent.

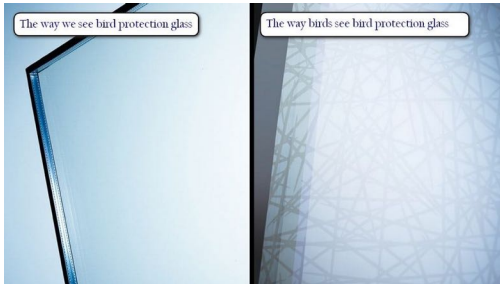
It strongly absorbs ultraviolet light.



Kestrels can follow urine trails



Ornilux Glass



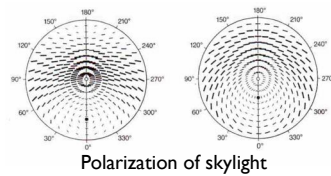
Bees don't have your visual acuity, but their vision has certain advantages.



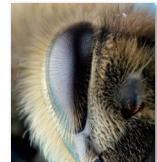
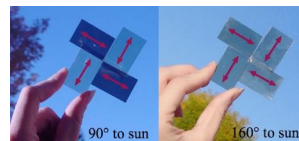
Ultraviolet Eyes

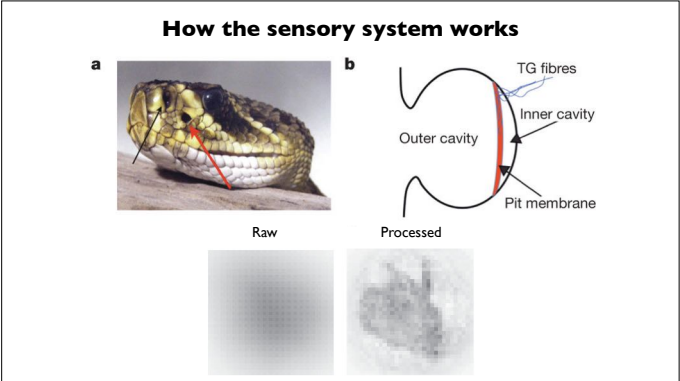
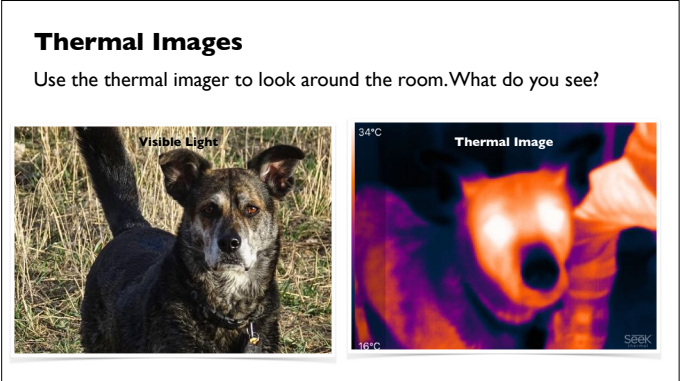
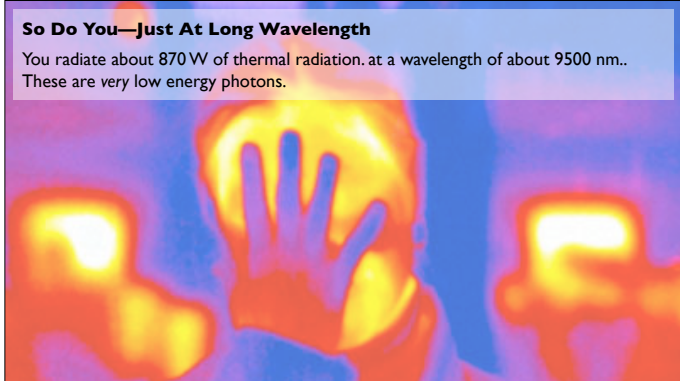
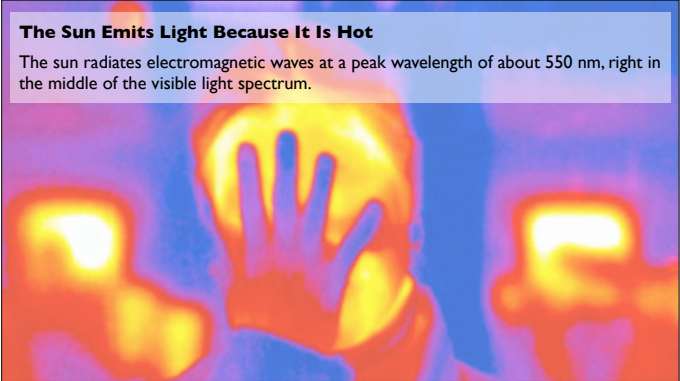
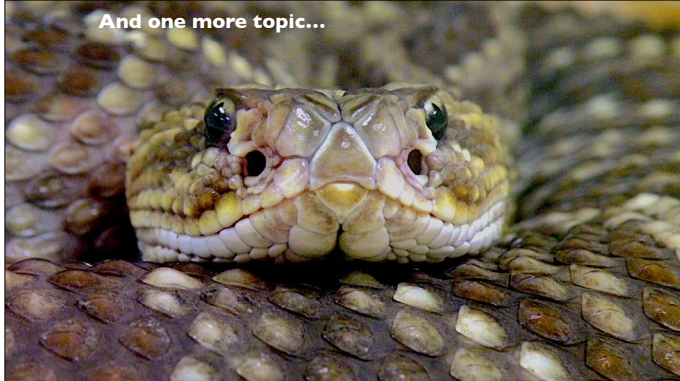
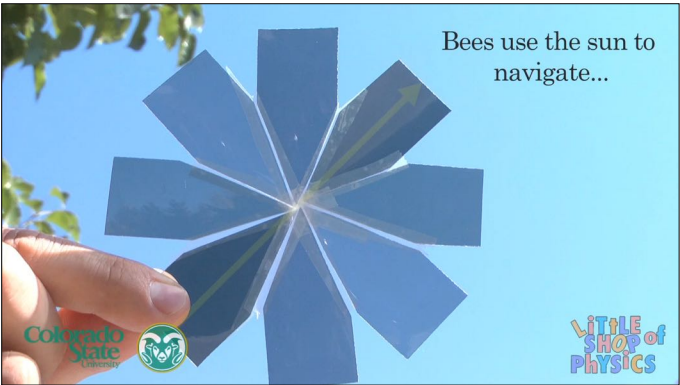
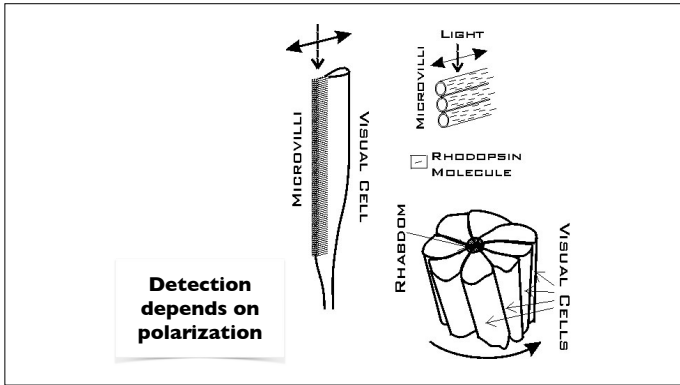


