[MUSIC PLAYING]

NARRATOR: In a world of living things, some have fur.

[HOWLING]

Some have fins.

[DOLPHIN SOUNDS]

Some wear pants and are named Bob.

BOB: Hi. I'm Bob.

NARRATOR: And some go extinct.

MAN 1: Dr. Smarty Pants, extinction. What is it? And why does it happen?

DR. SMARTY PANTS: Well, extinction is when a whole species of plant or animal is wiped out. Dinosaurs went extinct after a giant meteor struck the Earth, the Tasmanian Tiger and the passenger Pigeon were both hunted into extinction.

MAN 1: Could humans go extinct?

DR. SMARTY PANTS: It's possible. Only time will tell. Only time will tell.

[MUSIC PLAYING]

NARRATOR: Through the years, countless species have gone extinct, from the dodo bird to the saber toothed tiger, to Bob.

BOB: What? No, I'm still here.

NARRATOR: Oh, sorry. Not Bob.

[MUSIC PLAYING]

Coming soon to a *Brains On* near you. The story of extinction and the possibility of bringing long gone animals back to life.

No animals, plants, or Bobs were hurt in the making of this movie.

[MUSIC PLAYING]

CHILDREN: *Brains On.*

MARC SANCHEZ: Hi there, everybody. This is Marc, *Brains On* producer. And I just want to let you know that this is an encore edition of our extinction episode. Pretty exciting stuff, hey.

We get a lot of people writing in to say, hey, whatever happened to that episode about roller coasters you did? Or didn't you guys do a show about life on other planets once? Yeah, we did. And right now, we're busy planning new episodes of *Brains On,* and working on making the entire catalog easily accessible for everybody.

For now, this is a blast from the past, the extinction episode. As you'll hear, this episode did not go the way of the dodo. I'll be back about halfway through the show to sound off the Brains Honor Roll.

Until then, let's say hello to Molly. You want to do it with me? OK. On three, let's say, hi, Molly. OK, ready? 1, 2, 3. Hi, Molly.

MOLLY BLOOM: Hi. You're listening to *Brains On.* I'm Molly Bloom. And my co-host today is 10-year-old Kate Wexler. Hi, Kate.

KATE WEXLER: Hi.

MOLLY BLOOM: How are you today?

KATE WEXLER: Good.

MOLLY BLOOM: So you are very interested in dinosaurs, right?

KATE WEXLER: Yeah.

MOLLY BLOOM: And can you tell me just a little bit about how you got interested in them?

KATE WEXLER: Well, when I was little, my mom and my dad bought me dinosaur toys. And I love to play with them because they were so cool. And then when I got old enough so I could read something, I said, hey, what about read some dinosaur books? And that was for a long while.

But now I'm like, well, I know a lot about dinosaurs, but I don't really read them all the time now. But I love dinosaurs, so I just--

MOLLY BLOOM: So even though you're not reading lots about them right now, you're still-- you still like dinosaurs?

KATE WEXLER: Yeah. I learn about them basically every day, like news about they found new dinosaurs or something.

MOLLY BLOOM: Very cool. And so we asked you to interview for us, Paleontologist Kristi Curry Rogers. She works at Macalester College. And she actually does research in the field, which means she gets to go on digs for fossils. And she's been to Madagascar, Zimbabwe, and Montana here in the United States. And she even got to name a new species of dinosaur in the past. It was a long necked dinosaur that used to live in Africa.

KATE WEXLER: Cool.

MOLLY BLOOM: So Kate, will you introduce what we're going to hear next?

KATE WEXLER: Yes. Here's part of my interview with Kristi Curry Rogers.

[AUDIO PLAYBACK]

- Some paleontologists think and some paleontologists don't. Do you think that some small meat-eater dinosaurs have feathers?

- Yeah, that's a really good question. We have really good fossil evidence that meat-eating dinosaurs had feathers. So you can find fossils, especially fossils from China. And there are some beds in China that are probably about 120 million years old. And they are so-- they're made of fine, fine mudstones.

