

GRAYSON You're listening to *Brains On*, where we're serious about being curious. If you were shrunk down to the size of an ant, what would you do?

JUDAH: I would build ant hills and sting somebody because I'm a fire ant.

MILLIE: I would sneak around on people.

MICHAELE: If I were an ant, I would eat a giant pizza at my favorite restaurant.

EVAN: If I could shrink down to the size of an ant, I would explore my backyard, collect mica, climb trees that have become infinitely tall, and hard boil termite eggs.

SABINE: If I was an ant, I would eat everybody's ice cream because they wouldn't see me. [LAUGHS]

MOLLY BLOOM: You're listening to *Brains On*. Those voices you just heard were Judah from Saint Paul, Millie in Brandon, Florida, Michaele and Rachele in London, Evan from Herndon, Virginia, and Sabine from Seattle. As you might have guessed, today's show is all about ants. With me to explore the topic is 12-year-old Grayson Damadian from Lancaster, Kentucky. Hello, Grayson.

GRAYSON Hi.

DAMADIAN:

MOLLY BLOOM: So you are an insect enthusiast. What do you think you would do if you were the size of an ant?

GRAYSON I would probably run into a corner so no one could step on me.

DAMADIAN:

MOLLY BLOOM: That's very smart. And I hear that you started a bug club. Can you tell me about it?

GRAYSON Recently we've been learning about ants, and we've been learning about just the different parts of ants, like just the three different parts, the abdomens and things like that.

MOLLY BLOOM: And do you have actual insects there that you can look at?

GRAYSON We have some. A lot of the ones I have are pinned, but we do have alive bugs.

DAMADIAN:

MOLLY BLOOM: So when you say you have pinned insects, can you tell me what that means?

GRAYSON So it sounds really mean, but it's really not. But we have cases. And for butterflies, we spread out their wings, and they get sort of compressed, but we pin them, and then we put a label in the pin so they can see what the name of it is and where it was found and who found it and things like that.

MOLLY BLOOM: So these insects are no longer alive.

GRAYSON No.

DAMADIAN:

MOLLY BLOOM: OK. And I hear that you won first place with your insect collection.

GRAYSON I did, at the Kentucky State Fair.

DAMADIAN:

MOLLY BLOOM: Very cool. So can you just describe that award-winning collection for us?

GRAYSON It had, I think it was 111 species of insects. I had 11 orders.

DAMADIAN:

MOLLY BLOOM: What's an order?

GRAYSON It's like different species or families. So like hymenoptera, that is the order of the ant. That's what the ant order

DAMADIAN: is in.

MOLLY BLOOM: So it's sort of like a grouping of different kinds of insects.

GRAYSON Yeah. So there's different types of ants. In Kentucky, we have cow killers. They have a really powerful sting. And

DAMADIAN: there's just regular black ants. There's fire ants and things like that. They're all in that hymenoptera. They're in that one order.

MOLLY BLOOM: Very cool. And so why do people make these collections of insects?

GRAYSON I think-- I don't know. Some people-- I hope that not a lot of people do this, but some people do it for money

DAMADIAN: because you do win money. But catching them is fun. I like it just because you can see the real-- they're not really scary. When people get scared of them, scared of spiders or things like that, they're not really-- they're not that scary.

MOLLY BLOOM: Well, Grayson, you are obviously a great candidate to help us with today's show. Ants have inspired many of the questions sent to us by Brains On listeners.

GRAYSON Like this one from Casey.

DAMADIAN:

CASEY: Hi, my name is Casey. I live in Porter Ranch, California. And my question is, why do ants march in a straight line?

GRAYSON To help us answer this question, we've invited an esteemed journalist to join us.

DAMADIAN:

MOLLY BLOOM: She's a correspondent for ANN, the Ant News Network. She's reported from six continents, and she recently won the prestigious Formica award for investigative ant journalism. Please welcome our guest-- you just want me to call you an ant?

SUBJECT: Yeah, thanks. We're not big on individual names at the Ant News Network. It's really about the colony. Pleasure to meet you, humans.

GRAYSON Nice to meet you.

DAMADIAN:

MOLLY BLOOM: And you can call us Molly and Grayson. We are big on names here at *Brains On*.

