Lesson: “How can some animals see in the dark?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! I want to tell you about something funny that happened to me once at this place. OK, actually, it wasn't funny to me at first. But you'll see what I mean. First of all, this is my wife, Carrie. We met in a science laboratory. I'm not kidding. But that's a story for another time. When Carrie and I got married, we found a house that was available for rent. And I remember how excited we were to be all grown up, to have our own house we could live in. But one of our first nights in that house, things didn't go so well. It was 3 o'clock in the morning, pitch black. And I heard a sound—[thud, thud, thud]. I was terrified. “What is that?” I said to Carrie. [Thud, thud]. Even though I really didn't want to, I slowly got up to go outside and figure out what it was that was making that noise. I remember thinking, *oh man, I so wish my mom and dad were here to deal with this right now.* I grabbed a flashlight. I gathered up my courage, and I stepped into the hallway. [Thud, thud, thud, thud]—Oh my gosh, it was coming from the back of the house. So I started walking to the back door, trying not to trip over my cat in the process. I opened the back door, I went outside. It was dark and scary out there. We had no big street lights near the house, so I really needed that flashlight. I shined it all around, looking for what could be out there. But there was no one there. [Thud, thud, thud, thud]—there it was again. That's when I realized the sound was coming from behind me on the roof. I looked up and saw these bright eyes staring at me. They were raccoons. Sure enough, there had been a family of raccoons. And they liked our

little house just as much as we did. They'd been up there banging their little paws against the roof to try to force their way into the attic where they wanted to live. That's what the banging sound had been. They woke us humans up from a deep sleep. They'd been active because raccoons are a nocturnal animal, meaning they're most active during the night. Now, getting up on our roof must have taken some serious skill. They had to climb up the trees next to our house. And they had to find the one branch that was like a bridge to the roof. But how could they have seen what they were doing in the dark? They don't carry flashlights. They had to climb a tree in the pitch black. We human beings, who are active in the day time, we're so bad at seeing in the dark. I mean, look, I had to bring a flashlight with me. But raccoons, they can see really well when it's dark out. And you know, it's not just raccoons. Pretty much any nocturnal animal—like cats, owls, and deer—can all see really well in the dark using just their eyes alone. How is that possible? What do you think is special about the eyes of a nocturnal animal that makes them able to see so well at night?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to do a quick experiment with a partner and discover something that I think will surprise you. Then you're going to do a second quick experiment using the eye model you made in a previous Mystery. Now before we get started, let's think back to the three parts of the eye that you can see from the outside. There's the white of the eye, here. There's the iris, the colored part that's shaped like a donut. And there's the pupil, the black-colored hole in the middle of the iris. OK. Time to experiment. I'll show you what to do step by step.

ACTIVITY STEP 1

Find a partner to work with. Decide who will be the Watcher and who will be the Eyeball first. Don't worry, you'll switch jobs later.

ACTIVITY STEP 2

Eyeball, open your eyes wide. Watcher, look in your partner's eyes and find the white, the pupil, and the iris.

ACTIVITY STEP 3

Each person has a different job in this experiment. Listen carefully, so you'll know what your job will be, but don't do anything yet. Teacher, you're going to count down from 20. And then, you'll say, “Open.” Eyeball, you're going to close your eyes until you hear “open.” Watcher, you're going to watch for a change in Eyeball's eye when they open. The change will happen really fast, so you'll have to watch carefully. OK, now that everyone knows their jobs, go to the next step.

ACTIVITY STEP 4

Are you ready? Eyeball, close your eyes. Watcher, get ready to watch. Teacher, start counting down from 20. And don't forget to say “Open” at the end of the countdown.

ACTIVITY STEP 5

Switch roles and try it again. Eyeball, close your eyes. Watcher, get ready to watch. Teacher, start counting down from 20.

ACTIVITY STEP 6

Discuss this question as a class.

ACTIVITY STEP 7

This video shows an eye as the light gets turned on and off. Watch it, and then discuss as a class.

ACTIVITY STEP 8

Now, it's time for the second part of the experiment. Each person needs these supplies. Notice that you're going to be using the eye model you made in a previous activity.

ACTIVITY STEP 9

Color in the iris. Use the same color you used in your first eye model so that they match.

ACTIVITY STEP 10

Cut on the thick black line to cut out the pupil-card.

ACTIVITY STEP 11

Fold the card in half, like this. Then, cut on the dotted line. Unfold the card when you're done cutting.

ACTIVITY STEP 12

Watch this whole step before you do anything. Teacher, turn off the lights and uncover any windows. Students, use the eye model to make a picture on the retina, just like you did in a previous Mystery. Don't do anything with the pupil card yet.

ACTIVITY STEP 13

Discuss this question as a class.

ACTIVITY STEP 14

For this next step, you and your partner will need new jobs. Decide who will be the Focuser and who will be the Pupil Master.

ACTIVITY STEP 15

Pupil Master, slide the pupil card into the pocket, like this.

ACTIVITY STEP 16

Focuser, with the pupil card in place, make a sharp picture on the retina, like this.

ACTIVITY STEP 17

Both of you, watch the picture on the retina while the Pupil Master pulls out the card. What happens?

ACTIVITY STEP 18

Try the experiment a few times. Switch jobs if you'd like.

ACTIVITY STEP 19

Discuss these questions as a class.