They're almost like at the bottom of a lake or something. If you've ever stepped into the bottom of a lake and you've felt all this squishy mud on the bottom of a lake, that's the kind of sediment that these dinosaurs are preserved in. And because they're in such soft sediment, all of their body parts are preserved as a little shadow around their bodies. And so you can see their feathers.

So for at least some dinosaurs, we see their feathers, and we know that they had feathers. For some of them, we don't know for sure, like for the big long-necked dinosaurs, the sauropods, we don't have any fossil evidence that they had feathers. But for almost all the meat-eating dinosaurs, we do.

- Cool. That is really interesting. I didn't not know that. I did not know that.

- So here's a question for you. If all these meat-eating dinosaurs have feathers, even things as big as T-Rex, OK? So think about that, a T-Rex with feathers. Now do you think it's feathers were used for flying?

- Mm-mm.

- How come?

- Well, the Tyrannosaurus Rex is too big to fly or maybe kill itself.

- Yeah, so if it's got feathers and it's not using them for flying like birds do, what do you think that those dinosaurs might be using their feathers for?

- Maybe to block their sun off the skin, maybe.

- Maybe so. Have you ever worn a down jacket in the wintertime?

- Oh, yeah.

- Yeah. Sometimes, people in Minnesota wear winter coats with feathers inside, because feathers are really good insulation, right? Like hair. So mammals and birds are both warm blooded animals, and they both have insulation that helps keep their bodies warm when it's cold outside, like feathers, or helps cool them off when it's hot outside. Feathers do the same thing.

- Cool.

- So we think that dinosaurs may be first got their feathers as an adaptation because they're warm blooded. And they needed to cool off and heat up.

- Cool. So all reptiles are cold blooded, even dinosaurs?

- Maybe not. We think dinosaurs are doing something a little bit different. So we know that dinosaurs are reptiles, right? They have scaly skin. They look like reptiles. But birds have scales on their feet too, right? Have you ever seen a bird's foot, it's got little scales?

- Oh, yeah.

- So even birds are reptiles in an evolutionary sense, right?

- Oh.

- And so we think that dinosaurs, when they evolved on Earth, they're not really just reptiles, they're dinosaurs. So they're doing something a little bit different than their reptile relatives are. And one of the things that I like to study is what their bones look like under the microscope.

And so we can cut their bones up into really thin slices, and look at them under a microscope. And what we see is lots of holes and little dots. The holes are where blood vessels travel through the bones when the animal was alive. And that tells you how fast or slow an animal was growing.

And when we look at dinosaurs, we find that they grow just as fast as us and just as fast as birds.

- Cool.

- Right? So because they grow so fast, they're different than regular old reptiles. Because reptiles grow really, really slowly. When you look at reptile bones, they don't have any blood supply in their bones. It's really boring-looking bone on the inside.

But dinosaurs look just like our bones do. So if we cut my bone in half and took a look at it, it would look almost exactly like a long neck dinosaur's bones.

- Cool.

- Yeah.

- That's really cool.

- Yeah, it's surprising, isn't it? You think, they've got scales, they must be reptiles. But dinosaurs are special.

- Yeah.

- If you're a scientist, you start off with a hypothesis that you can test. So you say, I think dinosaurs were warm blooded. And then you try to find ways of testing your hypothesis.

So you can start to figure out from all these different lines of evidence, whether your hypothesis is right or wrong. And that's how science-- that's kind of how scientists do their job. They're always testing out these ideas and trying to prove themselves wrong.

- So do you have a theory about the biggest dinosaur? Did the biggest dinosaur always eat the biggest things?

- One of the things that's hardest for us to understand about the really big dinosaurs, they're the ones that I spend all my time studying because they're really hard to understand. So the long necked dinosaurs, they're also called the sauropods.

And the sauropods grew to sizes like they could be two school buses long. And they could weigh as much as a blue whale, the biggest animal alive on Earth today.

- Wow. Yeah.

- Yeah, so they got super big. And we don't know how they got so big. We don't even-- we don't know what they were eating.

Let's see if you can help me out with this. How would you figure out what a dinosaur was eating? What would you look at? What kinds of tools or clues could you use to help you figure it out?

- The stomach and the teeth because the teeth could have been worn down by a certain plant.

