

COLIN: You're listening to Brains On where we're serious about being curious.

VIOLET: Brains On is supported in part by a grant from the National Science Foundation.

KARA: I think it was just click that button.

GILLY: I did. Maybe if I-- Oh. Oh, I think we did it. We're on. Cue the theme music.

[THEME MUSIC PLAYING]

KARA: I'm Kara.

GILLY: And I'm Gilly.

KARA: We're two viruses with a dream and the ability to hack into podcast transmissions.

KARA AND And this is Going Viral with Kara and Gilly.

GILLY:

[THEME MUSIC PLAYING]

KARA: We saw that Brains On is trying to put out an episode about the immune system. And let's be honest, you don't need to hear about that.

GILLY: Talk about snoozefest: immune system? More like impugn system.

KARA: What? Oh, sorry. I heard the words immune system and I fell right to sleep. In addition to being boring, immune cells are, I'm just going to say it, rude, so rude.

GILLY: Excuse me, this person invited me into their body. I'm just trying to make myself at home in a cell, and what do they do?

KARA: They pick a fight. Those immune systems are always trying to destroy cute talented little viruses like us.

GILLY: What if I make the body feel sick? Isn't there room enough for all of us?

KARA: Yeah, sharing is caring. Come on.

GILLY: Oh, Kara-- Oh, OK, or hold on this transmission is-- Oh, no. This podcast feed has antiviral software.

KARA: Click disconnect, disconnect, disconnect before it gets us.

GILLY: First immune systems, now this? It ain't easy being virus these days. OK, bye, bye, relleños. And remember, stay infected.

KARA: And don't get sanitized. Let's go.

[THEME MUSIC PLAYING]

MOLLY BLOOM: You're listening to Brains On from APM Studios. I'm Molly Bloom, and my co-host today is Colin from Marietta, Georgia. Hi, Colin.

COLIN: Hi. I'm so excited to be here today.

MOLLY BLOOM: We are very excited that you're here, too. Today, we're talking about the immune system. That's the name for all the parts of the body that help fight off things like harmful bacteria and viruses.

COLIN: The immune system protects us to keep us healthy. And when we do get sick, it fights off all of the bad stuff so you can be well again.

MOLLY BLOOM: Right. Now, Colin, this episode was inspired by an incredible drawing that you sent to us of the immune system. And we were like, Wow, the immune system is so inspiring and there are so many cool parts. We should explore this in an episode. So I'm wondering, what first got you interested in the immune system?

COLIN: I first got interested in the immune system because of a couple videos and books about it.

MOLLY BLOOM: So you got a little bit interested, and then what happened? How did you learn more about it?

COLIN: It was mostly books, like a lot of books. What would you say is your favorite immune cell? Probably the macrophage.

MOLLY BLOOM: Why?

COLIN: Because it's basically just like the base of the immune system. It's the main soldier.

MOLLY BLOOM: The macrophages are awesome and we'll be talking about those in just a little bit. And what do you think other kids would love to know about the immune system?

COLIN: That you couldn't live without it. If you didn't have an immune system, you'd probably die in a few days.

MOLLY BLOOM: Yeah, it's really important and we don't give it enough love. I'm glad that you're here to help us with this episode.

[THEME MUSIC PLAYING]

The immune system is so cool and so important, but it largely goes about its business without us knowing it.

COLIN: A lot of it is inside our bodies, and so small that you need a powerful microscope to see it.

MOLLY BLOOM: It's the immune system's job to keep us healthy, fighting off bacteria and viruses and whatever else could make us sick. This is a big job so it takes a lot of different body parts and cells all working together to keep us safe.

COLIN: It's a lot to keep track of so let's paint a picture. I like to imagine my body like a city. The city is made of cells. Some cells form giant organs like the heart or lungs. I picture these as gorgeous buildings and factories. Other cells I imagine as different creatures.

Red blood cells are like unicorns galloping around the city, delivering oxygen and clearing out that carbon dioxide. My muscle cells are like dragons, taking sugar and breathing out fiery energy. And the cells of the immune system, I like to picture as lovable monsters.

CELLS: Lovable and helpful monsters.

COLIN: So helpful. And the viruses and bacteria, I like different kinds of bad robots who are trying to take over the city.

MOLLY BLOOM: Your body's first line of defense against germs is to try to keep these bad things from getting into the body in the first place.