ANT 1: Sure. Now your question about how we ants walk is one I've encountered many times since I began as a young larval reporter, which was actually just a few months ago. Our lifespans are very short. Anyway.

ANT 2: Hey, what's going on in here?

ANT 1: Oh, hi, ant. I'm doing an interview.

ANT 2: Oh, oh, cool.

ANT 1: As I was saying, the reason ants seem to walk in a straight line is that we're actually following a scent trail left by another ant. In fact, the line doesn't have to be straight at all. It can be curvy or squiggly or bend around corners. We're just following the scent.

ANT 3: Hey, guys. What's going on?

ANT 2: Ant's doing an interview.

ANT 3: Oh, sweet.

ANT 2: Yeah, she's doing so great so far.

ANT 1: Thanks, guys. When an ant first starts walking around, it's pretty much moving at random. Let's say we're looking for food.

ANT 3: I love food.

ANT 4: Me too.

ANT 5: Hey, are you guys talking about food?

ANT 3: Yes. I love food too.

ANT 1: Hey, ant. Food is delightful. So an ant will find a food source and leave a trail of a special chemical known as a pheromone. Other ants detect the pheromone trail and find their way to the food too.

ANT 6: Hey, guys.

ANT 7: We're here.

ALL: Hey, hey, hey.

ANT 1: That's how all these ants found their way to your studio, by the way. I left a trail of pheromones to demonstrate my point.

MOLLY BLOOM: Oh, OK. Well, we're happy to have you. All of you.

GRAYSON DAMADIAN: So all the ants tracking the path of pheromones look like they were walking in a straight line, but in reality they're just following the scents left behind other ants?

ALL ANTS: (TOGETHER) Exactly.

MOLLY BLOOM: So the nose knows, eh?

ANT 1: We don't have a nose, per se. We smell with our antennae. They're incredibly sensitive to these chemical trails.

ALL: Hey, guys. Hi.

MOLLY BLOOM: Well, thanks so much for being here today, Ant.

ANT 1: Any time, Molly. For ANN, this is ant signing off.

MOLLY BLOOM: You're on *Brains On*, not ANN.

SUBJECT: Oh, right. *Brains On*.

[CHATTER]

Who's leaving the crumbs?

CHILDREN: Brains On!

MOLLY BLOOM: Now that we've got that straight, let's move on.

GRAYSON Rory from Olympia, Washington wrote in with this question.

DAMADIAN:

RORY: Hello, Brains On. My question is, what do ants do to help the Earth?

DEBORAH Ants are really important. They dig in the ground and bring air into the soil.

GORDON:

MOLLY BLOOM: That's Professor Deborah Gordon.

GRAYSON She's a professor of biology at Stanford University. She has a lab dedicated to the study of ants.

DAMADIAN:

DEBORAH They have a lot of different kinds of relationships with many different kinds of plants. Plants make a home for the
GORDON: ant, and the ants live in there and defend the plant against other creatures that want to eat the plant. They're really important in the ecology of almost every kind of habitat on Earth.

GRAYSON So what made you decide to study ants?

DAMADIAN:

DEBORAH I was interested in systems that work without anybody in charge, and an ant colony is a great example because
GORDON: an ant colony consists of a lot of sterile workers-- those are the ants you see walking around-- and one or more reproductive females. And even though we call them the queens, they're not in charge, they don't tell anybody what to do, they don't give any instructions.

In fact, in an ant colony, no ant gives any other ant instructions. And so it's a really interesting question. How do they ever figure out how to get anything done?

MOLLY BLOOM: So how do they know what to do?

DEBORAH Each ant just uses the rate at which it meets other ants or it meets chemicals put down by other ants, and just
GORDON: that very simple flow of interactions tells it what to do. So no ant understands the big plan for what everybody's doing, and no ant knows why it's doing what it's doing. And that's what's so interesting, that the whole system still works really well.

GRAYSON How does an ant communicate with each other?
DAMADIAN:

DEBORAH Most ants can't see. So the first thing you need to know about ants is there's more than 14,000 different kinds,
GORDON: and they're probably all different in some ways, although they all live in colonies. But pretty much most ants can't see very well. There are a few kinds that can, but mostly they work by smell.