- Yup. The teeth are really good because you can look at the teeth under a microscope. And you can look for a little scratches made by plants, right?

- Mm-hmm.

- And stomachs are hard to fossilize because they're soft parts. And fossils are usually more easy to find if they're made of hard parts.

So you want to know another special gross thing that people studied to understand how dinosaurs eat?

- Mm-hmm.

- They study fossilized poop.

- Oh.

- Yeah, it's called-- fossils are called coprolites. And coprolites are just-- they look like rocks. But if you slice them and you look at them under a microscope, what you see are pieces of bones. If the animal was a meat-eating dinosaur, it's got bone fragments in it from the dinosaurs that it ate. And if it's a plant-eating dinosaur, you find pieces of plants.

And so you can use that-- you can study the plants in fossilized feces, coprolites, and you can begin to understand what kind of plants those dinosaurs were eating. So for the long neck dinosaurs, there's one coprolite that was discovered in India. And in that coprolite, there are leaves of pine trees. There are different kinds of grass, like bamboo and rice. And a lot of different other kinds of crazy-looking plants.

So we know that that dinosaur was eating stuff from the ground, like little tiny grass-like plants. And it was also eating things from the trees, and berries, and fruit, and things like that.

So those dinosaurs, from what we know about how-- we know that they grow faster than almost any other dinosaur on Earth. And they get those big sizes really, really fast. To do that, they have to eat almost everything. And they have to eat all the time.

- Yeah, because they get so hungry because maybe, their stomach is even bigger to eat more. They would maybe eat more because it's a bigger-- it's going to be bigger animal. And the bigger it gets, the bigger the stomach gets. And then they eat all the time to grow, grow, grow, grow.

- That's right. It takes more food to fill up that stomach and to help fuel those big growth rates. That's right.

- Do you think there's more out there?

- That is my favorite question, especially for people who want to be paleontologists when they grow up or think they might want to be paleontologists. There is a lot more work for paleontologists to do. And there are so many dinosaur fossils. Every year, there's-- there are maybe 20 new species of dinosaurs that get discovered.

And so as people have started looking in different places, like when you go to Madagascar for the first time and you look for fossils of dinosaur, you find new species because no one's ever looked there before. So there's a lot more to discover about dinosaurs.

In fact, I bet there are more questions about dinosaurs that are still to be answered than all the ones we've already figured out the answers to.

[END PLAYBACK]

[MUSIC PLAYING]

MOLLY BLOOM: All right, Kate. Are you ready? It's time for the mystery sound.

[MUSIC PLAYING]

CHILD: (WHISPERING) Mystery sound.

MOLLY BLOOM: Here it is.

[RATTLES]

What is your guess about the mystery sound?

KATE WEXLER: A woodpecker.

MOLLY BLOOM: Excellent guess. We're not going to reveal the answer yet. So while you're thinking about it, we've got a song for you. Now there are a lot of other species that have gone extinct besides dinosaurs. All sorts of plants and mammals that are no longer with us. Some went extinct millions of years ago, others, only recently.

We asked Sam Keenan to tell us about some of them.

[SAM KEENAN, AUSTRALOPITHECUS]

(SINGING) Funny birds who never flew. Wandering islands, nothing to do. Till hungry things came one night, and ate them all without a fight. Dinosaurs, big and small, used to play where there's a wall, till a big rock fell from the sky, they didn't get to say goodbye.

All around us and before us, there's a great animal chorus. They don't fight fair at all, ask good poor Neanderthal. Who knows phylums, classes, orders are just where we put the borders. Right up on the family tree, you, me, and the falling leaves.

[MUSIC PLAYING]

[ANIMAL SOUNDS]

I'd like to meet a saber tooth because maybe he would know the truth about the mammoths that would pose for paintings on the people's walls. Giant tortoises were with us, but they turned out to delicious. The great auk story is tragic. Some fools killed her for her magic. Have you heard of a sea cow? Because nobody can find one now.

All around us and before us is a great animal chorus. And they don't fight fair at all, ask the poor Neanderthal. Who knows phylums, classes, orders are just where we put the borders. Right up on the family tree, you, me, and the falling leaves.