COLIN: In our city, let's imagine our skin as being a big wall around the city. It blocks out those bad robot viruses from just waltzing in and making a mess of things.

BAD ROBOT: This wall is impenetrable, but my sensors detect openings over there.

MOLLY BLOOM: Yeah, germs often try to get in through openings in our body. Places like our noses, mouths, or eyes.

COLIN: In our city, there are indeed some openings in the wall so things can go in and out of the city. But these passageways are full of mucus and here's the science to keep the invading robots out.

BAD ROBOT: Oh, no. This is sticky. I am stuck.

MOLLY BLOOM: And just like when germs try to enter through your nose or mouth or eyes, there are other ways your body tries to get them out, like coughing or sneezing or tearing up.

COLIN: Yeah, the passageways in the wall have auto eject sensors.

BAD ROBOT: Trying to push through this sticky.

[COUGHS]

Oh, no.

MOLLY BLOOM: If a germ does happen to make it into your stomach, the acid there will often take care of it.

COLIN: The stomach acid is like there's a moat full of molten lava at the end of one of the entrances to the city.

BAD ROBOT: I have succeeded and navigated the passageway of mucous systems are go to attack. Oh, drat. I am melting.

COLIN: But let's say one of these global invaders makes it past the first line of physical barriers. Pass the wall, pass the mucus, pass the hair, pass the sneezes and the coughs. Don't worry, the city has lots of other ways to defend itself.

MOLLY BLOOM: Our bodies have helpful microbes living inside and on us. These are bacteria and viruses that aren't harmful to us, and in fact, can actually be helpful and keep the bad bacteria and viruses out.

COLIN: It's like having friendly robots hanging out near the entrances crowding out the bad robots.

BAD ROBOT: I traversed the mucous and now am ready to invade.

GARY: Hello, I am a robot too. My name is Gary. Are you a good robot or a bad robot?

MARY: Hi, Gary.

GARY: Oh. Hi, Mary.

MARY: That is not a good robot. My sensors say it is one of those bad robots trying to invade the city.

GARY: Apologies, Bad Robot. We are only accepting good robots at this time. We like living in this city body, and we don't want you to destroy it. Goodbye.

MARY: Goodbye.

GARY: Goodbye.

MARY: Goodbye.

GARY: Goodbye.

MARY: Goodbye.

GARY: Goodbye.

MARY: Goodbye.

GARY: Goodbye.

BAD ROBOT: Betrayed by robots. No.

MOLLY BLOOM: If germs are able to get past these physical barriers and the friendly microbes, there's another line of protection that's always ready to go. This is called the innate immune system.

COLIN: The innate immune system is a defense that is always on waiting to destroy pathogens.

MOLLY BLOOM: Pathogen is what we call the bad bacteria and viruses and other stuff that can make us sick. Pathogen equals bad stuff.

COLIN: In our city here, the pathogens are bad robots. And our innate immune cells are those friendly monsters I mentioned. So it's time for--

NARRATOR: Robots versus monsters.

BAD ROBOT: We're friendly monsters.

NARRATOR: With a killer instinct.

BAD ROBOT: And please don't lump those bad robots in with us good ones.

MAC: Care to try again.

NARRATOR: Bad robots versus friendly monsters.

MAC: Thank you.

COLIN: Anyways, once the bad robot's make it into the city, their friendly monsters are there to greet them and eat them.

MOLLY BLOOM: In your body, we call the immune system white blood cells, and there are many different kinds of white blood cells. Two of the ones that are always on ready to defend at the drop of a hat are the neutrophils and the macrophages.

COLIN: Speaking of which, look, this is Phil the neutrophil.

PHIL: My name is Neutrophil. I'm your service. I've got no time to kill. I'm at your service. Oh, hey there. My name is Phil the neutrophil. And I'm roaming around looking for robots. Going to eat robot. Oh, there's one. Oh, delicious.

COLIN: And here comes the macrophage.

MAC: Nice, job, Phil.

PHIL: Ha-ha. Thanks, Mac the macrophage.

[BURPS]

Oh, excuse me.

COLIN: Macrophages also eat bad robots. And like neutrophils, they have another power too.

MOLLY BLOOM: Oh yeah. When they eat pathogens.

COLIN: You mean bad robots?

MOLLY BLOOM: Yes, bad robots. They give off signals called cytokines that let other immune cells know something is up. It's like sounding the alarm. So the area will get inflamed calling more innate immune cells over to make sure no other bad robots are getting in.