And they smell with their antennae. So when one ant touches another ant with its antennae, it's smelling it. So if you start watching ants, you'll see them approach each other and touch each other with their antennae. And it turns out that they're smelling this layer of grease that they have on their bodies. And that grease has a smell that tells the other ant what job it's been doing and whether it belongs to the same colony.

And they also put out chemicals from glands in their body that have a smell. The most famous kind is called trail pheromone, and that's a chemical that one ant puts down on the ground where it's walking. And then another ant that comes along tends to be attracted to that smell, and so it goes in the direction of the smell. So those two different kinds of contact based on smell, when they touch antennae or when they smell a chemical that the other one just put down are mostly what ants use to communicate.

One of the things we can learn from ants is about collective search. So collective search is the problem of how a lot of different individuals, without telling each other very much, can work together to find anything in a space without a plan. So that's how ants do it.

So you can imagine that you had a group of people who knew that there was something really valuable like a diamond ring lost on a football field. And suppose they all had to just go out blindfolded without any plan and try and find this diamond ring.

The only information they would really have about what everybody else is doing is how often they bump into each other. So if a lot of them end up clustered in one place looking for the ring all in the same place, they're going to end up bumping into each other. And that's what ants do. They just use the rate at which they meet, and it's a measure of how many other ants are searching that same area.

And so if they don't meet anybody very often, they know they have to walk in a straighter line. Or they might not know it, but they do walk in a straight or line, and that way they cover more ground. But if they meet a lot of other ants, then they can be very careful searching right around right where they are because there'll be another ant nearby searching over there.

MOLLY BLOOM: I know a lot of our listeners spend a lot of time looking at ants in their backyards and observing them. Is there a way that those observations could help you with your research?

DEBORAH GORDON: Yes. Because of an experiment that we did on the International Space Station looking at how ants search collectively in microgravity, we set up a way for anybody to try it. We'd love for kids to try it. The Ant Colony Search website explains how to do the experiment. And you can enter the data so that we can soon post the results on lots of different species.

And I think, in this way, if lots of people try it with different species, we might learn about ways that ants search that we've never even thought of.

GRAYSON DAMADIAN: Thank you, Professor Gordon, for this interview today.

DEBORAH GORDON: Thanks to you, too. Bye.

MOLLY BLOOM: Professor Gordon says that collective search can be helpful in all sorts of human activity. Data can move more efficiently across the internet, search robots can become better at finding their way. It could even help us understand how cancer cells spread. Thanks, ants. We have a link to Professor Gordon's Ant Colony Search project in the Brains On newsletter. Just head over to brainson.org and click on the link to sign up.

[MUSIC PLAYING]

SUBJECT: Ant.

SUBJECT: News.

SUBJECT: Network.

SUBJECT: Hello, this is ant with the Ant News Network. We interrupt this program for a special announcement. Did you know some species of ant can build bridges using just their bodies? Let's say a group of army ants needs to cross a gap to get some food, usually another insect. Some ants will start stretching out from the edge of the cliff. More and more ants will join in and link bodies until they form a living bridge.

Then other ants can simply walk across to their feast. Do we mind being walked on? Not at all. We ants like to say teamwork makes the dream work. And that dream is usually delicious food. This is ant signing off for ANN.

MOLLY BLOOM: OK, thanks, ant. But this isn't ANN. You're on Brains On, and your interview is over, so you can leave now, OK? Anyway, Grayson, let's go back to our regularly scheduled programming. It's time for the mystery sound.

[ELECTRONIC STINGER]

CHILD: (WHISPERING) Mystery sound.

MOLLY BLOOM: Here it is.

[REVVING, SQUEAKING]

Any guesses?

GRAYSON It sounds like a vehicle or something. But I think--

DAMADIAN:

MOLLY BLOOM: A vehicle of some sort?

GRAYSON Yeah. I think it may be the ants talking to each other.

DAMADIAN:

MOLLY BLOOM: Ooh, I like that. That is an excellent guess. We're going to be back with the answer in just a bit.

