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

SUBJECT 1: *Brains On* is supported in part by a grant from the National Science Foundation.

MARY: What in the world? Joseph, get over here now.

JOSEPH: Coming, Mary.

MARY: I can't believe what I'm seeing. Look at what I found in the sea cliff.

JOSEPH: Whoa, it's huge.

MARY: I think those are the rest of the bones of that crocodile skull you found.

JOSEPH: Yeah. But Mary, whatever you dug up, it's no crocodile. It's so weird looking like a monster.

MARY: Don't be daft. It's not a monster. It's some kind of lizard fish.

JOSEPH: A Lish? No, no, no, a flizard.

MARY: Whatever it is, it's going to blow people's minds. What are we waiting for? Let's dig it out.

JOSEPH: Right. Let me grab a shovel.

MARY: This is it, brother. Mark this year, 1811. This is the year we're going to become famous. Soon everyone will know the name Mary Anning, the girl who discovered the world's first lish or flizard, or whatever this thing is.

JOSEPH: Do you think there are more flizards buried here?

MARY: Who knows? We'll just have to keep digging.

[MUSIC PLAYING]

MOLLY BLOOM: You're listening to *Brains On* from American Public Media. I'm Molly Bloom, and here with me today is 9-year-old Brielle from Calgary, Alberta in Canada. Hi, Brielle.

BRIELLE: Hi, Molly.

MOLLY BLOOM: As you just heard, Mary Anning and her brother Joseph were fossil hunters. In fact, they found that fliard, a species we now call an ichthyosaurs when they were kids. Mary was just 12.

BRIELLE: This is in the early 1800s, decades before we even had a word for this kind of animal.

MOLLY BLOOM: You'll hear more about Mary Anning and her amazing fossil finds later in the show. First, we're going to start with this question.

TESSA: My name is Tessa from Seattle, and my question is, why were sometimes so big?

MOLLY BLOOM: Now Brielle, you wrote us with a very similar question. So what got you curious about this.

BRIELLE: When I was seven, me and my dad were watching *Jurassic Park,* and I started watching *Walking With Dinosaurs* and going to dinosaur and fossil museums.

MOLLY BLOOM: Very cool. Do you have a favorite dinosaur?

BRIELLE: No, not really. There's so many to choose from.

MOLLY BLOOM: What's one of your favorites?

BRIELLE: Probably the sauropods. They have tree stump like feet and long necks and big tails.

MOLLY BLOOM: Oh yeah, those ones are very, very cool. So as someone who's super interested in dinosaurs yourself, why do you think people get so obsessed with dinosaurs, especially younger people?

BRIELLE: I don't really know why adults are. But I think I know why kids are. Kids believe in like mythical creatures like unicorns and people with scales and stuff. And then dinosaurs come along, which is basically giant 11 foot lizards from like a fairy tale. And they were real.

MOLLY BLOOM: So do you ever wish that those ancient dinosaurs still existed?

BRIELLE: No.

MOLLY BLOOM: [LAUGHS]

Why not?

BRIELLE: Could you imagine your neighborhood being crushed by dinosaurs?

MOLLY BLOOM: That probably would be a bad thing.

BRIELLE: Yeah, it would be.

MOLLY BLOOM: We put your question about dino size to a dino expert.

FEMKE HOLWERDA: Yes, and I am Femke Holwerda. I am a PhD student in vertebrate paleontology.

MOLLY BLOOM: Femke studies sauropods, those dinosaurs you mentioned with the long necks, longtails, and big tree stump like legs.

BRIELLE: You know your Brachiosaurus, your Diplodocus, and your Apatosaurus, to name a few.

MOLLY BLOOM: Exactly.

BRIELLE: I asked them how did dinosaurs like these get so big.

FEMKE HOLWERDA: So first of all, not all dinosaurs were super big. There were some dinosaurs that were actually quite small, like the size of a dog or goat. But then you also got the really big dinosaurs. And what we actually think is that the plant eating dinosaurs got so big, so they could actually reach to the foliage in the trees, and that they could just eat what other dinosaurs really couldn't reach.