[MUSIC PLAYING]

Almost every kind of beast who swam and slinked, or walked on feet has already come and gone, left us to take up the light. Now we sing and smile and love, cherish the sun shines above. Till it's time for all of us to join australopithicus.

KATE WEXLER: That was Sam Keenan with the song Authopologist-- Australopitheus-- Austratropotulus. The tongue twister song title.

MOLLY BLOOM: Austra.

KATE WEXLER: Austra.

MOLLY BLOOM: Lo.

KATE WEXLER: Lo.

MOLLY BLOOM: Pithecus.

KATE WEXLER: Pithecus.

MOLLY BLOOM: Yeah.

KATE WEXLER: Australopithecus.

MARC SANCHEZ: All right. I think you need a little time to practice pronouncing Australopithecus. And to do that, I want to recognize all the amazing kids who get in touch with us. Keep sending in your questions, drawings, mystery sounds, and high fives. Here is the latest installment of the Brains Honor Roll.

[MUSIC PLAYING]

[LISTING HONOR ROLL].

MAN 1: Brains On.

[MUSIC PLAYING]

MARC SANCHEZ: Do you want to be on the Brains Honor Roll? It's easy. Just send an email to brainson@mpr.org, that's M as in Minnesota, P-R dot org. We love listening to your mystery sounds and looking into all the questions that you have.

If you want to send us an actual letter or artwork, I would love for somebody to send in a drawing of an Australopithecus. Well, to do that, head over to brainson.org and look for our mailing address there. There's lots of cool stuff on the website for you guys to explore. That's brainson.org.

OK. Now back to the show and back to the--

[MUSIC PLAYING]

CHILD: (WHISPERING) Mystery sound.

MOLLY BLOOM: Do you want to hear it again?

KATE WEXLER: Yeah.

[RATTLES]

Is it an animal?

MOLLY BLOOM: Yup.

KATE WEXLER: OK. So I'm not-- motorcycles out. Motorcycles out. [LAUGHS] Is it a type of bird?

MOLLY BLOOM: It is. Because it is related to our episode, after all.

KATE WEXLER: Oh, yeah. [LAUGHS]

MOLLY BLOOM: So you said woodpecker originally. I'm not saying you're wrong or right, but is that-- you want to stick with that guess?

KATE WEXLER: Kind of.

MOLLY BLOOM: I mean, you're right. It is a kind of woodpecker.

KATE WEXLER: Oh. Oh, yey. I don't know there are many--

MOLLY BLOOM: That's OK.

KATE WEXLER: --kinds of--

MOLLY BLOOM: I'll tell you what kind it is. It's has a funny name. It's called Williamson's Sapsucker. And so it is--

KATE WEXLER: Seriously?

MOLLY BLOOM: It is a kind of-- it is, that's the name. And so this woodpecker, it lives in the Western mountains of North America. And the sound they're making is when they're drilling holes into trees to suck out the sap, which is why they have the name sapsucker.

KATE WEXLER: Because woodpeckers just peck.

MOLLY BLOOM: Exactly.

KATE WEXLER: [VOCALIZES]

MOLLY BLOOM: Exactly, like little jackhammers. And you know how Kristi was talking about how birds are related to dinosaurs, it turns out that some dinosaurs actually looked like woodpeckers.

A few years ago in 2010, scientists were able to decode the full body color of a specific dinosaur. This one was called the Anchiornis huxleyi.

KATE WEXLER: Wait, so they know the color of the dinosaur?

MOLLY BLOOM: Yeah. So what they did was, those feather fossils you were talking about, they were able to see in the fossilized feathers, teeny tiny parts of the cells. And those teeny tiny parts of the cells were what determined the colors of the feathers.

KATE WEXLER: Oh.

MOLLY BLOOM: And so this particular dinosaur looked like a woodpecker that was the size of a chicken, so like a really big woodpecker. And it had black and white wings and a rusty red crown around its head. So woodpecker--

KATE WEXLER: Never heard of that kind of dinosaur. There's a million dinosaurs, don't worry, I don't know all of them.