SAM: If I was the size of an ant, could I see a water bear or maybe even cling on to a cat's hair?

OLLIE: I would protect others from things that would like to eat us.

AURALIA: I would color with tiny pieces of crayon, and I would eat tiny, little crumbs.

ISAIAH: I would sneak food from the pantry when people aren't looking.

CHARLIE: If I were as small as an ant, I'd find big houses or mansions to explore and maybe make a nest somewhere secret where humans would not know about.

MOLLY BLOOM: Those voices came from Sam in Austin, Ollie in Birmingham, Auralia from Victoria, British Columbia, and Isaiah and Charlie from Vancouver, Washington.

Brains On listeners, we need your help. We're working on an episode all about spacesuits right now. And we want your answers to this question-- if you could invent a suit to help you with something here on Earth, what would it do? What would it look like? Send your dream suit descriptions to us at brainson.org/contact.

We'll include some of your answers in that upcoming episode. And while you're there, you can send us your mystery sounds, drawings, high fives, and questions, like this listener.

HADLEY: Hi, my name is Hadley, and I'm from Gibsons, BC. And my question is, why do mountains look blue from afar?

MOLLY BLOOM: We'll be back with an answer to that question during our Moment of Um at the end of the show, and we'll read the latest group of listeners to be added to the Brains Honor Roll. And if you stay tuned to the very, very, very end, you'll hear a preview of the latest episode of Smash Best-- the Mega Mini Boom Bonanza, so stay tuned.

GRAYSON You're listening to Brains On. I'm Grayson Damadian.

DAMADIAN:

MOLLY BLOOM: And I'm Molly Bloom.

ANT: And I'm an ant with another update from the ANN.

[MUSIC PLAYING]

WOMAN: Ant.

WOMAN: News.

MAN: Network.

WOMAN: Reports show that most ants are female. This includes the queen, duh, but also the worker ants and the soldier ants. Male ants are in short supply and really only have one main job-- they occasionally mate with the queen to help produce more ant colonies. Also, did you know ants don't have lungs? Nah, we just breathe through tiny holes in our sides called spiracles. Noses and lungs are overrated, anyway. Back to you, human. I mean, Molly.

MOLLY BLOOM: How did that ant get on my microphone?

GRAYSON Molly, there are lots of ants on your microphone. Mine too.

DAMADIAN:

MOLLY BLOOM: Oh, yeah. Trying not to be grossed out, but I guess it's cool that the ANN ants keep dropping in with all these ant facts. That's useful. Anyway, Grayson, human co-host, have you ever seen ants attack something?

GRAYSON I've actually never seen that happen. I've seen bees attack things, but I've never seen ants.

DAMADIAN:

MOLLY BLOOM: Well, actually ants can be quite aggressive. And to learn more about that, we're joined by a war correspondent from our friends at the Ant News Network, Sanden Totten. Sanden? Like Brains On producer Sanden Totten?

SANDEN Hey, Molly. Hey, Grayson.

TOTTEN:

GRAYSON Hey.

DAMADIAN:

MOLLY BLOOM: Since when do you work for the Ant News Network?

SANDEN You know, I've been moonlighting. It turns out the ANN pays really well. I mean, it's all in sugar, but still, it's good sugar.

TOTTEN:

GRAYSON So I've heard the term "army ants," but do ants really have wars?

DAMADIAN:

SANDEN Do they ever, Grayson. Let me tell you. First of all, ants can fight over food and territories and homes, and they can have epic battles. Even though there may only be a fraction of the colony fighting at any given time, these battles can be brutal. These ant soldiers will risk life and limb in service of the colony, many dying bravely in combat.

TOTTEN:

ANT SOLDIER: [GASPS] Tell the queen I love her.

SANDEN Can't you hear the sounds of the ant war ringing through the land? OK, well, we can't really hear the wars

TOTTEN: because they're tiny, but you get the idea.

MOLLY BLOOM: Sanden, we just talked about how ants are self-organizing. Is that how they fight too?

SANDEN Exactly. They aren't ant generals and ant lieutenants calling the shots. That would be ridiculous. Wars usually break out when two different colonies run into each other as one is moving or expanding its territory.