And then the idea is that the predators then got so big, so they could actually keep hunting down these massive long necked dinosaur prey. But then the prey got bigger again, so the predators had to get bigger again, and so on and so forth. And that's kind of the idea why they got so big.

BRIELLE: What was the biggest dinosaur?

FEMKE HOLWERDA: The biggest dinosaur to date is a Patagotitan. It's named after where it was found in Patagonia, Argentina, South America. It was about 36 meters long, which is bigger than the blue whale. It was about 15 meters high, weighed over 60 tons. It's really impressive to see its bones.

For example, I saw its thigh bone. And this thigh bone is much bigger than I am. Its vertebrae are also more or less the size of a table, whereas our vertebrae, our back bones are not bigger than the palm of our hand. So that gives you about an idea of how big it was.

BRIELLE: How are dinosaurs able to move if they were so big?

FEMKE HOLWERDA: What's so cool about these sauropods is that they have specific adaptations, especially in their backbones to make them less heavy so they could actually move quite well on the land. So what you see in birds is that they have hollow bones. They have air sacs in their bones that will help them lose that weight so they could fly.

We see this sort of the same in sauropods, which I think personally is really cool. So they wouldn't have to be that heavy. I mean, they were still really heavy. But they were not so heavy that they couldn't move anymore. And then of course, also if you see their legs and their arms, those bones are really massive and strong. So they would support all of that weight.

BRIELLE: How much did they have to eat to stay big?

FEMKE HOLWERDA: Well, the sauropods, from what we can tell from their bones, is that they grew really fast. You can, for instance, cut a bone open and count the growth rings, it's kind of like counting the growth rings on a tree, which is also pretty cool to do. You can see that they grew really fast, especially in their first years of their lives. They had to eat a lot. They were probably sort of vegetarian vacuum cleaners.

But then once they reached a certain size, they would be so big that they would be digesting so much they wouldn't have to eat so much anymore because they would get enough nutrients out of their diets because their gut would be so big, it would be a very efficient digestive system. So they would just have to stand there and digest but not eat so much.

BRIELLE: Do all the names of all the species of dinosaurs?

FEMKE HOLWERDA: Oh dear. No, I don't know all of them. I sometimes try to test myself and do a dinosaur alphabet.

BRIELLE: What's your favorite dinosaur?

FEMKE HOLWERDA: I think my favorite is the dinosaur that I did my whole PhD study on which is a distant cousin of this patagotitan. It's called Patagosaurus. I studied it a lot, so I feel like almost it could be my pet dinosaur.

BRIELLE: Are there any dinosaurs alive today?

FEMKE HOLWERDA: What we think is that the predatory dinosaurs, the theropods like T-rex, like Velociraptor have their descendants in birds. So birds could be seen as a sort of living dinosaur. Unfortunately, the long necked dinosaurs are no longer alive. They're extinct. And dinosaurs such as triceratops are extinct.

Makes me sad sometimes, but I also think we would have a lot of trouble if they were alive today, because can you imagine if you're cycling in your streets and they're suddenly a big sauropods? Yeah, that wouldn't work.

BRIELLE: [LAUGHS]

Thank you so much for my questions.

FEMKE HOLWERDA: You asked some really good questions.

BRIELLE: Bye.

FEMKE HOLWERDA: Bye-bye.

[MUSIC PLAYING]

MOLLY BLOOM: sauropods in the street, I really can barely picture that. But I know what would help.

BRIELLE: A drawing.

MOLLY BLOOM: Exactly. We'd love to see your dinosaur drawings. If you had a pet dinosaur, where would you keep it, how would you hide it, what would you do with it? Or maybe draw us a picture of a dinosaur walking down your street.

BRIELLE: Or humming a song.

MOLLY BLOOM: I like that.

BRIELLE: Or tap dancing.

MOLLY BLOOM: Or tap dancing. I like that too.

BRIELLE: Busting a move in the middle of your living room. Get creative and send us a picture of your masterpiece. We'd love to see it.

