

Brains On (APM) | Brains On! Soil: Can you dig it? 01CZ14SVATTNC1ZH26JZTZ3E3T

INTERVIEWER 1: You're listening to Brains On, where we're serious about being curious.

INTERVIEWER *Brains On* is supported in part by a grant from the National Science Foundation.

2:

[MUSIC PLAYING]

MOLLY BLOOM: What do we know about dirt? It's fun to play in.

JOSEPH It gets on your clothes.

PINEDA:

MOLLY BLOOM: And under your fingernails.

JOSEPH And maybe in your hair.

PINEDA:

MOLLY BLOOM: And maybe you accidentally eat some of it.

JOSEPH But dirt is not what vegetables and plants grow in.

PINEDA:

MOLLY BLOOM: Nope.

JOSEPH That's soil.

PINEDA:

MOLLY BLOOM: Right. Dirt may be soil, but soil is not just dirt.

JOSEPH Clay, sand, mud. Soil is everywhere. Even on the bottom of the ocean. And it's alive.

PINEDA:

MOLLY BLOOM: Today, we're digging into the stuff that's beneath our feet, and we have a lot in store for you. So let's get started.

AUDIO TRACK: Brains On!

SUBJECT: This is broccoli.

SUBJECT: We're growing right here carrots.

SUBJECT: Here, we have red lettuce.

SUBJECT: We planted it a little after we began the square.

SUBJECT: We're growing squash.

SUBJECT: And we dug up holes, and we would put seeds inside.

SUBJECT: This is beans. And put the dirt over it and water it so they could grow and sprout.

SUBJECT: Right here, we have tomatoes, and they're big.

SUBJECT: You can see the carrots sticking out. That means they're ready.

SUBJECT: I'm digging the dirt. When you touch it, it's soft. But sometimes it can be hard.

SUBJECT: If it rains, it's all squishy and dark. Smells like a little bit like a pencil.

SUBJECT: I see little animal sticking out and little pieces of wood.

SUBJECT: There's a worm right there. It's very long.

SUBJECT: Dirt helps the roots grow inside. And then it helps the stem stay sturdy.

SUBJECT: And the roots brings up the water or whatever it absorbs to the plants.

SUBJECT: Plants, roots grow to make it sprout.

SUBJECT: Brains On Dirt.

MOLLY BLOOM: Well actually, soil. We just heard from a few kids who spend a lot of time with it. Aldo Olivez, Carla Lopez, and Kathryn Gonzalez. They're fifth graders at Dolores Huerta Elementary School in Los Angeles. The school has its own organic garden where students learn about growing food and working with plants and, of course, soil.

I'm Molly Bloom, and my co-host today is also one of the gardeners you just heard from, Joseph Pineda. Hi, Joseph.

JOSEPH Hello.

PINEDA:

MOLLY BLOOM: Joseph, what is your favorite thing about working with soil?

JOSEPH I like how it helps plants grow, and you can see them sprout. And then they'll be ready to eat.

PINEDA:

MOLLY BLOOM: And is it fun to actually touch it and work with it?

JOSEPH Yeah it's really squishy. And it's soft when you touch it, but it gets your hands dirty.

PINEDA:

MOLLY BLOOM: Have you ever found anything surprising in the soil when you're working with it?

JOSEPH Yeah, I found a lot of bugs.

PINEDA:

MOLLY BLOOM: What kind of bugs?

JOSEPH Like worms and ladybugs.

PINEDA:

MOLLY BLOOM: Cool. We're actually going to get back to that in just a little bit and find out more about all the stuff that's living in soil. But first, we're going to answer another question. How many different kinds of soil are there? Producer Sanden Totten is here to explain.

SANDEN Soil is made up of three key ingredients. They are--

TOTTEN:

[DRUM ROLL]

Sand, silt, and clay.

[RIMSHOT]

Sand you may recognize from its starring role in the beach or the desert or--

[MEOWS]

Kitty litter. Kitty-- kitty? Getaway, shoo. Not now, kitty. I'm trying to explain the three types of soil.

