

Brains On (APM) | Brains On! Shark teeth: The sharp bits of a squishy animal
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VALENTINA: You're listening to *Brains On*, where we're serious about being curious.

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

NARRATOR:

MOLLY BLOOM: I am so excited we're finally doing an episode on sharks.

VALENTINA: Me, too. It's going to be totally "sharks-some."

SANDEN Nice one. "Sharks-some." That's great.

TOTTEN:

VALENTINA: Oh, hey, Sanden.

MOLLY BLOOM: What's in your cart there?

SANDEN Oh, nothing much. Just my latest invention. Megalo Dentures. They're dentures for sharks. They're nice, square

TOTTEN: chompers, just like grandma's. Genius, right?

VALENTINA: Points for creativity. That's for sure.

MOLLY BLOOM: But wait, Sanden. Don't sharks have lots of teeth?

SANDEN Yeah, they have lots of teeth, but they're constantly falling out, Molly. That's why they need dentures.

TOTTEN:

VALENTINA: Sanden, you know that shark teeth grow back, right?

SANDEN They-- they do? [GROANS] OK. This calls for a business pivot. Come on, Sandy. Think, think, think, think.

TOTTEN:

[FLURRY OF DESCENDING XYLOPHONE NOTES]

I got it!

[TRILL]

I'll become a "shark-odontist." You know, an orthodontist for sharks? Shark braces. That's where the money's at. You know, because their teeth come in every which way. I'll fix them with my "shark-odontist" skills. It's perfect.

VALENTINA: Foolproof.

SANDEN Right? Oh, I'm picturing my office right now. There will be calming pictures of beach sunsets hanging on the

TOTTEN: ceiling, kelp floss for one and all, and we'll have a treasure chest full of treats, too. Sugar-free ones, of course.

Ooh, we can get sharks favorites, like krill and squid.

MOLLY BLOOM: Don't forget stingray.

VALENTINA: Just no jaw-breakers.

SANDEN Oh, good point. Hmm. I better go find my white lab coat. Heh, got to look the part, right? "Shark-odontist"

TOTTEN: Sanden, here I come.

[THEME MUSIC]

MOLLY BLOOM: You're listening to *Brains On* from APM Studios. I'm your host, Molly Bloom. And today, I'm joined by my cohost, Valentina, from San Diego, California. Hi, Valentina.

VALENTINA: Hi, Molly.

MOLLY BLOOM: Today, we're doing an episode all about sharks, which is perfect because sharks are your favorite animal, right?

VALENTINA: That's right.

MOLLY BLOOM: So can you tell me a little bit about your connection to the ocean?

VALENTINA: So the ocean has always played a big role in my life I became obsessed with a sport called surfing. It's wave riding. We'll put it that way. And I have been going since I was about 10, so for about two years now I've been surfing. And it's just a way for me to relax and just chill and kind of forget about what I'm stressed about. And that's how the ocean has played a big role in my life.

MOLLY BLOOM: That is so cool. And so when you started surfing, you became more interested in the ocean in general.

VALENTINA: Yes. So I became more interested in the ocean and its creatures. I used to step on stingrays. Not very fun. I never got stung, thank goodness. But I was always just really curious. Like, oh, I wonder what they look like. Oh, I wonder what lives over there or what this animal does.

MOLLY BLOOM: And so when did you start becoming interested in sharks, particularly?

VALENTINA: It all started this one time I went surfing. To get a wave, you kind of have to wait for them. So I was kind of sitting there waiting for a wave. And then I got a wave. And I came back to my dad. My dad goes, you know there's a shark under you, right? And I was like, whoa? A shark? That's kind of scary.

And then I became obsessed with them because such a beautiful and majestic creature was under me. And then I just got into it more. And then they became my favorite animal.

MOLLY BLOOM: So do you think sharks are scary?

VALENTINA: Not really. I know a lot of people are scared of sharks, but I actually love them, and I am not scared of them.

MOLLY BLOOM: Valentina, you are not the only one who's curious about sharks. A lot of our listeners have sent us questions, too.

[UPBEAT MUSIC]

COOPER: Why do shark's teeth keep growing in?