MOLLY BLOOM: Thanks.

SUBJECT 2: And now a message from a dinosaur.

SUBJECT 3: Well, hello there. So glad you can join me. I wanted to clear up a misconception. Many people assume me and my fellow dinosaurs were dumb. They assume this because in some cases, we had rather small cranial cavities, implying we had small brains. This may be true, but does that mean that we were dumb? Who is to say? Am I right T-Rex?

T-REX: T-Rex hungry. Num, num, num.

SUBJECT 3: Ah, bad example. But let me tell you, we may have been smart. Maybe we had lively discussions about Triassic weather or sauropod politics. Maybe we had art, plays by Shakespeare Saurus, paintings by Picasso Dactyl. You weren't there. You don't know.

Plus, how do you define intelligence anyway? I mean we were around millions of years. A lot longer than you people have been on Earth.

T-REX: T-Rex eat this tree. Num, num. Tree is gross.

SUBJECT 3: So in conclusion, don't assume we were dumb. Thank you.

SUBJECT 2: This has been a message from a dinosaur.

MOLLY BLOOM: I hope your ears are ready for a dinosaur sized challenge, Brielle, because I think I hear one coming. It's the--

SUBJECT 4: Mystery sound.

MOLLY BLOOM: Are you ready?

BRIELLE: Uh-huh.

MOLLY BLOOM: Here it is.

Any guesses?

BRIELLE: A very noisy house with someone tired, trying to get up. And they're just like, oh, stop making noise. I'm trying to wake up.

MOLLY BLOOM: I really like that guess. It is an excellent, excellent guess. And we're going to be back with the answer in just a little bit. For now, we're going to keep exploring the world of dinosaurs.

BRIELLE: You know, dinosaurs weren't the only Super sized creatures in the ancient times. Lots of animals were bigger.

MOLLY BLOOM: From massive snakes and alligators.

BRIELLE: To mega insects and even giant penguins.

MOLLY BLOOM: This made one of our listeners curious.

GABRIEL: Hi, my name is Gabriel. And I am from Winter Garden, Florida. I'm 6 years old, and my question is, why were snakes and alligators bigger in the dinosaur time than they are now?

BRIELLE: We asked Brian Switek to help explain.

MOLLY BLOOM: He's a writer for *Scientific American* and author of the book *My Beloved Brontosaurus.*

BRIAN SWITEK: Yeah, so there are lots of ideas about why animals were larger. One of the most popular ideas was differences in oxygen content in the air. So way back when well over 300 million years ago during a time period called the Carboniferous, plants were evolving in a way that they hadn't before and created these dense forests. And they're pumping a lot more oxygen into the air.

And this allowed arthropods, basically cousins of dragonflies and millipedes and other things in the sort of bug category, to use the colloquial term, to get larger because they could breathe more efficiently. And the ones that flew in the air, there was a greater amount of pressure in the air because of the additional oxygen. So this was a special case that allowed invertebrates to get very large as they were colonizing the land during this distant time period.

But if we are thinking about dinosaurs, if we are thinking about alligators and prehistoric snakes, oxygen levels weren't that different from what they're like today. There wasn't enough really to make that sort of difference.

BRIELLE: Others have wondered if animals were bigger in the past because there was more food available, or even that maybe there was less gravity holding things down.

MOLLY BLOOM: Interesting. But there's no evidence to back up either of those ideas. However, Brian Switek says there is a new idea that many scientists are looking into.

BRIELLE: It has to do with how long it takes baby animals to develop.

MOLLY BLOOM: We call this gestation. For human babies, the gestation period is nine months. During that time the mom is pregnant and carries the baby in her womb as it grows.

BRIELLE: But Brian says that's not how baby dinosaurs develop.

BRIAN SWITEK: All dinosaurs lay eggs, just like our modern dinosaurs. Just like birds. All the prehistoric ones that we love hatched out of eggs about the size of a grapefruit to a soccer ball, depending on the species. So not very large. And they had to grow very, very, very fast. Whereas when we look at our largest mammals, things like elephants and giraffes and rhinos, gestation happens inside the body, inside the body of their mothers. And it takes a very, very long time.