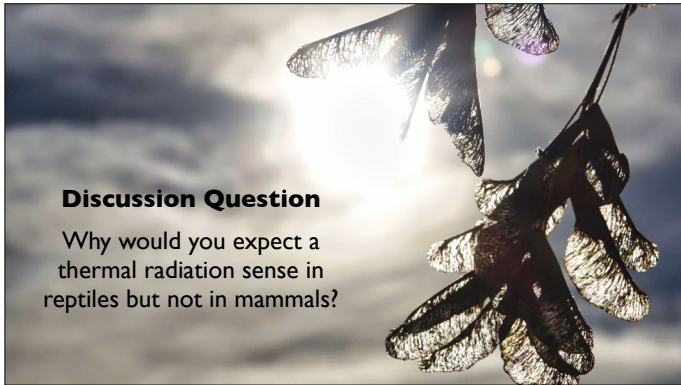
Navigating By The Sky



Bee eyes detect polarization





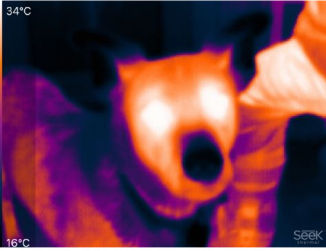


Discussion Question
Why would you expect a thermal radiation sense in reptiles but not in mammals?

Reptiles vs. Mammals

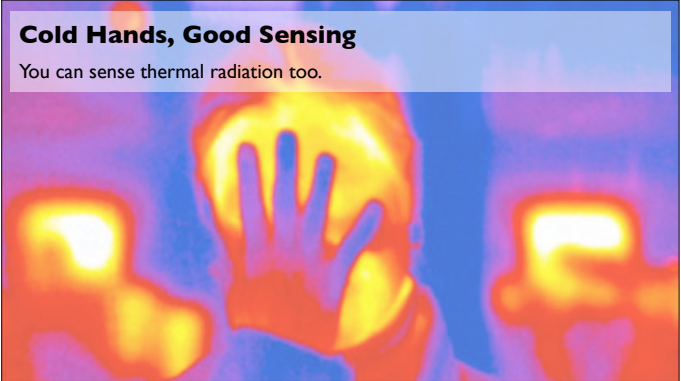


Why the cold nose?
Dogs can probably sense thermal radiation using their chilly noses.



34°C
16°C
seek

Cold Hands, Good Sensing
You can sense thermal radiation too.



Next Topic:
Sensing Sound.

