Lesson: “How does a tiny seed become one of the heaviest trees on Earth?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi. It's Jay from the Mystery Science team. Check this out. This is one of the biggest trees in the world. People call it General Sherman. It's named after an army general from long ago. General Sherman is an absolutely ginormous sequoia tree growing in Northern California. Scientists estimate this tree weighs over a million pounds. That's more than the weight of one hundred African elephants. It's taller than some skyscrapers. And this tree is still growing, which is even more incredible when you consider that this enormous tree grew from a seed smaller than the tip of your finger. So where did all this heavy wood and other tree stuff come from? I mean, if an animal was that big, it would need to eat lots of food to get that huge and heavy. A single African elephant can eat hundreds of pounds of food in a day to get as big as it is. And this tree weighs more than one hundred elephants. All animals have to eat food to grow bigger. The materials that make up an animal's food become the materials that make up an animal's body. Another word for these materials is matter. Matter includes anything that takes up space and has weight. And an important thing to know is that matter doesn't just magically appear out of nowhere. When something gets bigger and heavier, the matter making it bigger and heavier came from somewhere else. If you eat chicken, the matter in that chicken becomes the matter in your body. That chicken got the matter in its body from the food it ate, like this corn. Matter in a corn plant

becomes matter in a chicken, which becomes matter in your body. This is called a food chain, and almost every food chain starts with a plant. When we humans eat food, we take matter from outside our bodies and put it inside our bodies. It's similar for plants. For a plant to grow, matter has to move from outside a plant to inside a plant. But plants can't eat the same way that humans and animals do. A tree can't walk the savanna looking for grasses to chomp or stand in line at a food cart to buy tacos, and the plant can't reach down Mhmm. Pick up a sandwich and raise it to its mouth to eat it. Anything a plant takes in has to be right next to it already, basically already touching it. So what materials are already right next to a plant like General Sherman?

EXPLORATION VIDEO 2

A tree has to get the matter it needs from nearby, basically from the stuff already touching it. If we take a look at General Sherman, we can see a few materials touching it already. Its roots are buried in soil. When it rains, water drops onto the tree and into the soil near its roots. And then there's the stuff surrounding most of the tree, the air. I wonder if we could grow a plant with only these three materials: soil, water, and air. Let's see what happens if we try to grow seeds in a closed container that only has soil, water, and air inside. Nothing else. Okay. We'll start by putting some soil in a jar. We'll leave some room in the jar for air. Now we can add some seeds. If we put these seeds on a scale, we see that they weigh 0.96 grams. Once we sprinkle the seeds inside the jar, we'll add a little water, seal the jar up, and leave it to grow. If we check back a few days later Woah. Okay. The seeds definitely grew. There's a whole bunch of tiny plants growing in there now. And if we separate out the plants and weigh them, we see they weigh more than six grams, so much heavier than the seeds we started with. Nothing new was added to the jar after we sealed it up. And we know that matter can't come from nowhere, so this is

evidence that the plant used soil, water, or air to grow bigger. But we still don't know which materials it used. Was it the soil? Water? Air? A combination?

ACTIVITY 1 INTRODUCTION VIDEO

In today's activities, you'll be investigating which materials plants use to grow from a tiny seed to a massive, giant tree, like General Sherman. Throughout the lesson, you'll gather evidence from lots of different plant experiments. You'll use that evidence to decide for yourself: are plants using the soil, the water, the air, or a combination of these three materials to grow? For each material, you need to answer two questions. First of all, is it matter? Matter is anything that takes up space and has weight. And second, is there evidence that the plant is moving the material from outside its body to inside its body? In the end, you'll need to make a claim about what you think plants use for their growth. The more evidence you gather, the more confident you'll be in your claim. We'll investigate the soil, the water, and the air, one by one. We'll start with the soil. It's the first piece of the puzzle to understand how a tiny seed became a gigantic tree weighing over one million pounds. Are you ready to figure out this mystery together? We'll show you how to get started step by step.

ACTIVITY 1 STEP 1

Throughout today's activities, you'll work with a partner so that you can discuss your ideas. When you're done with this step, click the arrow on the right.

ACTIVITY 1 STEP 2

Get your supplies.

ACTIVITY 1 STEP 3a

The first piece of evidence you'll gather today is from an experiment that was conducted hundreds of years ago. This scientist named Helmont thought of a clever way to test if plants use soil for their growth. He started with a little tree sapling and weighed it. The tree weighed five pounds. He also weighed the soil. The soil weighed two hundred pounds. Helmont planted the tree in the soil and gave it some water. Then he let it grow and grow and grow. This experiment went on for years. After a few years, he carefully separated the tree from the soil so he could weigh them both again. The tree went from five pounds to one hundred and seventy pounds. That extra weight had to come from somewhere. Helmont wondered if it came from the soil, so he weighed the soil again. If soil moved from outside the tree to inside the tree, do you think the soil would weigh less, weigh the same, or weigh more? Discuss.