MOLLY BLOOM: Giraffe's gestation for instance is around 13 to 15 months. Some elephants can stay pregnant for almost two years. And during that time, the baby is growing, but it can't grow too big or the mother won't be able to carry it and this.

BRIAN SWITEK: It seems ends up putting a limit on the size of how large they can get. So much energy and so much time is put into developing this offspring inside the mother's body, that basically to get any bigger they'd have to gestate that offspring for longer, that the embryo would have to stay inside its mother for a longer amount of time and take even more energy to be born at a larger size. And this is basically a big risk. There's a lot that can go wrong during pregnancy.

So it seems that the largest mammals that ever lived and the largest mammals alive today are hitting some kind of barrier that they can't carry their offspring any larger to bump up that body size, whereas dinosaurs just totally bypassed that by laying eggs. And it didn't dictate that they became large, but it opened up this possibility for them to grow to larger sizes because they didn't have this constraint on them from the way they reproduce.

MOLLY BLOOM: Since there doesn't seem to be a concrete reason why there were so many large animals in the past, it leaves us to wonder.

BRIELLE: Why aren't there more big animals now?

MOLLY BLOOM: In fact, it wasn't too long ago that large saber toothed cats and massive mammoths roamed the planet. Brian says maybe we shouldn't be asking why so many animals were bigger in the past, but instead, why so many animals are smaller now.

BRIAN SWITEK: That's right. Yeah, we're living in a very unusual time where there should be more. There should be large animals all around us. And some of them still persist. I mean, grizzly bears, jaguars, deer. These are all ice age animals that are still with us. They're just smaller than the ones that we often think of. So really part of the reason why the past looks so strange is because the present that we're living in is actually the weird time, and we just have it backwards.

[MUSIC PLAYING]

MOLLY BLOOM: Hey, Brielle, are you ready to tackle that mystery sound again?

BRIELLE: Yeah.

MOLLY BLOOM: All right. Let's hear it one more time.

All right. Any new guesses?

BRIELLE: No. I still think it's a very noisy house in the morning and someone's trying to get up, and they're like, ah.

MOLLY BLOOM: I really like that guess. Well, here with the answer are brothers James and Thomas from Peachtree Corners, Georgia.

THOMAS: That was the sound you just heard of a goat talking.

MOLLY BLOOM: A goat talking. Did you know goats can make that sound?

BRIELLE: No.

MOLLY BLOOM: Yeah, me neither. Well, apparently goats have a lot to say, especially when there's food around. This one sounds particularly human.

BRIELLE: I didn't even come to the conclusion that it was a goat. I thought it might be a pig. But--

MOLLY BLOOM: Yeah, I did not know goats could make sounds anything like that. James and Thomas captured this mystery sound at a farm near their home. If we could actually speak with goats, James would try to solve another mystery.

JAMES: Why do you eat people's clothes?

MOLLY BLOOM: So if you could talk to a goat, Brielle, what would you want to talk to the goat about?

BRIELLE: Don't eat people's clothes.

MOLLY BLOOM: Good advice. Do you have a mystery sound to share or a question you've been itching to ask us?

BRIELLE: We're waiting to hear from you. Just email us at hello@brainson.org.

MOLLY BLOOM: Like Jake did.

JAKE: My question is why is the sun so hot.

BRIELLE: We'll answer Jake's question at the end of the show in our Moment of Um.

MOLLY BLOOM: We'll also shout out the latest group of kids to join the Brains Honor Roll. So stick around.

[MUSIC PLAYING]

SUBJECT 2: And now a message from a dinosaur.

SUBJECT 3: Greetings and salutations. You know, it really bugs me that we dinosaurs are depicted in movies and TV shows as big scaly monsters, like Godzilla or something. We're not monsters. Sure, maybe we forget to compost our scraps, or we don't remember to send holiday cards to all of our co-workers. But does that make us monsters? Hardly. In fact, many of us might have been rather fluffy and fancy, isn't that right, Velociraptor?