[MEOWS]

OK, where was I? Oh yeah, sand. Sand particles are pretty big as far as soil goes. You can see the individual grains with your naked eye. Next, you've got silt. Compared to sand, silt has pretty small particles. And you can't really see them without a magnifying glass. When it's dry, silt looks like cocoa powder. It's light, airy, and--

[BLOWS]

It blows away really easily. When it's wet, it's mud. Messy, but feels pretty good to squish between your toes. Ooh yeah, that's nice. Lastly, there's clay. Clay has teeny tiny particles. Get it wet, and clay is some sticky stuff. Dry it out, and it can be as hard as concrete.

[THUDS]

Plants have trouble getting their roots into clay, but it's perfect for making pottery. Most soil you find in the wild, though, is a mixture of these three things. A little bit of sand, a little bit of silt, and a little bit of clay. If the soil has all three of these things in equal amounts, it's called loam. And it is glorious. You can grow all kinds of things in loam. And that, everybody, is the dirt on soil.

AUDIO TRACK I love science!

1:

INTERVIEWER With Professor Patricia Menchaca.

3:

PATRICIA MENCHACA: My name is Patricia Menchaca, and I am a soil and water scientist. Soil is called a soil because it has a variety of components that make it different from dirt. So when soil hangs out for a little while in the same place and is exposed to different temperatures and water and chemicals, it slowly starts to change in color sometimes. It will start to develop certain structures.

So when you pick up a big clump of soil and you start to break it apart, you see that it starts to break apart roughly in the same shapes and the same sizes and specific depths. And that's what makes it a soil, is that over time, the ambient environment is actually changing its properties.

Well, dirt is different in the sense that when you dig it up, you damage all of those properties and you just have a big mishmash of dirt.

[LAUGHS]

MOLLY BLOOM: All right. Soil is not dirt. Professor Menchaca will be back really soon with some more awesome facts about soil. But first, a song.

[MUSIC PLAYING]

(SINGING) Can you dig me? Gophers, moles, and prairie dogs can. Can you find me? Am I under water? Do I cover the land? And I'm glad to hold the roots of plants in place. It's me that makes the smiling face in the moon. But I, too, do make castle. Just add water in the sandbox with your mother. You could bury hidden treasure like a penny or a measuring spoon. Just please, don't eat me. I'm no good for you.

(SINGING) So call me soil or call me earth. It doesn't matter much to me. Because everybody walks all over me. So be a clay, silt, sand alone. Without me, flowers would never grow. And Mr. Earthworm couldn't call me home. So go outside and play with dirt.

[WHISTLING]

MOLLY BLOOM: That was Mike Olson with Bridget Kearney and Mike Calabrese.

JOSEPH And they're part of the band Lake Street Dive.

PINEDA:

AUDIO TRACK: I love science!

INTERVIEWER With Professor Patricia Menchaca.

3:

PATRICIA Plants can wilt when they're dry. That is also true for overwatering of plants. Plants, like humans, also need air to breathe and to continue to grow. If you fill up those pore spaces in between the soils with all water, then you're suffocating the plant, and they no longer have access to the air in the pores. Therefore, killing your houseplants.

MENCHACA:

[VOCALIZING]

AUDIO TRACK: Brains On.

MOLLY BLOOM: I'm Molly Bloom.

JOSEPH And I'm Joseph Pineda.

PINEDA:

MOLLY BLOOM: And today, we're digging into soil. But before we learn more about the sandy, silty, clay-y stuff, it's time for the mystery sound.

[MYSTERY SOUND CUE]

AUDIO TRACK: Mystery sound.

MOLLY BLOOM: Here it is.

[BUSTLING SOUNDS]

Do you have any guesses?

JOSEPH Yeah. A garbage truck?

PINEDA:

MOLLY BLOOM: Excellent guess. We are going to find out the answer a little bit later.

[MUSIC PLAYING]

So far we've learned what soil's made of. But what does it actually do?

JOSEPH Richard Hayden, head gardener of the Natural History Museum of Los Angeles County, is here to help us find out.