TOTTEN:

GRAYSON So they just start wars when they bump into each other at random?

DAMADIAN:

SANDEN Yeah, kind of. See, some ant species will have scouts that go out on their own. And if they stumble across
TOTTEN: enemies, they'll run back to the nest, leaving a trail of these pheromones we talked about behind them so other ants can find the fight. Other types of ants, they just travel in big gangs, and when they come across enemies, they swarm and attack.

MOLLY BLOOM: I've heard ants can use some pretty extreme tactics when they fight, like don't some ants tear their enemies apart?

SANDEN Yeah, it's kind of gruesome. That's not uncommon for some species, but that's only the start of ant wars, Molly.
TOTTEN: Some ants have powerful jaws that can slice their enemies. Others, they use stingers. Some even use weapons, sort of. There's a species called *Dorymyrmex bicolor*, or the pyramid ant, and it will actually drop rocks into the entrance of its enemies nest to trap them.

MOLLY BLOOM: That's actually really clever.

SANDEN Yeah. And if you want extreme, there's a species of ant in Malaysia that will sometimes explode in battle,
TOTTEN: spreading a corrosive glue all over its enemy. The ant dies doing this, but it can do serious damage to foes as well.

MOLLY BLOOM: Wow, that is a gruesome. I almost feel bad for the ants.

SANDEN Yeah, I'll just say, I wouldn't want to fight an army of ants.

TOTTEN:

GRAYSON Well, moving on.

DAMADIAN:

SANDEN Wait, I was not done. There's a lot more about ant attacks I want to talk about. So for instance, there's this ant,
TOTTEN: the southern wood ant. It can spray a substance called formic acid from its abdomen. It uses this against attackers, and apparently the stuff kind of smells like vinegar.

MOLLY BLOOM: Gross, but I could see that being effective.

SANDEN Yeah, and fire ants, they can actually inject their enemies with a toxic venom. That's why people think their
TOTTEN: stings feel like fire. Ouch. Then there's the raspberry crazy ant that can protect itself from this venom.

GRAYSON Wait, raspberry crazy ant? That's the name?

DAMADIAN:

SANDEN Yeah. It's called the crazy ant because it does these fast, erratic movements, and it was discovered first in Texas
TOTTEN: by a guy named Tom Raspberry. No joke. So that's how it got the name. Great name. The raspberry crazy ants, they can excrete a substance that actually protects them from the fire ant's venom. And this has helped them take over large parts of the Southwest, formerly ruled by the fire ants.

MOLLY BLOOM: So we're talking about fights between different species of ants, right?

SANDEN Yeah. Sometimes that's the case, but sometimes, Molly, it's the same species fighting, just different colonies of
TOTTEN: that species. Sort of like ants from different families fighting each other.

GRAYSON That sounds confusing. If they are the same species, don't they all look alike? How do they tell who's on which
DAMADIAN: side?

SANDEN The same way you tell if milk is bad-- you sniff. Every ant colony has its own distinct odor. Like take this ant here.
TOTTEN:

ANT 1: Hello.

SANDEN And this ant.
TOTTEN:

ANT 2: Howdy.

SANDEN They're from the same colony, and watch when I put them together.
TOTTEN:

ANT 1: [SNIFFS] I never met you, but I like you already.

ANT 2: [SNIFFS] Mm. Hello, new BFF.

SANDEN But then I take this other ant here.
TOTTEN:

ANT 3: Hiya.

SANDEN She's from a different colony. Watch what happens when I drop her in with the other two.
TOTTEN:

ANT 2: Oh, look. A new friend. [SNIFFS] Wait a minute. [SNIFFS] You're not one of us. Death to the outsider.

[GROWLING]

Get him!

ANT 1: Rip them apart.

SANDEN There you have it. An ant's scent is sort of like it's uniform. That's how they identify their friends and their foes.
TOTTEN:

GRAYSON Thanks for the info, Sanden.
DAMADIAN:

SANDEN No problem. For the Ant News Network, I'm Sanden Totten, signing off.
TOTTEN:

MOLLY BLOOM: I guess we need to start paying out sugar bonuses. I do not want to lose Sanden to the competition.