COLIN: And now, the monsters like Mac the macrophage here burps after they eat.

[BURPS]

MAC: Oh, excuse me.

COLIN: And other friendly monsters smell it and make their way over.

DENNY: Mac? Oh, that was Mac. Smells like he ate a Bad Robot. Hey, macrophages. There are some bad robots that need chomping, and I'm hungry. I'm coming back.

COLIN: Oh man, here comes a dendritic cell. Now, we're talking.

MOLLY BLOOM: Dendritic cells are another type of white blood cell. They're an important part of the immune system as you will see in a bit.

DENNY: Hi, I'm Denny, the dendritic cell. Come out, come out little Bad Robot. I'm not going to eat you.

BAD ROBOT: Oh, that's a relief.

DENNY: I'm just going to break you into pieces and then wear them like a gal.

BAD ROBOT: Oh, no.

MAC: Looking good, Denny.

DENNY: Thanks, Mac.

MOLLY BLOOM: Whoa. That was intense. After dendritic cells like Denny break apart pathogens and put them on their surface, these broken apart bits are called antigens. These antigens are super important to the next phase of stopping the robot invasion. We'll hear about that in a minute. But first, I have something for you to break apart, Colin. It's time for--

COLIN: Mystery sound.

MOLLY BLOOM: Here it is.

[HORN HONKING]

That is really short so we should hear it at least a couple more times.

[HORN HONKING]

OK, Colin, what do you think?

COLIN: It sounds a lot like a horn. I think it's maybe a type of horn maybe on an old fashioned car or something.

MOLLY BLOOM: Very good guess. Well, we'll be back with the answer and give you another chance to guess after the credits at the end of the show.

[MUSIC PLAYING]

We're working on an episode about telekinesis. That's the word used to describe the superpower of moving things with your mind. If you had the superpower, what would you use it for? So Colin, how about you? What would you use telekinesis for?

COLIN: I really don't like global warming. So if I could, I would probably shoot most of the carbon dioxide out into outer space.

MOLLY BLOOM: That is a really good use superhero-like. Very awesome. What would your superhero name be if you were saving the planet like that?

COLIN: Carbon Colin.

MOLLY BLOOM: Ooh. Yes, Carbon Colin. I love it. Well, listeners, you can set a recording of your answer to us at brainson.org/contact. While you're there, you can also send us mystery sounds, drawings, and questions.

COLIN: Like this one.

LOIS: My name is Lois. My question is, what is tree bark made out of?

MOLLY BLOOM: You can find an answer to that by heading to our Moment of Um podcast. We're bringing you bit-sized answers to your big questions every weekday. Find it wherever you listen to Brains On. And remember, you'll hear an answer to the mystery sound after the credits.

COLIN: So keep listening.

You're listening to Brains On from APM Studios. I'm Colin.

MOLLY BLOOM: And I'm Molly. And we're explaining how the immune system works.

COLIN: Right. Remember, if your body is like a city, the immune system is like the creature helping the fins at city from things called pathogens, viruses or bacteria.

MOLLY BLOOM: In our example, pathogens are bad robots and the immune system cells are friendly monsters. OK, cue the music. So last, we left our fair body city. Denny the dendritic cell had destroyed a Bad Robot trying to invade the city and is now wearing pieces of said robot like a gown.

COLIN: Those pieces are now called antigens.

MOLLY BLOOM: Right. And now, Denny is heading to the nearest lymph node. There are lymph nodes all over your body. In your armpits, on your neck, even ones that line your intestines.

COLIN: In our city, the lymph nodes are like radio stations.

DJ: You're listening to WNOD where easy listening means easy listening. And we're interrupted by a guest in the studio. Oh, hey Denny the dendritic cell, good to see you.

DENNY: Tell them. Tell them it's time.

DJ: Oh, dear golly gosh. Denny. Denny. You're covered in Bad Robot antigen bits. Red alert. Red alert. This is not a drill. There are bad robots roaming our city. I repeat. There are bad robots roaming our city.

COLIN: Here's why help is needed. These bad robots can make copies of themselves.

MOLLY BLOOM: But to do that, they need to break into offices around the city and use their photocopiers and 3D printers. This allows them to make lots and lots more bad robots.

COLIN: Viruses do this in your body by breaking into the cells of your body, and using their materials to make more viruses. Then they destroy the cell.