VELOCIRAPTOR: I'm covered in pretty feathers. I'm so dainty and beautiful.

SUBJECT 3: Exactly. So don't assume we were scaly, ugly monsters. Thank you for your time.

[MUSIC PLAYING]

SUBJECT 2: This has been a message from a dinosaur.

[MUSIC PLAYING]

BRIELLE: Congrats, Molly.

MOLLY BLOOM: Thank you. But what are you congratulating me for?

BRIELLE: It's almost *Brains On* 100th episode.

MOLLY BLOOM: Oh right, it's just around the corner. In fact, we'd love to hear from you for that episode.

BRIELLE: Yeah, 100 episodes, I mean, we shared a lot of great science facts.

MOLLY BLOOM: Is there something you learned on *Brains On* that you bring up at parties?

BRIELLE: Or a fact that made you the star of the class.

MOLLY BLOOM: Or just a fact that totally blew your mind. If so, tell us about it and we may play your answer in our 100th episode.

BRIELLE: Thanks.

[MUSIC PLAYING]

MOLLY BLOOM: Today on *Brains On,* we are talking dinosaurs.

BRIELLE: And how epically big some of them were.

MOLLY BLOOM: But we've gotten lots of non-sized related dinosaur questions too. So we put them to our sauropod expert Femke Holwerda.

BRIELLE: Like this one from Henry in Vancouver, British Columbia.

HENRY: What was it like during the time of the dinosaurs?

FEMKE HOLWERDA: The time of the dinosaurs is called the Mesozoic. And it starts with the Triassic period. And actually in the Triassic period, the Earth was basically one big supercontinent called Pangaea. And then at the end of the Triassic, this supercontinent started to break apart into two big continents.

So that's already huge changes, right? So the climates changed a lot as well. The supercontinent and the Triassic was quite dry, big deserts everywhere. Then because of the breakup of the continents, the climate change and it got more humid and got more green. And then towards the end of the Mesozoic, the Cretaceous periods, these continents broke up into more or less the continents that we have today.

And the sea level rose a lot. So you got lots of tropical seas everywhere because the temperature was also a lot higher throughout the Mesozoic, a lot higher than it is today. In the Cretaceous, you actually also got the first flowering plants. So up to then there were no flowers on Earth at all. It's a really crazy idea as well. Of course, it all ended with the extinction of the dinosaurs.

MOLLY BLOOM: Marcelo from Ithaca sent us this question after learning that scientists had identified the probable feather color of one species of Dino.

MARCELO: Have scientists identified the colors of any other dinosaurs after the one with the feathers that were red?

FEMKE HOLWERDA: Any artist who draws a dinosaur can go crazy because for a lot of dinosaurs we don't know what colors they had. So that's fun. When you draw a dinosaur, you can make it purple, you can make it green, you can make it yellow with red dots, you know?

RISHAN: Hi, my name is Rishan. And my question is, how did dinosaurs get their names?

FEMKE HOLWERDA: The name dinosaur was actually invented by this English scientist called Richard Owen. He said, OK, we need a name for all these giant reptiles that we keep finding in the ground. And he decided to call them dinosaurs because dinosaur comes from deinos, which is Greek for terrible, and saurus, which is Greek for lizard. So he called them terrible lizards because he thought they're so scary, they come right out of a fantasy, horror novel.

And so actually lots of people kind of kept with that tradition of calling them saurus. So for instance, Patagosaurus is lizard from Patagonia. Tyrannosaurus, the tyrant lizard. Although, I think nowadays it's changing a little bit. You get different names, and people play around with naming them a little bit more.

CORMAC: This is Cormac from Crimson, Rhode Island. I was wondering what was one of the first things paleontologists found out about dinosaurs.

FEMKE HOLWERDA: Well, there are some records even from ancient times where people found dinosaur bones, but they really didn't know what to do with them. Their records for example from the old Greek historians that people had found dragon bones in Mongolia and in China, and then of course, they weren't dragons. They were dinosaurs. It wasn't until 1840 where they were named-- where they were actually recognized as, hey, wait a minute, these are actually giant reptiles from a long time ago.