GRAYSON I hear ANN also provides free housing for all it's staff. It's deep underground with no windows, but still.
DAMADIAN:

MOLLY BLOOM: Really? Huh. I wonder if they're looking for a podcast host. For now, let's just go back to the mystery sound. Here it is one more time.

[REVVING, SQUEAKING]

Any new guesses?

GRAYSON OK, it sounds like a Razor scooter that's been held up, and the wheel is just turning.

DAMADIAN:

MOLLY BLOOM: Oh, that is a great guess. I know exactly what you're talking about. Here with the answer is Melanie Moses.

MELANIE That was the sound of a group of Swarmie robots collectively searching for cubes that we've placed out in the
MOSES: environment.

MOLLY BLOOM: So you were close. It was something mechanical moving around.

GRAYSON I kind of thought it might be ants talking to each other, but yeah, it makes sense now.

DAMADIAN:

MOLLY BLOOM: Well, ants are connected to this mystery sound. Melanie teaches computer science at the University of New Mexico. She also runs the NASA Swarmathon. It's a challenge where students from around the United States program swarms of robots called Swarmies to pick up resources as though they were on other planets.

MELANIE The Swarmies are robots that are about a foot long. They have little grippers out in the front that look a little bit
MOSES: like the mandibles, the jaws of an ant, and they use those to pick up blocks that we place for them. They have four wheels, a camera, and it might look just a little bit like a tiny Mars rover.

[REVVING]

A Swarmie is a robot that we designed here at the University of New Mexico along with our partners at NASA. It's an autonomous robot, and it's different from other robots because it's designed to cooperate with teammates. The original inspiration for the Swarmies were seed harvester ants, where all of the robots are identical and they search for little cubes that we scatter in the environment and collect them together.

What's interesting about these robots is there's no one operating them. There's only code running on the computer that our students have written. So they can communicate with each other, but they don't actually have a human operator that tells them what to do. They have to be programmed to make their own decisions based on what they encounter in the world.

In the 2020s there's a journey to Mars, which is NASA's effort to land the first astronauts on Mars. Before they send astronauts, those astronauts are going to need a lot of resources when they arrive. They're going to need water and oxygen and fuel to get back home, building materials. And so NASA has a project to send robots-- and they're investigating whether swarms of robots are an appropriate way to do this-- basically to gather resources from the Martian surface and collect them in places that astronauts could use them.

MOLLY BLOOM: This year's NASA's Swarmathon takes place April 18 through the 20th. You can see it live at the Kennedy Space Center or stream it on their site, NASAswarmathon.com.

[MUSIC PLAYING]

SUBJECT: Ant.

SUBJECT: News.

SUBJECT: Network.

SUBJECT: Hi, ant here, breaking into this show for an ant farm update. And no, I'm not talking about those plastic boxes humans put us in. I'm talking about the very real farming that some ants do. For example, we farm tiny insects called aphids. Us ants like to eat the sugary secretions that come out of aphids rear ends. Don't judge. It's delicious.

To keep a continuous supply of this gooey ambrosia, some species will eat the wings off aphids so they can't fly away. They'll also protect the bugs from predators and take them into ant nests to keep them out of the rain. After all, a happy aphid makes sweeter rear-end juice. Wait, that sounds gross. I mean, a well cared for aphid makes tastier rear-end secretions. Still gross. Whatever. You know what? I'm just going to sign off. This is ant for ANN.

SUBJECT: And I'm ant.

SUBJECT: And I'm also an ant.

SUBJECT: We ants leave a chemical trail of pheromones to help other ants find food or to let them know where to join in the fight.

SUBJECT: We use collective behavior to get our jobs done. The queen ant isn't in control. In fact, no ant is in control.

SUBJECT: Humans are just beginning to find uses for collective behavior. Data networks, cancer research, and robots are just a few of the emerging fields we ants can help humans better understand.

MOLLY BLOOM: Speaking of humans, hi. Grayson and I are hosting this episode.

SUBJECT: That's it for this episode of Brains On, brought to you by ANN, the Ant News Network.

GRAYSON What the?

DAMADIAN:

SUBJECT: Brains On is produced by humans Marc Sanchez, Sanden Totten, and Molly Bloom.