ACTIVITY 1 STEP 3b

Here's what we think. If the soil moved from outside the tree to inside the tree, we think the soil would weigh a lot less. But if the soil didn't move from outside the tree to inside the tree, then the soil would probably weigh about the same. Go to the next slide to see the results of this experiment.

ACTIVITY 1 STEP 4a

Okay. Let's find out what happened. Check it out. When Helmont weighed this soil at the start of the experiment, it weighed about two hundred pounds. When he weighed it at the end of the experiment, it was still about two hundred pounds. Now that you have evidence from Helmont's

experiment, answer questions one and two about soil on your Plant Matter Mystery worksheet. Then discuss. Is there evidence that plants get matter from soil? Why or why not?

EXPLORATION VIDEO 3

In the last activity, we saw an experiment from long ago that gathered evidence about whether plants get their matter from soil. Here's what we noticed. When the plants grew bigger and heavier, the soil didn't get smaller and lighter. In other words, the soil wasn't going anywhere. It was not moving from outside the plant to inside the plant. Now you probably know that most plants grow best in soil. But from what the experiment showed us, we know that plants don't get most of their matter from soil. There's just no evidence to support that idea. Whatever materials plants are using to build their bodies, it's got to be mostly something else. We know that plants must get their matter from materials around them. Soil, water, or air. If soil is not where plants get most of their matter, then there are two possibilities left, water and air. Let's focus on water. It's pretty easy to collect evidence that water is matter. When you put water in your water bottle, it gets full and it gets heavy. It definitely takes up space and has weight. But to know that plants get matter from water, we'd also have to know that water can move from outside a plant to inside a plant. If you've ever watered a plant, you might notice that the water doesn't stay where you first poured it. After a while, it disappears. But does that mean it's moving from outside the plant to inside the plant? We can test this to see what's really going on. Take a look at this. These are parts of a plant you probably already know: celery. We're going to place the celery in cups of water dyed with food coloring. If the water moves into the plant, we should be able to see the dye in the plant. If it doesn't move into the plant, then the celery should stay the same. Watch what happens as the celery sits in the water for a long time. See there? The line of the water in the cup is going down. But did the water move into the plants? Let's compare what the

celery looked like before the experiment and after. Check out the tops of the celery. Notice how the color has changed? This is evidence that the water has moved from outside the celery plant to inside the celery plant. Now that we've looked at some more evidence, take another look at your worksheet to see if we're closer to answering our big question about where plants get their matter.

EXPLORATION VIDEO 4

We know there are three materials that most plants come in contact with: soil, water, and air. And we know they must use at least one of these materials as a source of matter. At this point, we've gathered lots of evidence about soil and water. There was not much evidence that plants get matter from soil. There was evidence, however, that water might be a source of matter for plants. Before we decide, there's still one material we haven't investigated air. It might seem strange to think of air as a source of matter for plants. It's so easy to forget that air is even there. Could something that almost seems invisible be responsible for the matter that makes up pounds and pounds of bark, needles, and wood in a plant like General Sherman? To figure that out, we'd have to know, is air even matter in the first place? How could you find out?

ACTIVITY 2 INTRODUCTION VIDEO

In this activity, you're going to figure out if air is matter. Matter takes up space and has weight. So does air weigh anything? This is a tough challenge. I mean, air is all around us all the time, but we can't even see it. We can't grab a handful of it. So how can we possibly weigh it? In a moment, you're going to come up with ideas for how you could weigh air using anything you see in this picture. Then we'll show you videos of people doing three different experiments using

these objects. You'll use your observations from these experiments as evidence to decide for yourself if air weighs anything. We'll show you how to get started step by step.

ACTIVITY 2 STEP 1a

With your partner, take a close look at the objects you see here. Talk with your partner about what you could use in an experiment that would show whether or not air weighs anything. You can use anything you see here. It might help to think about how you could compare the weight of an object inflated with lots of air, to the weight of an object that is deflated without much air in it. How many experiments can you think of? Discuss with your partner. I'll set a timer for three minutes in case that's helpful. Okay. Time's up. Go to the next step.

ACTIVITY 2 STEP 1b

There are lots of right answers. We thought you could choose something that can hold air, like basketballs, balloons, or even scuba diving tanks. Then, you could weigh one that is filled with a lot of air and one that is filled with just a little air. We can use a scale like this to measure how much each of them weighs. Or we can use this balance scale. The balance scale won't tell us exactly how much the objects weigh, but it will tip down toward the side that's heavier so we can compare the weight of two objects. We've chosen three different experiments for today. One that uses basketballs, one that uses balloons, and one that uses scuba diving tanks. Go to the next slide to get started.