MOLLY BLOOM: It's bad news. To make matters worse, viruses tend to have special parts that let them easily open and enter a cell. It's like they were designed to break into our body cells. So in our example, our Bad Robot pathogens just happen to have keys for hands that can unlock every office in the city. And once they start breaking into the offices and making copies.

COLIN: Copies that want to break into more buildings and make more copies.

MOLLY BLOOM: Our cities are in trouble. Soon they're crawling with bad robots, which means our bodies are feeling sick. Back to the lymph node radio stations.

COLIN: They send out their signal when they hear about robot invasion. And these signals from the lymph nodes call in the adaptive immune cells. These are specialized fighters T cells and B cells. T cells are the friendly monsters in charge.

T CELLS: Macrophages, it's time to step up your game and be the monsters. It's your time to shine.

MAC: Roger that, T cell monster. Here we come.

MOLLY BLOOM: Look. Look at the B cell monsters parachuting in to fight the bad robots.

COLIN: And the arm just antibodies. Look, they're destroying the robot's ability to get into the buildings.

MOLLY BLOOM: Thanks to messages from other parts of the immune system, the B cells know exactly what kind of antibody to make to stop the exact germ they're fighting.

COLIN: Since these bad robots use their robot hand keys to get into the building, the B cell monsters are throwing perfectly-shaped clamps fit over the hand keys exactly.

MAC: Try opening the door now, you stinky robot.

BAD ROBOT: Oh, no. My hand keys are clamped, now I'm stuck in the street with no defenses. And here comes a macrophage.

MAC: Thanks for making my lunch easier to catch B.

B CELLS: Any time, Mac. Bon appetit.

MOLLY BLOOM: Once the invasion of bad robots has been stopped, the general fighters like Mac the macrophage and Phil the neutrophil go back on patrol.

COLIN: The specialized fighters, the B cell and T cell monsters, clear out and called back.

MOLLY BLOOM: But there are a few B cell and T cell monsters that were involved in this battle that hang around, watching out in case this Bad Robot comes back again. These are the B and T memory monsters.

B CELLS: Hey, T, remember the time that Bad Robot was keys for hands tried to invade the city?

T CELLS: Do I ever. Remember how you put those clamps on the key hands? Yeah, that was great.

COLIN: So if these key handed robots come back, the friendly monsters will be able to fight it off even quicker than they did the last time.

MOLLY BLOOM: In your body, you have memory immune cells that do the same thing. They stick around to remind the body of what they learned in the fight. That if a pathogen comes back, they can quickly wipe it out again.

COLIN: It's a genius system.

[THEME MUSIC PLAYING]

MOLLY BLOOM: Wow. I love imagining these friendly monsters protecting our bodies. I mean, cities. I mean, bodies. I totally get why you fell in love with the immune system, Colin. It's this whole kind of secret world constantly at work. I mean, most of us know what our hearts are up to.

COLIN: It's pumping blood through our bodies.

MOLLY BLOOM: And our lungs?

COLIN: Inhaling in that sweet, sweet oxygen and exhaling that carbon dioxide.

MOLLY BLOOM: And our tongues?

COLIN: Tasting.

MOLLY BLOOM: Sweat glands?

COLIN: Sweating.

MOLLY BLOOM: Stomachs?

COLIN: Stomaching. I mean, digesting.

MOLLY BLOOM: But if I said thymus, most people's response would be--

COLIN: But the thymus is so important to the immune system, and the immune system is the best.

MOLLY BLOOM: So I'd say it's time to give the unsung heroes of the body some love. Colin, will you do the honors?

COLIN: Gladly. Bone marrow. To the brave bone marrow, the spongy yet mighty tissue found inside our bones, you constantly produce the cells we need.

MOLLY BLOOM: The red blood cells, which carry oxygen through the body.

COLIN: The awe inspiring immune system cells, also called the White blood cells, which fight off germs making the mistake of entering our bodies.

MOLLY BLOOM: For your constant manufacture of these important cells, we bestow upon you the medal of the unsung hero.

COLIN: Thymus. To the stunning thymus, the small yet powerful organ gracefully seated above the heart.

MOLLY BLOOM: You work so hard in our youth producing all the T cells we will ever have in our whole lives, and then you gently recede into retirement as our bodies become teenagers.

COLIN: For your important contribution of these many T cells to our immune systems, we bestow upon you the medal of the unsung hero.