MOLLY BLOOM: I give up, Grayson. Let's go drink some hot cocoa while they wrap up.

GRAYSON Sounds good to me. It's getting pretty crowded in here.

DAMADIAN:

MOLLY BLOOM: Careful where you step. Special thanks to Veronica Rodriguez, Amy Damadian, Sarah Gustavus, Cameron Wiley, Annie Gilbertson, Rebecca Plevin, Kristen Lepore, Kyle Stokes, Mark Hoddle.

WOMAN: John Lambert, Nancy Yang, Tracy Mumford, Julie Seiple, Rose Martin, Jeff Jones, Jeff Cayman, Christine Hutchins, and Lauren Dee. If you like the show, let all the other ants-- I mean, humans know. This has been ant.

WOMAN: And an ant for ANN, the Ant News Network.

GRAYSON Sorry, guys. Excuse me. Just one quick thing.

DAMADIAN:

MOLLY BLOOM: Yeah, yeah, yeah. We need to do the Moment of Um. I mean, um.

[VOCALIZING]

HADLEY: Hi, my name is Hadley, and I'm from Gibsons, BC, and my question is, why do mountains look blue from afar?

RACHEL DIXON: Mountains look blue from afar because blue light is being scattered through the particles in the Earth's atmosphere, and the more particles between you and that mountain range, the bluer that those mountains look. Hi, my name is Rachel Dixon, and I'm a forester for the US Forest Service. I work on the Pisgah National Forest, which is in the Blue Ridge mountains in western North Carolina.

When sunlight hits the Earth's atmosphere, it's made up of a rainbow of colors. The air particles in the atmosphere scatter the blue light more efficiently than the other colors. This scattering of blue light back to your eyes is what makes the sky look blue and what also gives mountains their blue color.

The Blue Ridge Mountains appear even bluer than most because of the types of trees that grow in the forests here. Some plants, but especially oak trees, produce a chemical called isoprene, which helps plants keep making food from sunlight on hot days and keeps heat from damaging their leaves. Oak trees are plentiful in the Blue Ridge Mountains, and one of the major producers of isoprene.

When isoprene is released, it mixes with the air particles above the tree tops, and when sunlight hits the air particle isoprene mix, it magnifies the scattering of blue light, making the Blue Ridge Mountains especially blue.

MOLLY BLOOM: Whether these names are close up or far away, they look great to me. This is the Brains Honor Roll. This is how we say thanks to all of our brilliant listeners who share their ideas, drawings, and high fives with us. They are wonderful.

[LISTING HONOR ROLL]

(SINGING) He's on a roll [INAUDIBLE].

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

GRAYSON Thanks for listening.

DAMADIAN:

MOLLY BLOOM: And now for that special preview of the Smash Boom Best Mega Mini Boom Bonanza, where we're doing four super-quick speed debates-- rats versus pigeons, zombies versus werewolves, autumn versus spring, and breakfast versus dinner.

SUBJECT: Best.

SUBJECT: Boom.

SUBJECT: Smash.

SUBJECT: Smash.

SUBJECT: Boom.

SUBJECT: Best.

MOLLY BLOOM: And now for our final debate of the day-- breakfast versus dinner. This idea was sent to us from Tim in Gillette, New Jersey. Let's see who he thinks will win this debate.

TIM: I think breakfast will win because you can eat breakfast in bed.

MOLLY BLOOM: Breakfast in bed is a delightful treat. Ty, which meal do you think is the coolest?

TY: I don't really know. I don't think I have opinion for this, because they're both really good. Dinner's the best meal of the day, the biggest, the tastiest, most time to prepare. But at the same time, breakfast is really good because when you wake up, your mouth's like, oh, I'm parched. Time to eat food. So I don't know. Give me an opinion, guys.

MOLLY BLOOM: Yeah, very tough. Well, let's see what Amy from Southwest High School has to say. She is here to defend dinner, and Maddie from Central High School is touting breakfast. Let's start with Amy and team dinner.