I think people weren't quite ready to accept how long that was ago. I mean, it is crazy if you think about it. Millions of years on the Earth before we were here.

[MUSIC PLAYING]

MOLLY BLOOM: Before Richard Owen coined the term dinosaur, fossil hunters were unearthing the bones of amazing creatures.

BRIELLE: Like the ichthyosaurs Mary Anning found.

MOLLY BLOOM: Right. We heard about that at the top of the show.

MARY: It's some kind of lizard fish.

JOSEPH: A lish? No, no, no, a flizard.

MARY: Whatever it is, it's going to blow people's minds. What are we waiting for? Let's dig it out.

MOLLY BLOOM: But that wasn't the only startling fossil she found. Here to tell us more about her life and work is our pal John Lambert.

[MUSIC PLAYING]

JOHN LAMBERT: The flizard Mary found at age 11 was just her first step towards becoming one of the best fossil hunters of her day. Unfortunately, because she was a woman from a poor background in the man's world of 19th century science, she didn't get all the recognition she really deserved. I called up Ponice Rutsch to learn more about Mary's life. She's the creator and host of an awesome podcast called *Babes of Science.*

PONCIE RUTSCH: Mary Anning was part of a very poor family in this area of Britain called Lyme Regis. Mary Anning was one of 10 kids. But most of her siblings didn't survive childhood. She and her brother Joseph are the only two kids who made it, I want to say passed like five or six years old.

JOHN LAMBERT: Mary proved especially hardy when as a baby she was struck by lightning and survived.

PONCIE RUTSCH: Everything around her is devastated and Mary survives. And that creates this sort of town lore about Mary's resiliency. And later, Mary starts demonstrating this intense curiosity about the world around her and in part, people say that that's because the lightning struck her. And so the lightning instilled this fierce curiosity and sort of fire in her from a really early age.

[MUSIC PLAYING]

MARY: I don't think you need lightning to explain why I'm curious. With such wonders buried in our backyard, I think the better question is why everyone else isn't as curious as I am.

[MUSIC PLAYING]

JOHN LAMBERT: Mary developed her interest in fossil hunting from her father Richard. He was a carpenter, but his true love was combing the rocky cliffs and beaches of Lyme Regis looking for fossils. It was hard work, best done in stormy weather when the rain and wind exposed hidden fossils. But if you could find one, you could sell it to one of the many tourists who visited the town.

The family managed to scrape by with this additional source of income for a while. But unfortunately, tragedy soon struck the Anning household.

MARY: So when Mary is 10, her dad dies. So their main source of income is suddenly gone. Mary Anning continues to fossil hunt because there is some money that can be brought in by collecting these fossils and selling them to the tourists that pass through.

JOHN LAMBERT: So Mary kept digging.

MARY: There's got to be more amazing things here.

JOHN LAMBERT: And Mary grew up out on the beach looking for fossils, eventually becoming quite the expert by the time she was an adult.

MARY: This area looks interesting. I bet I'll find something extraordinary here. Time to grab my trusty shovel and start digging.

JOHN LAMBERT: Mary would sell some of her smaller finds to tourists, but she corresponded with paleontologists about her larger discoveries. Her first big break was that flizard we already heard about, a rather scary looking marine reptile which was later dubbed an ichthyosaur, which literally means fish lizard.

PONCIE RUTSCH: A more esteemed fossil hunter purchases the ichthyosaur fossil and sends it to a museum where it goes on display for the public. Mary Anning's name however, is not on the fossil. The guy who bought the fossil is the one whose name goes on the little plaque.

MARY: We didn't get any scientific credit for the finding, but at least we got paid enough to feed our family for a few months.

JOHN LAMBERT: Another of Mary's famous finds was the first fully intact plesiosaur, another marine reptile with paddle like appendages and an exceptionally long neck. Picture something that looks sort of like the Loch Ness Monster.