TEDDY: How are shark teeth so sure?

ROBBIE: My question is, are shark teeth made of bones or cartilage? Thank you.

MOLLY BLOOM: Wow. Those questions were really on point. Thanks to Cooper, Teddy, and Robbie for sending them to us. Here to tell us more about shark teeth is our friend, Ruby Guthrie. And wait, is that a shark?

RUBY GUTHRY: Hey, Molly. Hi, Valentina. I hope you don't mind, but I also brought my friend Greg. And I just had to because he's a great white shark.

GREG: G'day. I'm Greg. And yes, I'm a shark, and I'm white. And I'm really glad you think I'm so great, Ruby.

RUBY GUTHRY: Oh, it's just the truth. Greg and I go, like, way back. We've been pen pals for ages. Thanks for swimming up to meet us, Greg.

GREG: You bet.

RUBY GUTHRY: Greg, one of my favorite things about you, besides your positive attitude and witty banter, of course, is your smile. I've never seen anything like it.

GREG: Crikey, what a compliment. What can I say? I was just born like this.

RUBY GUTHRY: It's true. Unlike us humans, sharks like Greg here are born with their teeth. They actually have rows and rows of them.

GREG: Yeah. I've got five rows, to be exact.

VALENTINA: What a mouthful.

GREG: Definitely. I think there's about, (MUFFLED) 1, 2, 3, 4, 5, 6-- whoa. 300 in here. And mine look like a bunch of little, sharp triangles.

VALENTINA: Reminds me of a bread knife.

RUBY GUTHRY: Totally. They have that spiky, jagged, zigzaggy edge.

GREG: Right. And just like a knife, these sharp teeth are really useful. They help me catch and eat my dinner.

RUBY GUTHRY: And different sharks have different shape teeth, depending on how they hunt and what they like to eat. Bull sharks have longer, needle-like teeth that help catch slippery prey, or there's angel sharks, who have dense, flat teeth, which are great for cracking crustaceans they find on the bottom of the ocean floor.

GREG: Hmm, love a crusty crustacean.

RUBY GUTHRY: Mm, mm. Another unique thing about shark teeth is that they fall out all the time.

GREG: But it's no biggie. It's just because our teeth aren't rooted in our mouths, so they break off or fall out really easily.

RUBY GUTHRY: And sharks don't just have one set of baby teeth and one set of adult teeth, like us humans. Sharks are actually constantly regenerating their teeth, meaning just as quickly as they fall out, they're replaced by new ones. And that's where those rows of teeth come in handy. So when Greg loses a tooth, one of the others from the back row moves forward, kind of like a conveyor belt of teeth.

GREG: Yeah. All of this is normal for us sharks. Great whites like me can go through about 20,000 teeth in our lifetime.

VALENTINA: Think of the tooth fairy cash.

GREG: You bet. I definitely strike big.

[KA-CHING]

RUBY GUTHRY: All teeth aside, I'm here to say that sharks are a lot more squishy than you may think.

GREG: It's true. I give the best hugs. Do you want one?

MOLLY BLOOM: I think I'll pass.

RUBY GUTHRY: Back to the squish. You see, sharks don't have a single bone in their body. Instead, sharks are made up of cartilage.

GREG: It's the same sort of squishy tissue in humans that makes up the tip of your nose or your ear lobes.

RUBY GUTHRY: And that's what makes shark teeth so important.

GREG: That's right. It's really the only sharp tool I have to defend myself and catch my food.

RUBY GUTHRY: So not only are shark teeth, like, way cool and beyond useful, but they can also tell us a lot about sharks of the past. To learn more about this, I spoke with Professor Sora Kim. She teaches environmental studies at UC Merced and does a lot of research on shark teeth.

SORA KIM: Yeah. And so I think that people really discount teeth. They're like, oh, yeah, there's so many shark teeth in the fossil record, and they all look the same. They're just pointy. But they tell us so much information.

RUBY GUTHRY: Sora told me there's a ton of shark teeth fossils out there, and that's mainly because shark teeth are the only part of the animal that isn't made up of that squishy cartilage we mentioned earlier.