PINEDA:

MOLLY BLOOM: Hi, Richard.

RICHARD Hello.

HAYDEN:

JOSEPH Thanks for being here. So what is in soil that helps plants?

PINEDA:

RICHARD So many things. Well, soil is more than just minerals, more than just pieces of rock and clay and silt. It's also living, breathing organisms. Bacteria and fungi and protozoa, which are little single-celled organisms. And lots of worms. And then the other important things are water and oxygen.

HAYDEN:

JOSEPH Why are worms helpful to soil?

PINEDA:

RICHARD That's a good question. Well, worms like to eat bacteria, and they help decompose all of the plant material that's dead. And worms, as they travel through the soil, they create little channels that allow water and oxygen to move into the soil.

HAYDEN:

MOLLY BLOOM: And are there specific nutrients in the soil that plants need to grow?

RICHARD There are lots of nutrients in the soil that plants need. And the interesting thing is that all of those nutrients are generally always there. But they're not in a form that plants can use until these organisms come along and convert them into soluble, which means water-based, ways of the plants being able to take up the nutrients.

HAYDEN:

JOSEPH So how does that work?

PINEDA:

RICHARD Well, the simple version is that there's nitrogen that's generally always present. It comes from the air. It comes from decomposing plant material. And it also comes from animals, because animals, when they poop in the woods or in the soil, they also leave nitrogen.

And so the bacteria and the fungi come along, and they eat all of these materials. And then they convert that nitrogen into a form that can be used by the plants. My favorite way of talking about the cycle is calling it the poop loop. Because what happens is the bacteria and the fungi are also eaten. So they eat materials. And then the fungi and the bacteria are eaten by protozoa, which are single-celled organisms that are sometimes called amoebas or flagellates or [? sillates ?] are some of the words.

And then those in turn are eaten by little microscopic worms that are called nematodes. And sometimes there are little animals called arthropods, which is a type of insect. And it's like if you've ever heard the song *The Little Old Lady Who Swallowed the Fly*, well, this is the story of the little bacteria that got swallowed by the amoeba that got eaten by the nematode.

And all of those animals, as they're processing and they're eating, they're pooping out forms of different minerals that the plants need.

MOLLY BLOOM: That's so interesting.

RICHARD And it's really interesting, because the plants are always in control, believe it or not. You may just think of plants sitting there in the soil and it's just hanging out. But in reality, the plant, when it needs a certain type of mineral-- let's say maybe it needs phosphorus, which is an important mineral and it needs that to make good solid building blocks for growing strong.

And it'll say, well, I need some phosphorus. So what it does is it has the ability to send out a little signal through its roots called an exudate, which is like-- if you picture us sweating, that's what the root does. The root sends out a little liquid. It's almost like a sugary substance that attracts the specific kind of organism that's going to convert the phosphorus. So it's always sending little signals, and it's getting the little organisms in the soil to produce what it needs.

MOLLY BLOOM: Wow.

RICHARD Right?

HAYDEN:

MOLLY BLOOM: I have a question. So are the little creatures you were talking about that each other, what is the smallest one of those that we can see?

RICHARD Well, actually most of-- we need a microscope to see all of these. And of course until we get to earthworms or something, we can generally see those. But the very smallest one is bacteria. In a teaspoon of soil, there can be up to a billion bacteria. That's how small they are.

MOLLY BLOOM: Wow. And so the nematodes, I mean, how big are those in comparison to a bacteria then?

RICHARD They're still microscopic, and they're still single celled. But if you're looking through a microscope, it's the difference between seeing a dot, like a period in a sentence, and a pencil.

HAYDEN:

JOSEPH Big difference.

PINEDA:

RICHARD That's a big difference, yeah. All of this, when we look through the microscope and we look at soil, we generally
HAYDEN: take a soil sample and we mix it with a special kind of water and we mix it up and then we take just one drop.
And we can see 30,000 bacteria and yards of fungus all in just one little drop of soil. There's a lot going on.

MOLLY BLOOM: Great. Well, thank you so much for talking to us today.

RICHARD It's been my pleasure.