MOLLY BLOOM: So we've heard a lot about the friendly monsters keeping our bodies healthy. And a question we've heard some people ask lately, if my immune system is so great, why do I need to get vaccines?

ASA GUDEA: It's like saying I have a brain, I don't need to read. Your immune system needs to be taught.

COLIN: That's Dr. Asa Gudea. Immunologist and immune system expert.

MOLLY BLOOM: She's saying, even though we all have smartness already, it doesn't mean we shouldn't go out of our way to learn new things like how to read.

COLIN: Well, how to do a Double Dutch jump well?

MOLLY BLOOM: Or speak a new language.

COLIN: Or memorize every single cell in the immune system.

MOLLY BLOOM: Exactly. Vaccines are like teaching your body something new. So by getting vaccines, you're making your immune system even smarter and stronger and better at protecting you from viruses and bacteria that want to infect you.

ASA GUDEA: Vaccines are essentially a snapshot of the infection itself so that your body can start to prepare itself. And if you ever encounter the real thing, you have those memory responses ready to go and you can get a head start on the process.

MOLLY BLOOM: Because sometimes those bad robots can make more and more copies of themselves overwhelming the friendly monsters. And this is when you can get really sick.

COLIN: Right. And like we've mentioned before, if your body has a memory of a bad thing, it can fight back faster.

MOLLY BLOOM: So the vaccines train your friendly monsters to be ready to fight the bad robots from the minute they hit the streets of your city.

COLIN: This is why for most vaccines, you need more than one dose.

MOLLY BLOOM: Right, because it can take a few lessons for this stuff to really sink in. The vaccines most of us get when we're little are all multiple doses. We just don't remember them because we were just babies when we started getting vaccinated against all sorts of bad robots.

ASA GUDEA: Your immune system gets better at recognizing the threat and actually expands the amount of memory cells that you have that are able to target that threat. And a way to think about this is that the immune system does something where with that first shot, you have this activation of memory B cells and memory T cells in your system.

And then when that second exposure happens shortly after, your immune system goes into these pools of memory B cells and memory T cells that have been created, and selects out the best warriors, the cells that are able to respond the fastest and to bind the best and make the best antibodies. And it pulls those out and uses those as references for future attacks from that threat.

COLIN: Immune systems are smart, but vaccines help make them even smarter.

[THEME MUSIC PLAYING]

OK, Molly. We've learned a lot today. But I want to see just how much immune system knowledge you have. Are you ready for a little pop quiz?

MOLLY BLOOM: A pop quiz? Oh, geez. OK, Molly, you got this. OK, ready Colin.

COLIN: Here we go. The immune system pop, pop, pop quiz.

[THEME MUSIC PLAYING]

Number 1. T cells are one of the most important to white blood cells of the immune system, and play a central role in fighting infection and may help fight cancer. When do T cells develop?

MOLLY BLOOM: I think I know this one. T cells develop in the thymus.

COLIN: Correct.

MOLLY BLOOM: Woo.

COLIN: Good job.

MOLLY BLOOM: Thank you.

COLIN: Number 2. White blood cells are a super important part of the immune system. What is another name for white blood cells?

MOLLY BLOOM: OK. Another name for white blood cells is Jonathan? Is that right? Do we call them Jonathan?

COLIN: No. We call them leukocytes.

MOLLY BLOOM: Leukocytes. OK, got you. Leukocytes.

COLIN: But you're so close. Jonathan and Luke. Yeah, Jonathan and Luke are both names.

MOLLY BLOOM: Yes. Yes, right. It should be Jonathan-a-cites.

COLIN: Jonathan-a-cites. OK, number 3. Phagocytes are cells that surround and kill bad invaders in the body like Mac the macrophage and Phil the neutrophil in our city example. How many of these cells are there in 1 liter of blood? One large bottle of water's worth in blood. A. 3 billion, B. 10 billion, C. 17 billion, D. 6 billion.

MOLLY BLOOM: So you're asking me how many of these phagocytes, is that what you said, are in a liter of blood?

COLIN: Yeah.

MOLLY BLOOM: Well, I'm glad you gave me some multiple choices because I was not going to say billions. OK. I'm going to go with D. 6 billion.

COLIN: Correct.

MOLLY BLOOM: Wow, that was a lucky guess.