SORA KIM: Sharks don't have bones. They have cartilage. And that matters for the fossil record because bone has a lot more of a mineral called hydroxyapatite, which allows it to preserve better in the fossil record. But cartilage does not have as much of this hydroxyapatite content and is much more organic. And so that tends to degrade very quickly when it's buried in the soil or sediments.

RUBY GUTHRY: That's why we have so many fossils of shark teeth because they have a lot of that mineral, hydroxyapatite, meaning they can preserve really, really well. And turns out you can find out a lot about a shark all from its teeth.

SORA KIM: The chemistry of the teeth can actually give us information related to water temperature, water salinity, and then if there's organic material preserved, which is a big if, we are able to get aspects of diet.

RUBY GUTHRY: So Sora starts by analyzing the chemistry of modern shark teeth. And from that, she can gather if the water is warm, salty, or where in the food chain the shark is. Then she compares it to the fossils, and that's where we can get more of an idea of how sharks were in the past.

GREG: Wow. My mouth is so powerful, it's like a whole encyclopedia. You go, mouth-apedia. [? High ?] [? fin! ?]

RUBY GUTHRY: The shape of the tooth also says a lot.

SORA KIM: The shape can also tell us something. Like, it turns out that little sharks have little teeth and big sharks have big teeth. And so within even a single shark species, you can look at the size of a tooth and you can tell how big the shark is.

RUBY GUTHRY: So by analyzing these shark teeth and comparing them with fossils, we can get a sense of how sharks evolved over time. Their teeth are like clues to understanding a big shark puzzle. And there's been some wacky pieces throughout time.

SORA KIM: I think of sharks as, like, going through different experiments of, like, will this work, or not? And I think that the basic plan of have lots of teeth, teeth fall out, be a carnivore-- that plan has stayed the same. But there have been little offshoots to the plan which may not have worked out so well.

[UPBEAT MUSIC]

RUBY GUTHRY: For example, there was the helicoprion, a shark with a spiral jaw lined with rows of spiky teeth, super swirly-whirly.

SORA KIM: So helicoprion with the whirly teeth-- not so good.

RUBY GUTHRY: Don't get it twisted. They looked awesome. But they went extinct. And then there's the infamous megalodon, the biggest shark that ever lived. The megalodon was so massive, two adults could stand in its jaw.

SORA KIM: Megalodon, for example. Giant teeth. Most likely very giant body. Also not a great plan, it turns out, because it takes a lot of energy to be giant.

RUBY GUTHRY: Even though some of these species aren't around today, sharks on the whole have been around for more than 400 million years.

SORA KIM: They actually made it through most mass extinction events unscathed. And even the one that took out the dinosaurs-- it did not really affect sharks that intensely.

RUBY GUTHRY: So sharks, and their teeth, for that matter, have really stood the test of time.

SORA KIM: But despite all of this, we are still learning so much about this group of animals, that they still remain kind of an enigma, and there's still so much to learn about them.

GREG: Ooh, enigma. I'll have to add that to my resume.

RUBY GUTHRY: Oh, definitely.

GREG & RUBY: Hi, fin!

[CLAPS]

VALENTINA: Thanks for sharing, Ruby.

MOLLY BLOOM: And thanks for visiting, Greg.

GREG: The pleasure is all mine.

RUBY GUTHRY: Shark you later, bruh.

GREG: Turtles.

[SLOWED-DOWN ELECTRONIC MUSIC]

(SINGING) Brains on, on, on.

MOLLY BLOOM: Valentina, I have something for you to sink your teeth into. It's the--

[SLOW MUSIC]

(WHISPERING) Shh. Mystery sound.

MOLLY BLOOM: Here it is.

[WHIRRING, SLOWLY ASCENDING IN PITCH]

[CHILDREN CHATTERING HAPPILY]

[WHIRRING CONTINUES]

So what are your thoughts?

VALENTINA: I'm guessing there was some sort of fire truck, maybe, or an ambulance? I also heard some sort of whining or wimping, so maybe a dog.

MOLLY BLOOM: So that's the high-pitched noise you heard.

VALENTINA: Yeah.

MOLLY BLOOM: What else did you hear in there?