HAYDEN:

JOSEPH Thank you.

PINEDA:

[MUSIC PLAYING]

MOLLY BLOOM: And now, before we dig back into soil, it's time for a visit from Joy Dolo, the host of our new history show *Forever Ago*. Hi, Joy.

JOY DOLO: Hello. Sheesh, it's raining cats and dogs out there. Good thing I have my trusty flying time traveling umbrella.

MOLLY BLOOM: Your what?

JOY DOLO: You know what? It's hard to explain. How about a sneak peek of this week's episode of *Forever Ago* instead? It's how I got this magical umbrella in the first place.

MOLLY BLOOM: Sure, let's hear it.

JOY DOLO: Roll it.

INTERVIEWER Now where in Europe do you think they could really use umbrellas?

4:

SUBJECT: Maybe where that Mary Poppins lady is from.

SUBJECT: Yeah, England. Always looks cloudy in pictures there.

INTERVIEWER That is so true. In England, it rains over 100 days a year. So yeah, they really need umbrellas over there. They
4: actually have their own name for them. And they're called brollies. Speaking of which, grab onto your brollies.
We're headed to merry ol' England.

SUBJECT: I got this. Whoa! This is going to take some getting used to.

[MUSIC PLAYING]

JOY DOLO: You can hear the rest of this episode about umbrellas on Thursday.

MOLLY BLOOM: *Forever Ago* is available on Apple Podcasts, Stitcher, or wherever you listen.

JOY DOLO: Thanks for having me, Molly.

MOLLY BLOOM: Any time.

JOY DOLO: Bye.

MOLLY BLOOM: Bye. We love hearing from Joy, and we love hearing from our listeners, too. If you have a drawing, mystery sound, or question you want to share with us, you can do that by heading to brainson.org/contact. That's how we got this one from Nolan.

NOLAN: My question is, what's inside of a tooth?

MOLLY BLOOM: Listen for the answer to that in our Moment of Um at the end of the show. Plus, we'll read the most recent group of listeners to be added to the Brains Honor Roll. Keep listening.

And now, let's head off to the Brains On Game Show studios, where a live studio audience has gathered to cheer on a group of soil lovers.

JOSEPH Soil lovers?

PINEDA:

MOLLY BLOOM: You'll see. When we name the thing.

HOST: What time is it? It's time to--

AUDIENCE: Name the thing!

HOST: We have two teams raring to compete for the grand prize today. Competing on the Orange Team is an earthworm.

EARTHWORM: So exciting to be here!

HOST: And a gopher.

GOPHER: Hey, Mom!

HOST: And on the Purple Team, we have a mushroom and Bob.

MUSHROOM: I'm ready to win!

BOB: A mushroom?

HOST: Here are the rules. One member of each team will have a stack of words. Their job is to give clues to their teammate and get them to guess the word. There will be two rounds of 60 seconds each. The team with the most correct guesses at the end of the game wins the grand prize. Are we ready?

TEAMS: Yeah!

BOB: What?

HOST: Today's category is soil.

TEAMS: Yes!

[APPLAUSE]

BOB: Is that the same thing as dirt?

[BOOS]

HOST: Now remember, Bob, dirt and soil aren't the same thing. We'll start with the Orange Team. The earthworm will be giving the clues first. Please put 60 seconds on the clock.

[BEEPS]

Start now.

EARTHWORM: OK. Oh, so these are really tiny.

GOPHER: Smaller than you?

EARTHWORM: Oh yeah, definitely. They're so small that each teaspoon of soil contains hundreds million to billion of them.

GOPHER: Bacteria!

HOST: Correct! Bacteria is in soil.

EARTHWORM: OK, next. OK, easy. So worms like me can eat food scraps or other organic stuff like dead leaves. And when they come out of our other end, our castings.

GOPHER: Your poop?

EARTHWORM: Let's not be vulgar.

HOST: 40 seconds.

EARTHWORM: Our castings make up this.

GOPHER: Oh, I know.

EARTHWORM: Some people put it in their gardens.

GOPHER: Vermicompost!