MOLLY BLOOM: Yeah, it's not one of the huge ones. So we'll have a photo of that dinosaur online at our website, brainson.org, if you want to check that out.

Have you seen the movie, *Jurassic Park?* I mean it's PG 13, I think, so maybe.

KATE WEXLER: Well, half of it because I got so scared. Scary.

MOLLY BLOOM: It's a scary movie. So the premise of that movie is that there's this island where a scientist has found a way to clone dinosaurs, to bring them back from extinction.

KATE WEXLER: Oh, yeah.

MOLLY BLOOM: So the way they did it was they found a mosquito stuck in Amber, fossilized, that had bit a dinosaur. So there was dinosaur blood in the mosquito. And they took that blood and took the DNA from the blood, and cloned a dinosaur.

But that movie is fiction.

KATE WEXLER: Yeah, definitely.

MOLLY BLOOM: It's not real. But our friend, Sanden Totten, explains why despite our hopes and dreams or maybe our fears, scientists are not likely to clone dinosaurs any time soon.

SANDEN TOTTEN: It has to do with DNA, that stands for--

ROBOT: Deoxyribonucleic acid.

SANDEN TOTTEN: But that's hard to say. So we just call it DNA. Now DNA is a molecule. That means it's very, very tiny. And all living things have DNA in their cells. Elephants, [ELEPHANT SOUND], monkeys, [MONKEY SOUND], crickets, [CHIRPING], birds that eat crickets, [CHIRPING] [BITE SOUND], and people.

ROBOT: Calling about robots.

SANDEN TOTTEN: No.

ROBOT: Oh.

SANDEN TOTTEN: Robots aren't living things. So sorry, no DNA.

ROBOT: That is too bad.

SANDEN TOTTEN: Now DNA is like a blueprint with all the instructions on how to build an animal. So imagine a builder.

MAN 2: Hi. Good to see you. We're just going to whip up a lion here.

SANDEN TOTTEN: The builder looks at the DNA instructions. And there's all the information about what the lion is like, and how to put it together right down to the very last cell.

MAN 2: All right. Well, let's see. We need to have a tail, yellow fur, some internal organs, have a big teeth and a big mouth.

[BELL CLANGS]

We're done.

[ROARS]

Yikes, it's time to skedaddle.

SANDEN TOTTEN: Now if the builder can get fresh blueprints by snagging DNA from the cells of a living creature, he can build that animal through a process known as cloning. That's how scientists made a cute little sheep named Dolly in 1996.

ROBOT: What if you want to build an animal that isn't alive anymore, like something that went extinct?

SANDEN TOTTEN: Good question, robot. If you can get some DNA from that animal, even if it's extinct, it should work. Maybe you find that DNA in a fossilized bone, or maybe it's in a feather or a hair. Then the builder just has to look at these old instructions.

MAN 2: Let me just dust these off.

SANDEN TOTTEN: And get to work.

MAN 2: Let's see, we got some feet, head, big teeth in a big mouth. There we go. I built us a saber tooth tiger.

[ROARS]

Oh, man. Yikes again. I got to go.

ROBOT: Sanden, what if you got DNA from a dinosaur? Could you clone it as well?

SANDEN TOTTEN: No. The problem is DNA decays over time. That means these instructions fall apart. Imagine a newspaper left out on the street. After a while, it'll get yellow and crumbly. Pages might go missing or get torn in half. That's what happens to DNA over time.

It takes only about 500 years for half the instructions in DNA to go away. So even if the builder had these DNA instructions, he would have a lot of trouble reading them.

MAN 2: Well, let's see here. These are pretty busted. I think it might be of a lizard, maybe an alligator.

SANDEN TOTTEN: After another 500 years, half of what's left falls apart, and so on, and so on until there's nothing but a few scraps left.

MAN 2: Just a few pages here. Let's see. What am I trying to make?

SANDEN TOTTEN: By 1 and 1/2 million years, the DNA instructions are completely unreadable. Now remember, dinosaurs went extinct 65 million years ago. So even if we found a sample of dino DNA, the instructions would be so old and ratty, even the best builders couldn't use them to build a dinosaur.

MAN 2: I give up. No idea how to put this animal together.