[BELL DINGS]

AMY: What do you think about when I say the word "dinner"? Pizza, pasta, tacos, whatever, it is, I know your mouth is watering. Why? Because dinner is the best meal of the day. Countless studies show that families who eat dinner together are better together. Improved academics, higher self-esteem, and lower depression rates are all benefits of eating dinner as a family just a few times a week.

[RECORD SCRATCHES, CRYING]

Do y'all hear something? Oh, that's just lunch crying about how much cooler dinner is. There's also studies that show how great dinner is for your body and physical life. Looking to get ripped this summer?

SUBJECT: Yeah.

AMY: Eating protein and carbs before sleep can help you gain muscle. Looking to stop those scary nightmares?

SUBJECT: Uh-huh.

AMY: Eating some types of carbs during dinner has been linked to better dreaming. Looking to solve all your problems? Eat dinner. Dinner can be literally anything your heart desires, which makes it different from other meals. Can you see yourself crunching on French fries for breakfast, digging into an apple pie for lunch? I don't think so. But can you eat cereal and sandwiches for dinner? Yeah.

Other meals can be skipped or forgotten about. Skipping dinner feels like a betrayal to your stomach.

[GRUMBLING]

Why would you skip the best meal of the day? I know I wouldn't, because dinner is the bomb.

[APPLAUSE]

MOLLY BLOOM: Fighting words from Amy there. So Ty, what did you think about her declaration of greatness about dinner?

TY: It was very passionate, I'll say that much. I also like how dinner has a lot more variety.

MOLLY BLOOM: Definitely. It was a very well organized argument. Very logical. Let's hear Maddie's rebuttal.

MADDIE: All right, here's the biggest problem with dinner-- you do not get the same level of breakfast food. Sure, you can try and have breakfast for dinner, but are you going to get the experience of seeing the sun rise over your backyard of a few feet and get a few bites of cereal, pancakes, bacon, everything your heart desires? No, you're going to be stuck around a tiny dining table with the sun already set and gone. It's just not as atmospheric. Dinner lacks potential.

MOLLY BLOOM: OK, let's hear what Maddie's declaration of greatness about breakfast is all about.

[BELL DINGS]

MADDIE: Breakfast. It's the only meal where it's very acceptable to eat pancakes, donuts, and bacon on one plate. Who doesn't love that? Some fun breakfast facts for you. Eating in the morning actually helps your body better break down glucose, which is also called blood sugar. And who wants your blood to be sweet? Blech. I certainly don't. Now, that isn't actually how blood sugar works, but I'm going to go with it in favor of breakfast.

Not to mention that breakfast energizes the body. People who eat breakfast show an increase in physical activity throughout their mornings compared to people who skip breakfast. Also, eating breakfast gives you a mental edge. Those stable glucose levels we talked about earlier helps your ability to focus, reason, and process information.

Sure, dinner can say they're going to help you be the best at school, the best at sports, but it's actually breakfast giving you that foundation to start your day. So eat breakfast. Be a super smart, active superhero.

[APPLAUSE]

MOLLY BLOOM: Hmm. Ty, what did you think about Maddie's argument there?

TY: Well, now I'm kind of leaning in for breakfast. I was leaning into dinner. I'm excited for the rebuttal.

MOLLY BLOOM: Yes, let's hear Amy's breakfast rebuttal.

AMY: So just hearing about breakfast makes my skin crawl. It's just such a lonely meal. Dinner can be eaten with your family, in front of your TV, with your friends, with anybody. But breakfast, it's kind of a solitary thing. And I feel like when you eat breakfast, you miss out on the community and the love and the happiness that dinner can give you. So I really think that dinner is just superior in that sense.

And also, while breakfast may be the good start to your day, dinner is the preparation for your start of the day.

CREW: Time.

[APPLAUSE]

MOLLY BLOOM: All right. Ty, they've given you a lot to chew over. Weigh the evidence and tell us which one is the Smash Boom Best-- breakfast or dinner?

TY: "Chew over." Really?

MOLLY BLOOM: Mm-hmm. Yeah. Did you like that?

TY: Oh, OK.

MOLLY BLOOM: Want to find out who wins this breakfast versus dinner showdown and the three other debates in our first ever bonanza? Subscribe to Smash Boom Best on your favorite podcast app, and visit smashboom.org to vote for your favorites.