HOST: Correct! Worm poop is called vermicompost.

EARTHWORM: Hey.

HOST: I mean, worm castings. Sorry.

EARTHWORM: Thank you.

HOST: 30 seconds left.

EARTHWORM: OK. So this is where the oldest soil in the world is found. It's about 17 million years old. Also, koalas--

GOPHER: Australia!

HOST: Correct soil in Australia and South Africa is 17 million years old.

EARTHWORM: OK, so soil is made up of lots of organic matter, which you know is all the decomposing plants and microorganisms and stuff. And there's also water, air, and rocks and stuff.

GOPHER: Minerals! Minerals!

HOST: Correct. Minerals are part of soil, too. Time's almost up.

EARTHWORM: OK. This soil contains equal parts sand, silt, and clay.

GOPHER: Easy, loam.

HOST: Correct. Loam is made up of sand, silt, and clay. Can they get one more?

GOPHER: We got this.

EARTHWORM: As plants and animals die and decompose, they form this.

GOPHER: Humus!

[BUZZES]

HOST: Correct, and right at the buzzer. Six correct answers means six points for the Orange Team. Well done.

[APPLAUSE]

Let's see if the Purple Team can top that. Mushroom will be giving the clues, and Bob will be guessing. Ready?

BOB: Excuse me? But I'm pretty sure humus is that pasty dip made from chickpeas.

MUSHROOM: No, Bob, that's hummus. Hummus is made of chickpeas and is good for you. Humus is what decaying plants and such turn into. And that helps mushrooms like me grow.

BOB: This game is not at all like I thought it'd be.

HOST: Please put 60 seconds on the clock. Audience, are you ready?

AUDIENCE: Name the thing!

HOST: And time starts now.

MUSHROOM: OK, this is a type of soil that's made up of really tiny particles.

BOB: Tiny soil?

MUSHROOM: It's actually the type of soil with the smallest particles.

BOB: Small soil.

MUSHROOM: It holds water really well.

BOB: Oh, you mean watery soil.

MUSHROOM: Rhymes with tray. Could also be used to make a mug or a vase.

BOB: Clay?

HOST: Correct!

MUSHROOM: All right, Bob. We got this. These guys make burrows.

BOB: What's that animal? The one on the Orange Team.

MUSHROOM: No, not gophers.

BOB: Oh.

MUSHROOM: Their burrows are water filled, because they live in the soil that's under water.

BOB: Are you making this up?

MUSHROOM: No, Bob. Focus. When they make these burrows, they help get oxygen into the soil.

BOB: Underwater soil-genators?

MUSHROOM: They're also known as mud bugs?

BOB: Crawfish.

HOST: Correct. Time's ticking away.

MUSHROOM: Ooh, I'm one of these!

BOB: A mushroom?

MUSHROOM: Right, but more broadly. We help decompose stuff in soil. Or we help roots get nutrients.

BOB: Mushroot. You're talking about mushroots.

MUSHROOM: Mushroots? That's not a thing! OK. Sometimes we might be less helpful and actually damage some plants.

BOB: Weeds?

MUSHROOM: No. Me! I'm one of these. Me! Rhymes-- with rhymes with--

[BUZZES]

HOST: Oh, too bad. Time's up.

MUSHROOM: Fungus! It's fungus.

BOB: Oh.

HOST: That's right, Bob. Mushroom here is a fungus. Let's check the score. Orange has six, and Purple-- you got two. Orange Team wins. Congratulations.

[CHEERS]

GOPHER: High five, wormy! Oh, right. No hands.

EARTHWORM: What do we win?

HOST: Today's grand prize is a big pile of loamy soil.

GOPHER AND Yes!

EARTHWORM:

BOB: Dirt?

HOST: No, Bob.

AUDIENCE: It's soil.

GOPHER AND We got the soil. We got the soil. We got a big pile of loamy soil.

EARTHWORM:

HOST: See you next time on--

AUDIENCE: Name the thing!

MOLLY BLOOM: We're going to channel that fierce guessing energy exhibited by the earthworm and gopher into figuring out the mystery sound. Let's hear it one more time.