MARY: Its neck was so long that the esteemed anatomist George Cuvier thought it was a fake. My specimen caused such a stir, that the geological society of London had to call a special meeting to discuss it, which I was not allowed to attend.

JOHN LAMBERT: Throughout Mary's life, she continued the painstaking work of fossil hunting, garnering some recognition. But her gender and social class kept her from truly shining.

PONCIE RUTSCH: There were a lot of men who turned to Mary as like a source for their fossils because they weren't good enough to find them themselves, or they weren't living around a place where they could fossil hunt all the time. They wanted to stay in their intellectual circles in their fancy cities and talk about the fossils once they had them. Whoever had purchased the fossil, that was who got the credit for introducing it into these circles of intellectual conversation.

JOHN LAMBERT: Simply because she was a woman, Mary was excluded from these intellectual circles. Nevertheless, she persisted and earned a solid reputation among many of the scientists who studied fossils in her day. Lady Harriet Silvester, the wife of one of those intellectual men, wrote this glowing praise of Mary in her diary.

HARRIET SILVESTER: The extraordinary thing in this young woman is that she has made herself so thoroughly acquainted with the science, that the moment she finds any bones, she knows to what tribe they belong. She has arrived to that degree of knowledge as to be in the habit of writing and talking with professors and other clever men on the subject. And they all acknowledge that she understands more of the science than anyone else in this Kingdom.

JOHN LAMBERT: Even if she never got full credit in her day, Mary Anning's work helped broaden our understanding of the history of life on Earth. Mary died at age 47. But today she lives on in the hearts of curious fossil hunters everywhere, still digging to uncover that next big find.

[MUSIC PLAYING]

BRIELLE: Dinosaurs came in lots of shapes and sizes. Some were huge, bigger than blue whales.

MOLLY BLOOM: Others were small like the size of a dog.

BRIELLE: The largest dinosaur we know is the patagotitan. It might be the biggest animal that ever walked the Earth.

MOLLY BLOOM: Lots of other animals have ancient relatives that were bigger in the past.

BRIELLE: Scientists are still trying to understand why that happened and why we don't see more large animals today.

MOLLY BLOOM: That's it for this episode of *Brains On. Brains On* is supported in part by a grant from the National Science Foundation.

BRIELLE: *Brains On* is produced by Marc Sanchez, Sanden Totten, and Molly Bloom.

MOLLY BLOOM: We had engineering help from--

[LISTING HONOR ROLL]

Special thanks to--

[LISTING HONOR ROLL]

BRIELLE: And before we go, let's have a Moment of Um.

JAKE: My name is Jake. My question is why is the sun so hot.

RAJ KATTI: My name is Raj Katti. I'm a PhD student in physics at Caltech. And I'm going to answer why is the sun hot. So the sun is made out of a huge number of atoms, many, many more than the number of grains of sand on Earth. And they're all whizzing around each other.

Now the atoms at the center of the sun are under enormous pressure. And the pressure is so high that every once in a while atoms will smash into each other to produce other heavier atoms. But it turns out that the atoms produced in these collisions have just a little less mass. They're just a little bit lighter than the combined mass of the initial atoms.

And well, why is that? Where did that mass go? Well, it turns out that when the initial atoms collide with each other, a little bit of their mask gets converted into a very high energy form of light. And well, where does this light go? It collides with other atoms in the sun, transferring a little bit of its own energy to the other atoms with each collision.

And there's the answer. The sun has a high temperature because atoms in it collide with each other. And in doing so, they convert just a little bit of their mass into light. And that light heats up other atoms in the sun.

[MUSIC PLAYING]

MOLLY BLOOM: Our fans light up our world by sending us questions, drawings, mystery sounds, and high fives. When they do, we add them to the Brain's Honor Roll. Here's the latest crew.

[MUSIC PLAYING]

[LISTING HONOR ROLL]

That's it for this episode. See you next time.

BRIELLE: Thanks for listening.

MARY: What are we waiting for? Let's dig it out.