VALENTINA: I heard some people talking. I don't think that's the mystery noise, though.

MOLLY BLOOM: We'll play it again and have another chance to guess a little later in the show.

[CHILL MUSIC]

We're working on an episode all about the multiverse.

VALENTINA: It's the idea that there are multiple, different universes existing all at once.

MOLLY BLOOM: And we want to hear from you. What do you think clothes are like in a parallel universe? Do we only wear magenta, shoes as earmuffs, zebra print everything? Valentina, what do you think people are wearing in a parallel universe?

VALENTINA: I think that we are wearing whatever we like, just like we do now, and shoes as earmuffs-- I do not think we would do that. Maybe as a fashion choice, maybe. But not as an actual thing you would wear, kind of like how we wear certain things for different occasions. Maybe that would be for a party or a gathering. I don't know.

MOLLY BLOOM: Oh, I like that. So it's like, shoes as earmuffs are the new formal wear. So, like, at the big award shows, all the celebrities will have shoes on their ears looking so cool.

VALENTINA: Yes. Also, I think that animals and humans would be different. So we would be considered animals and maybe animals would rule the world.

MOLLY BLOOM: Oh, good thoughts. So, like, in that scenario, maybe the animals are the ones with the cool clothes.

VALENTINA: Yes.

MOLLY BLOOM: Very interesting idea. Well, send us your answers at BrainsOn.org/contact. While you're there, you can also send us mystery sounds or drawings or questions.

VALENTINA: Like this one.

TY: Hi, my name is Ty.

ELLIE: And I'm Ellie.

TY: And we're from Salt Lake City, Utah. Our question is, if steam is just tiny droplets of water in the air and water moves down when poured out, shouldn't steam travel down, too?

ELLIE: So why does steam travel up, rather than down?

MOLLY BLOOM: We'll answer that during our Moment of Um right after the credits. And then we'll read the most recent listeners to be added to the Brains Honor Roll.

VALENTINA: So keep listening.

MOLLY BLOOM: You are listening to *Brains On* from APM Studios. I'm Molly.

VALENTINA: And I'm Valentina.

[WATER RUSHING]

MOLLY BLOOM: Hey, Valentina, do you hear that? The tides are turning.

[ROCK MUSIC]

Quick, Valentina. It's time to swim over to the shark side. Don't worry. The water's fine. It's time to play Jaws Jeopardy.

VALENTINA: Call me a hammerhead shark because I'm about to nail this.

MOLLY BLOOM: It's going to be "jaw-some." Valentina, pick your category.

VALENTINA: Hmm. I'll go with Shark Senses for 200.

MOLLY BLOOM: All right. True or false? Sharks can hear the heartbeat of their prey from hundreds of feet away.

VALENTINA: I think that is true.

[DINGS]

MOLLY BLOOM: You are right. It is true. But not using their ears. Most sharks have electro-sensory organs that look like small pits around their snouts. These small pits can detect electrical fields that come from contracting muscles, like a beating heart. This allows sharks to find their prey from hundreds of feet away, even if the prey is completely still or hiding under sand.

VALENTINA: That's kind of cool. OK. Next up, I pick Shark Brains for 400.

MOLLY BLOOM: "Fin-tastic." True or false? Sharks can be hypnotized.

VALENTINA: I think that is false.

[WRONG ANSWER TONE]

MOLLY BLOOM: It's actually true.

VALENTINA: What?

MOLLY BLOOM: It's easier for humans to hypnotize some sharks than others, but when you flip a shark over, some of them enter a state called tonic immobility, where their muscles relax and their breathing becomes deep, just like hypnosis. While sharks are in this state, researchers can study them very closely.

VALENTINA: That is insane, and also very, very cool.

MOLLY BLOOM: Yeah. It is really cool. All right. Let's choose the next category.

VALENTINA: I'll choose Shark Skins for 600.

MOLLY BLOOM: True or false? Sharks have slippery and smooth skin.

VALENTINA: Hmm. This one is actually a really tricky one because I think it could be any option. I'm going to guess that is true.