COLIN: OK, number 4. We talked about lymph nodes. They are part of the lymphatic system that works with your immune system to keep you healthy. Which of the following is not part of the lymphatic system? A. Thymus. B. Spleen C. Thyroid D. Tonsils.

MOLLY BLOOM: Hoofty. A. Thymus B. Spleen C. Thyroid D. Tonsils. I'm going to go with D. Tonsils.

COLIN: No. Sorry.

MOLLY BLOOM: What's the answer?

COLIN: The answer is thyroid.

MOLLY BLOOM: Thyroid, OK. And thyroid is?

COLIN: It's part of the endocrine system.

MOLLY BLOOM: Oh, yes. Very good. All right.

COLIN: Lastly, true or false. Our immune system remembers every microbe that it has ever fought and defeated.

MOLLY BLOOM: True or false? It seems impossible, but I'm feeling optimistic about the immune system. So I'm going to say true.

COLIN: Correct.

MOLLY BLOOM: Yes.

COLIN: This seems that if a microbe inches the body for a second time, the immune system has a stored record that enables it to quickly recognize and fight off the microbe before it gets a chance to infect you.

MOLLY BLOOM: Wow. That is awesome. Good job, immune system.

COLIN: Yeah, nice work. I'm going to give you an I plus.

MOLLY BLOOM: I plus?

COLIN: I for immune system. It's the highest grade. Congrats. You are now a fellow fan of our amazing immune system.

MOLLY BLOOM: I am so honored. Thank you for believing in me and thanks to the immune system for keeping me healthy all these years.

[THEME MUSIC PLAYING]

The immune system has lots of parts working to keep us safe.

COLIN: Skin and coughs and mucus and stomach acid all help to keep germs out.

MOLLY BLOOM: If pathogens do get in our bodies, we have innate immune cells as the first line of defense.

COLIN: With B cells and T cells ready to come in to fight in a more specialized way.

MOLLY BLOOM: Vaccines train our immune systems making them stronger, smarter, and ready to fight germs from the moment they enter our bodies. That's it for this episode of Brains On.

COLIN: This episode is produced by Molly Bloom, Ruby Guthrie, Rose DuPont, Menaka Wilhelm, Marc Sanchez, Sanden Totten, and Anna Weigel.

MOLLY BLOOM: Anna Goldfield is our esteemed fellow and our executive producer is Beth Pearlman. The executives in charge of APM Studios are Alex Shaffer, Lilly Kim, and Joanne Griffith. And we had engineering help from Johnny Vince Evans. Many thanks to Nicole and Nathaniel Dicus, Carson, Nora, Coco Sanchez, Brant Miller, John Sklaroff, Tracy Mumford, and Stewart Bloom.

COLIN: Brains On is a nonprofit public radio program.

MOLLY BLOOM: There are lots of ways you can support the show. You can donate by our books or tell your friends about us.

COLIN: Head to brainson.org to find out more.

MOLLY BLOOM: Now, Colin, are you ready to go back to that mystery sound?

COLIN: Yes.

MOLLY BLOOM: All right, let's hear it again.

[HORN HONKING]

Maybe one more time.

[HORN HONKING]

Do you have any new thoughts?

COLIN: No, because this time, I actually heard like a low buzzing before the sound that sounded like a car driving. So I still think it's maybe an old fashioned car or maybe like one of those play horns that clowns use or something.

MOLLY BLOOM: Sure. Some kind of horn. All right, do you want to hear the answer?

COLIN: Yes.

MOLLY BLOOM: Here's the answer.

ADA: Hi, my name is Ada.

ZAYN: And my name is Zayn. We live in Prague, Czech Republic.

ADA: And that was the sound of me pressing the air out of my bagpipes right before putting them away.

COLIN: A bagpipe.

MOLLY BLOOM: You were very close. A horn is very similar blowing air making music.

COLIN: It had to do something about air.

MOLLY BLOOM: Yes. So you were actually close as opposed to me saying Jonathan. Good job. Nice work. Don't forget to check out the Moment of Ump podcast where right this very minute, we have an answer to the question, what is tree bark made of? I spy a list of beautiful names that have sprouted up. It's the Brains Honor Roll. These are the incredible listeners who send us their questions, ideas, mystery sounds, drawings, and high fives.

[LISTING HONOR ROLL]

[THEME MUSIC PLAYING]

We'll be back soon with more answers to your questions.

COLIN: Thanks for listening.