[BUSTLING SOUNDS]

Let's find out the answer.

GREGOR
FRAZIER: This is Gregor Frazier, located in Hutchinson, Minnesota. And we're on Frazier Farms. That was the sound of a 4020 bucket tractor digging into the dirt. We use it for rock picking. So when you find a big rock in the ground, you just dig around it and pull the rock out.

We're known as the rock belt around here. Because it was years ago that the glaciers came through here mainly and they really scraped away the ground, and they've exposed a lot of rocks and everything. And so every year that you go out there and plow or till, you just keep pulling up more rocks and more rocks.

Biggest rock that I've pulled out was-- we measured it. It was 8 and 1/2 feet long, it was 6 and 1/2 feet wide, and it was 4 and 1/2 feet thick. And that would probably weigh about five ton. We actually started with that tractor and then we got it out onto the surface and we took a backhoe and then dug a hole next to it and pushed it in the hole and buried it. If you'd ever hit anything with that, you would destroy your equipment.

And so that's the purpose of rock picking, is get the rocks out of the soil so then you can safely plant all your crops.

MOLLY BLOOM: So there we go. It was a tractor. You garden in your yard.

JOSEPH Yeah.

PINEDA:

MOLLY BLOOM: And he gardens in his yard, but it's just way bigger. And he has to use way bigger equipment.

[MUSIC PLAYING]

JOSEPH So soil is necessary for plants to grow.

PINEDA:

MOLLY BLOOM: But they couldn't do it without friendly microorganisms and other critters living in the soil.

JOSEPH And soil's all over the place.

PINEDA:

MOLLY BLOOM: Even underwater.

JOSEPH And it's definitely not the same thing as dirt.

PINEDA:

MOLLY BLOOM: That's all the digging we have time for on this installment of *Brains On*.

JOSEPH This episode was produced by Sanden Totten, Marc Sanchez, and Molly Bloom.

PINEDA:

MOLLY BLOOM: Many thanks to Jay Bell, Sophie Nikitas, Desiree Gutierrez, Nicole Carter, Sylvia Lopez, Hubert Pineda, Eric Wringham, Chris Peters, Jess Horowitz, and Tess Vigeland.

JOSEPH To listen to more episodes of *Brains On*, head to our website.

PINEDA:

MOLLY BLOOM: brainson.org.

JOSEPH You can subscribe in iTunes, find us on Stitcher, or your favorite podcast app.

PINEDA:

MOLLY BLOOM: Now, before we go, it's time for our Moment of Um.

AUDIO TRACK: Uh. Um. Uh. Um. Um. Um.

NOLAN: My name is Nolan. I am six years old. And my question is, what's inside of a tooth?

ROBERT JONES: Hi. I am Robert Jones, and I am a dentist and faculty member at the University of Minnesota. Well, the tooth is like a fruit or a planet or anything else that you can think of that has layers. The surface that you brush is made of a white crystal material that is not regenerating. That's called dental enamel. And this layer is thick, like the outside of an orange.

Now deeper inside the tooth is a layer that is like our bone. And in the very center of our tooth is an area called the dental pulp. And this has blood vessels and nerves that allow you to feel hot and cold on your tooth. The inside of the tooth, that's more like our bone. There's parts of it deep inside that can regenerate that's connected to our blood vessels. In the inside of our teeth, they are alive. On the outside, it's not alive.

AUDIO TRACK: Um. Um. Um.

MOLLY BLOOM: My teeth and I are ready to breeze through this list of names. It's time for the Brains Honor Roll. These are the listeners who keep us going by sharing their fantastic ideas, mystery sounds, and questions with us.

[MUSIC PLAYING]

[LISTING HONOR ROLL]

AUDIO TRACK: Brains Honor Roll. High fives.

MOLLY BLOOM: Now in the name of science--

JOSEPH Go out and get your hands dirty.

PINEDA:

MOLLY BLOOM: Thanks for listening.

[VOCALIZING]

AUDIO TRACK: Brains On.