[WRONG ANSWER TONE]

MOLLY BLOOM: It's actually false. Shark skin feels similar to sandpaper, thanks to the tiny, teeth-like structures all over their bodies called plaquoid scales. They point backwards, helping sharks glide quickly through the water so sharks can swim faster using less energy.

VALENTINA: Wow. Remind me not to touch a shark, please.

MOLLY BLOOM: Yeah. They've got big teeth and lots of little, tiny, pointy things all over.

VALENTINA: That sounds like a-- this-- the ocean's porcupine.

MOLLY BLOOM: Yeah, definitely.

VALENTINA: [LAUGHS]

MOLLY BLOOM: Totally. All right. Let's pick the next category.

VALENTINA: Can I get Shark History for 800?

MOLLY BLOOM: Whatever floats your boat. True or false? Sharks are older than trees and dinosaurs.

VALENTINA: I think that is true.

[DINGS]

MOLLY BLOOM: You're right. It is true. Sharks are very old and "so-fish-ticated." Scientists believe sharks are over 400 million years old, making them some of the most ancient creatures in the world. They've even lived through five mass extinctions.

VALENTINA: Wow. Imagine how, like, I guess adaptive they have to be, if they've been through five mass extinctions and still survived. They must have to adapt a lot, right?

MOLLY BLOOM: Yeah. Sharks are incredible. All right. We have time for one more question.

VALENTINA: For my final question, I want Sharks Superpowers for 1,000.

MOLLY BLOOM: There's no fin left to lose. True or false? Sharks can glow in the dark.

VALENTINA: Oh, this is a tricky one. I think that is true.

[DINGS]

MOLLY BLOOM: It is true. A few different types of sharks are able to produce green and blue light. The glow, called bioluminescence, comes from thousands of light-producing cells in the shark's skin. Researchers think that sharks use this ability to camouflage themselves from predators below.

VALENTINA: Wow. Imagine seeing a glow in the dark shark.

MOLLY BLOOM: It would be incredible. I "fish" we had more time, but that's all for today on Jaws Jeopardy.

[ROCK MUSIC]

OK, Valentina. It's time for the mystery sound again. Are you ready?

VALENTINA: Of course.

[WHIRRING, SLOWLY ASCENDING IN PITCH]

[CHILDREN CHATTERING HAPPILY]

[WHIRRING CONTINUES]

I'm thinking maybe it's raining, very windy?

MOLLY BLOOM: Any new thoughts about that high-pitched noise?

VALENTINA: Um, I think that is some sort of siren. I believe that is a fire truck siren.

MOLLY BLOOM: Good thinking. Are you ready to hear the answer?

VALENTINA: Sure.

KAREN: I'm Karen, and I'm from Oldsmar, Florida. And this is the sound of someone zip lining.

VALENTINA: Oh. Oh, that makes sense. That's why the-- you could hear the wind in the microphone of the recording device go shh.

MOLLY BLOOM: So can you describe what a zip line is?

VALENTINA: You are kind of-- the whole solution, you're trying to get to point A to point B. You're on point A right now. And there's this giant line from point A to point B. And it's kind of like a little-- maybe like a little swing, and I guess you kind of go down on it. Usually, this, I guess, rope would be kind of downwards, so you build up momentum, and then you get to point B. I've never tried zip lining. I think that'd be really cool.

MOLLY BLOOM: Yeah, that's a really, really good description. Yeah. People are attached to a line with a harness. And it's usually pretty high up. And they zip down the line, suspended in the air. That's pretty amazing. I'm not sure I'm brave enough to do it. But it is an excellent mystery sound.

(SINGING) Ba, ba, ba, ba, ba, ba, ba, ba, ba, ba, *Brains On.*

OK. So we've taken a look at how sharks grow their teeth, but what are they using those teeth to chomp on? Producer Menaka Wilhelm is here to tell us about what sharks do with their jaws.

MENAKA Hello.

WILLHELM:

VALENTINA: Hi, Monica.

MENAKA So, mainly sharks use their impressive jaws to eat stuff. I asked Annabel Gong about this. They study sharks at the University of San Diego.