ACTIVITY 2 STEP 2

Get your supplies.

ACTIVITY 2 STEP 3

It's time for Air Experiment 1. In this experiment, we'll use a basketball. First, let's take a basketball full of air and weigh it. Look carefully and observe how much it weighs. Now, let's deflate the basketball, squeezing out air from it. Okay. Now, it has very little air in it. Let's weigh this too. Look carefully and observe how much it weighs now. Here are those measurements again, when full of air and with very little air. Now, go to the next step to discuss.

ACTIVITY 2 STEP 4

Discuss, then answer the questions for Air Experiment 1 on your Weighing Air worksheet.

ACTIVITY 2 STEP 5

It's time for Air Experiment 2. In this experiment, we'll use balloons. Just like the basketball experiment, we'll use fully inflated balloons and compare them to deflated balloons. This balance scale was too small, so we used a meter stick to make a bigger balance scale like this. This balance scale will tip down toward the side that's heavier. Let's attach a couple of fully inflated balloons on one side and a couple of deflated balloons on the other side. Check it out. Now that you've made your observations, go to the next slide to discuss.

ACTIVITY 2 STEP 6

Discuss, then answer the questions for Air Experiment 2 on your Weighing Air worksheet.

ACTIVITY 2 STEP 7

It's time for Air Experiment 3 with scuba diving tanks. This scuba tank is filled with just a little air. Watch what happens when it's dropped in the pool. This is a scuba tank that's filled with lots of air. Watch what happens to this tank when it's dropped in the pool. Now that you've gathered more evidence, go to the next slide to discuss.

ACTIVITY 2 STEP 8

Discuss, then answer the questions for Air Experiment 3 on your Weighing Air worksheet.

ACTIVITY 2 STEP 9

Now that you've gathered evidence from three different experiments, let's go back to our original question. Is air matter? Why or why not? Think about all your observations, and then discuss.

WRAP-UP VIDEO 1

In the activity, we noticed that objects filled with lots of air are heavier than objects filled with just a little air. This is evidence that air takes up space and has weight. By looking at what we saw in our tests, we can make a claim that is supported by the evidence. Air is matter. The air around us is made up of a mixture of many different gases, and all of those gases are matter. So air is matter. But we still need to know, can air move from outside a plant to inside a plant? Well, take a look at this. Scientists using microscopes discovered something very interesting on the underside of plant leaves. It looks like this, like little microscopic mouths. Watch how they move. They're even able to open and close. These are called stomata, from the Greek word for mouth. All kinds of plant leaves have stomata, from big, flat leaves, like these, to tiny, skinny needles

like these. Scientists studying stomata under microscopes have found that air can actually pass through them into the plant, kind of like how air can pass through our mouths into our bodies. This is evidence. Air moves from outside plants to inside plants. Now that we've gathered evidence, we might be able to answer our original question: where do plants get their matter?

WRAP-UP VIDEO 2

General Sherman is not just any plant. This tree is as tall as a skyscraper, weighing over a million pounds. And yet, this enormous tree gets its matter from the same sources that even the teeny tiniest plant does. It gets matter from water and air. General Sherman soaks up water through its roots, and sometimes even through its leaves. The tree uses some of that water's matter to build the matter of its body, like its bark, trunk, seeds, and more. But the matter in this tree doesn't just come from water. Actually, most of the matter that makes up most plants, including General Sherman, comes from something else, the air. The air around a plant moves through tiny holes on its leaves or its needles, in General Sherman's case, to inside the plant itself. Plants then use a gas in the air called carbon dioxide to help build their bodies. That's incredible when you think about it. A tree can turn this and this into something like this. This huge, towering giant of a tree and all its bark and branches and roots come from stuff we don't even notice most of the time. You might be wondering how this happens. That's a complex process, but it has to do with one more thing you can find near this tree that we haven't talked about yet: sunlight. Unlike water and air, sunlight is not matter. It doesn't weigh anything, but plants still need sunlight to grow. Plants use sunlight as a source of energy. That energy helps plants build matter from water and air into things like leaves, roots, and bark. Plants are sometimes called producers because they produce matter from what seems like nowhere, but the evidence shows that it is coming from somewhere. A plant's matter comes from almost

entirely water and air. Now air and water aren't food, but matter in air and water becomes matter in plants, which becomes matter in the animals that eat it, which becomes matter in the animals that eat them. In a way, if you trace the matter in your body all the way down the food chain, much of that matter started as air. A little matter passed from one thing to another can build some impressive stuff. Next time you see a living thing, whether it's a blade of grass, an ant, or an elephant, take a minute to think of all the matter that went into building its body. Amazing things can't come from nowhere, but sometimes they can come from out of thin air. Have fun and stay curious.