WRAP-UP VIDEO 1

Now, when you did your experiment, you noticed something really strange. After having your eyes closed for a while, when you go to open them, watch. Your pupil gets smaller. Let's watch that again. Here, check it out. You see that? Any time that it's dark, like when you turn the lights out and let your eyes get used to the dark, your pupil gets bigger. It expands. Let's watch that. See? But when you go to turn the lights back on again, let's see what happens. Gets smaller, you see that? Why would the pupil do this? Why does it change size depending on how bright or dark the room is? Well, one thing to notice is it's not just the pupil. That colored part, the iris, that was changing, too. The iris is controlled by a muscle that can make it shrink or expand in size. And that makes that hole in the middle, the pupil, get larger or smaller. So why does this happen? What could the changing size of the pupil have to do with darkness versus bright lights? What the iris and pupil are doing are controlling how much light enters the eye. When it's dark around you, your eyes need more light to see. So the pupil gets nice and big to let in lots of

light. But when it's bright around you, now your eyes need less light. So the pupil gets smaller, letting less light into the eye. You've probably noticed before that when you turn off the lights or you walk into a dark room, you can't see anything at first. It's black. But if you let your eyes adjust, if you wait a few minutes, like this, you can start to see at least a little bit. You see that door there now? Now you know one reason why that happens. As you wait in the dark, your iris muscles opened up the pupil so that any extra light that's in the room can enter your eye, allowing you to see better. But now what about the raccoon and other nocturnal animals? They can see so well in the dark. Why is that? Why can so many animals see so much better than we can when it's dark out? Well, to figure that out, you have to observe. Have a look at some of their eyes compared to ours. See what you can notice now that you know something about the iris and pupil. What can you tell?

WRAP-UP VIDEO 2

Even on the darkest night, there's still at least a little bit of light, like from the stars or from the moon. That may not be enough light for us human beings to see very well at night. But every eye needs at least a little bit of light in order to see. Animals that are good at seeing in the dark, like this owl, have pupils that can open really wide. Having large pupils means that this owl's eyes let in lots of light. Even if it's just starlight, it's still more light than our eyes let in. Or check out this creature. It's an animal called a tarsier. It's related to monkeys, and it's nocturnal. In the daytime, the tarsier's pupils, you can see, are very small, really small. But at night, it can open its pupils up nice and wide, like this. So this tarsier is able to see in the dark just by the light of the stars. Or look at this gecko. Now, its pupils are shaped like slits instead of circles, but it's the same idea. When the lights turn off, check this out. Its pupils get really big. But when the lights turn on, do you see that? Tiny pupils again. Lights on. Lights off. So no matter how dark it gets,

this gecko can still see. The eyes of nocturnal animals have pupils that can open really wide to let in as much light as possible. But there's one more trait that helps nocturnal animals see on dark nights. Remember these raccoons that I found on my roof? You saw in this picture that their eyes seemed to be glowing when I shined a flashlight at them. Now, maybe you've noticed other animals whose eyes glow like this when you shine a light on them. Why is that? What's going on? Like, have you noticed if you take a picture of your dog when the flash of the camera's on, see how its eyes look like they're glowing? Or have you ever seen deer in the headlights of a car? Look at that, glowing eyes. Or here's a flash photo of a cow at a farm. What is going on with these animals' eyes? Why do their eyes seem to glow when you shine a light at them? Well, again, let's take a look inside. Let's see a dissection of a cow's eye and see if we can figure it out. Here we go. So there's the front of the eyeball. You can see the dark iris and pupil. And the scientist is going to cut it open so we can see inside. Ready? Now look towards the back of the eye. There, do you see that? It's blue at the back. So at the back of a cow's eye, there's this layer of really shiny blue stuff. What is that? Well, the blue stuff in the cow's eye, it's actually a lot like this reflective tape that some bike riders wear at night so that cars notice them. When a bright light hits reflective tape, it glows brightly, see? Same thing with the blue in the cow's eye. When you shine a flashlight into a cow's eye, some of the light reflects off of that shiny blue stuff in the back and bounces back out of the front of the eye. So that's the glow you're seeing. When you see an animal's eyes shine like this, you're seeing the color at the back of their eyeball shine brightly, just like reflective tape. Scientists think that this shiny layer helps these nocturnal animals make better use of the light that gets into their eyes. Many nocturnal animals have this shiny layer, but it's not always blue-colored, like in cows. In dogs and cats, you could see that it was green-colored. And in alligators and lizards, look at that. The shiny back layer looks to be kind of reddish or orange. In raccoons, it's yellow. Now, if you shine

a light at a person, you won't see anything shiny. Human beings don't have a shiny layer at the back of our eyes. We're not nocturnal. We're most active during the daytime. All we have at the back of our eyes is the retina, which is mostly a bunch of blood vessels. But if you take a photograph of someone in a dark room using a flash, and you do this very quickly so that the person's pupils don't have time to shrink down in size, then you might see this, what some people call "red-eye." Have you ever seen this in a photo? Why does that happen if we don't have anything shiny back there? Why does it look red? Well like I said, there are blood vessels in the back of human beings' eyes in the retina. So if you've ever noticed someone in a photograph having red eyes, that is what you're seeing. The red is actually the blood vessels at the very back of your eye. So that's something you can try at home. Go home and take some flash photos of yourself. And if you have a dog or a cat, do that too. See if you can notice a shiny layer at the back for the animals, meaning they're animals that can see well in the dark. And see if for yourself you can just notice the blood vessels. Have fun!