WILLHELM:

ANNABEL GONG: Most sharks eat fish, crustaceans, like crustaceans meaning crabs and shellfish, squid. Really depends on their size. So if you're a really big shark, you could eat other sharks, too.

MENAKA WILLHELM: Many sharks are big animals, and they need to eat a lot of food to keep themselves going, including smaller species of sharks. And that might make these sharks sound like the big, bad wolf of the ocean. But their eating also keeps other animals healthier.

ANNABEL GONG: They'll eat sick or dying animals.

MENAKA WILLHELM: Because if a shark eats a sick fish, its sickness won't spread to any other fish. And sharks actually eat enough other animals that what they eat affects their whole ecosystem. That's the ocean they live in and all the animals and plants they share it with. And since we're talking about what these animals eat, you can kind of think of an ocean ecosystem as an ocean grocery store.

ANNABEL GONG: Yeah, sure. I would love to work in a shark grocery store.

[BUBBLING WATER]

[BELL RINGING]

Hi, welcome to Fins. How can I help you?

GREG: Oh, I'm just a white shark looking for a seal. I know where I'm going, but thanks anyways.

MENAKA
WILLHELM: So here in Fins, the ocean ecosystem grocery store, predators like sharks are shopping for things to eat, like rays and fish. But while sharks shop for rays, those rays are doing their own shopping. They're looking for crabs and clams. And meanwhile, crabs and clams are picking out plants to munch on. Everyone is connected in a food chain.

ANNABEL
GONG: It connects animals to other animals based on who they eat and who they get eaten by.

MENAKA
WILLHELM: Sharks have a special place in the food chain. They're what's called apex predators.

ANNABEL
GONG: An apex predator is also called a top predator. And they're the animals at the top of the food chain. And they don't usually have very many predators or any predators at all, which means that they don't really get eaten very often.

TIGER SHARK: Top of the food chain. I gotta eat. I'm helping the ocean.

MENAKA
WILLHELM: But it looks like that tiger shark is almost ready to check out.

[HUMMING]

Wow, it's so big. It's almost as long as a small car. And it has those faint dark stripes on its side. Let's see what it's got in its basket.

ANNABEL
GONG: Did you find everything OK?

TIGER SHARK: I sure did.

[BEEP]

ANNABEL
GONG: Oh, seems like you got a ray. I tried this one before, and it was pretty shocking, let me tell you.

TIGER SHARK: [LAUGHS] And some sea snakes.

[BEEP]

ANNABEL
GONG: I love those ones.

TIGER SHARK: Same. All right.

[BEEP]

ANNABEL Oh, it looks like you got some old license plates and some old tires. Interesting choice. Not really what I would go
GONG: with, but I hope you have a lovely dinner tonight.

MENAKA Sometimes hungry apex predators mix up trash and food. They've got lots of eating to do. But back to the
WILLHELM: animals that sharks eat. Everyone in this store is connected in a food chain, remember? So if the sharks left this grocery store, that would leave the stingrays as the top predator. And there would be way more rays around.

ANNABEL And in turn, these stingrays would start eating all the crabs and all of the clams and all of the little animals that
GONG: live in the sand.

MENAKA With more rays shopping for the same stuff, the rays might eat their way through all the crabs in the store.
WILLHELM:

ANNABEL When you're removing this shark from the store, you're basically removing the crabs from the store, too. So
GONG: pretty much it would just be stingrays and some algae just hanging out.

MENAKA Because without any crabs, no one would be eating the algae, so Fins would go from having tons of different
WILLHELM: animals in stock to just having two sections. (ECHOING) Ray on aisle one. Algae on aisle two.

ANNABEL That's not a very interesting store unless you like stingrays and algae only.
GONG:

MENAKA It's also not great for the ocean. If there's too much algae in part of the ocean, it uses up a lot of the oxygen in
WILLHELM: the water, which makes it harder for coral reefs and other animals to survive. But when sharks shop at Fins, they keep the balance of the food chain, so lots of animals stay in the store.

TIGER SHARK: Just doing my part.

[TYPING]

[KA-CHING]

ANNABEL All right. And your total is going to be \$34-"finty."
GONG:

TIGER SHARK: Now, that seems like a made-up price.

ANNABEL This is a made-up grocery store!
GONG:

[CLASSICAL MUSIC]

[DOORBELL RINGS]

(SINGING) Brains, brains, brains on.

[ELECTRONIC MUSIC]

VALENTINA: Sharks don't have bones. Instead, they're made up of cartilage.

MOLLY BLOOM: But sharks have rows and rows of teeth that help them catch and eat prey.

VALENTINA: These teeth fall out all the time, but they are quickly replaced, like a conveyor belt.

MOLLY BLOOM: And we learned so much about the history of sharks all by analyzing their teeth.

VALENTINA: With those awesome teeth, sharks can eat all kinds of stuff.

MOLLY BLOOM: Like crabs, rays, sea snakes, even other, smaller sharks.

VALENTINA: And that helps keep the ocean's food chains balanced.

MOLLY BLOOM: That's it for this episode of *Brains On*. We're about to hear an answer to the question--

TY: If steam is just tiny droplets of water in the air, and water moves down when poured out, shouldn't steam travel down, too?

ELLIE: So why does steam travel up, rather than down?

MOLLY BLOOM: But first some quick credits.

VALENTINA: *Brains On* is produced by Molly Bloom, Marc Sanchez, Sanden Totten, Ruby Guthrie, and Menaka Wilhelm.

MOLLY BLOOM: We had engineering help from Johnny Vince Evans, and our intern is [? Catherine ?] [? Sundqvist. ?] We had production help from Dave [? Lashansky ?] and Kunsang Dorjee. Special thanks to Paulina Herrera and Paul Guthrie. Our executive producer is Beth Pearlman and the executives in charge of APM Studios are Lily Kim, Alex Schaffert, and Joanne Griffith.

VALENTINA: *Brains On* is a nonprofit public radio program.

MOLLY BLOOM: You can support the show and help us keep making new episodes by heading to BrainsOn.org/Fans. While, you're there you can donate, join our free fan club, or check out our merch.

VALENTINA: There are face masks, T-shirts, and hats.

MOLLY BLOOM: And you can buy the *Brains On* book there, too. It's BrainsOn.org/Fans.

VALENTINA: Now, before we go, it's time for a Moment of Um.

[CHORUS OF VOICES SAYING "UM" AT EVEN INTERVALS]

TY: If steam is just tiny droplets of water in the air, and water moves down when poured out, shouldn't steam travel down, too?

ELLIE: So why does steam travel up, rather than down?

NICOLE SHARP: Steam rises instead of falls because it's lighter than the air surrounding it, whereas water is heavier. Hi, I'm Nicole Sharp, and I'm an aerospace engineer. One thing to think about here is what happens when liquid water turns into steam. Basically, if you have, say, a droplet of water and you heat it up into steam, what's going to happen is all of the molecules, all of the little bits of water inside there, are all going to get further away from one another. They're going to spread out, and they're going to take up more space.

Density is what really ends up mattering when we try to figure out whether something is going to float or sink. Density is how much stuff you have compared to how much space that stuff takes up. So if I have water and I pour it out of a glass, that water is surrounded by air. And air has a very low density. Water has a very high density. So I pour that liquid water out, and it falls down to the ground.

But if I instead have steam, the density is much, much lower. And now, in fact, that density is less than the density of the air, and therefore, the steam rises instead of falling.

The reason that all of this happens here on Earth is because we have gravity. And things actually get a lot more complicated when you don't have gravity because then you don't get this kind of separation between the light things and the heavy things, the way that we do here on Earth. So if you were living on the International Space Station, for example, you would find that steam or heat or anything like that doesn't rise. The only way to get those substances to move around on the station is to actually have fans and to force the air to move.

[THREE VOICES SAYING "UM" AT EVEN INTERVALS]

MOLLY BLOOM: Here's a steamy, dreamy list of names. It's the Brains Honor Roll. These are the incredible listeners who send us their questions, ideas, mystery sounds, drawings, and high fives.

[ELECTRONIC MUSIC]

[LISTING HONOR ROLL]

(SINGING) Brains are all alive.

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

VALENTINA: Thank you for listening.