SANDEN TOTTEN: And that's why we can't clone dinosaurs. Wah wah.

ROBOT: That's so sad. I was hoping to meet a Tyrannosaurus Rex one day.

MAN 2: Not me. Not with those big teeth and big mouths. I think I'll just stick to building cute cuddly animals.

MOLLY BLOOM: So from the information that Sanden gave you, was there anything surprising or particularly interesting to you about it?

KATE WEXLER: It was interesting when he said, you can clone any other non a million year old things because you can't really do that. But if it's like less than a million years, you can clone anything. But it's really complicated with math and symbols that don't even look like letters or symbols, but--

MOLLY BLOOM: Exactly. It's hard, but it's possible.

KATE WEXLER: Yes, it's possible, but they don't really know how to do it yet. Not--

MOLLY BLOOM: Not yet.

KATE WEXLER: --successfully.

MOLLY BLOOM: But they're working on it.

KATE WEXLER: Yes.

MOLLY BLOOM: Our producer, Marc Sanchez, is here to tell us about a scientist who's doing just that.

MARC SANCHEZ: Hey, Molly.

MOLLY BLOOM: Hi, Marc.

MARC SANCHEZ: Today, I have the tale of a pigeon. Not the tail of a pigeon, not the tail feather, but the tale, T-A-L-E of a pigeon, mainly the passenger pigeon, which sadly, went extinct about a little over 100 years ago.

MOLLY BLOOM: How did it go extinct?

MARC SANCHEZ: Well, if you skip to about 200 years ago, in the 1800s, they were plentiful. Legend has it, you could look up at the sky and a flock of passenger pigeons could fly by and darken the whole entire sky.

MOLLY BLOOM: Wow.

MARC SANCHEZ: Block out the sun. But by 1914, the last one known to us died in a zoo, sadly.

MOLLY BLOOM: So they went from being so plentiful, and a little bit later, they were gone. So what happened?

MARC SANCHEZ: Well, it turns out, the passenger pigeon is a yummy treat and a cheap treat. So people ate the passenger pigeons because they were everywhere, and they could find them cheaply and easily. And also, during the 1800s, the train-- the railroad system began getting more and more robust, and also, refrigeration became possible in the railroad system. So we could ship passenger pigeons all over the country.

Another problem for the poor passenger pigeon was that, as humans started taking away they're forest too. They had fewer places to live.

MOLLY BLOOM: That's sad.

MARC SANCHEZ: It is sad. But there's this guy who's had a lifelong obsession with the passenger pigeon, specifically, and conservation in general. And he's working to bring back the passenger pigeon. He wants to make them de-extinct.

BEN NOVAK: Well, I'm Ben Novak. I'm currently working in Santa Cruz, California. We get DNA out of fossils and stuffed taxidermy specimens you see at museums. The work that I'm doing here is I am sequencing DNA out of extinct passenger pigeons to bring the species back to life someday.

MARC SANCHEZ: OK. So how does de-extinction get out of the realm of just a science fictiony thing of bringing something back to life?

BEN NOVAK: Well, we have a quick really fast history lesson. So back in the '90s, there were a few scientists that isolated a gene out of jellyfish, a gene that produces a protein called green fluorescent protein. And that's exactly what it does, it glows green.

And they cut it out of a jellyfish genome, and they stuck it into mice. And they ended up with glowing mice. Since then, they've made glowing fish that you can buy at the pet store. They've made glowing kittens. And just recently, they made glowing bunnies. And they use it to test a lot of things. This isn't just for fun, of course.

But when that happened, we realized that we could take DNA from one thing, we could put it into another, that we could actually change the DNA code of a living animal or plant. And since then, the field of bioengineering that is related to this has gone farther and farther and farther along.

And in the last two years, we got to a point where it's not just inserting random chunks of DNA somewhere, but we can finally actually cut and paste the DNA that we want into a genome, and essentially, rewrite the genetic code of one organism into the genetic code of another.

MARC SANCHEZ: And can you walk me through the steps? How do you get a glob of DNA to de-extinct an animal?

BEN NOVAK: Well, of course, you have to know what DNA you're working with first. So that's where the work I'm doing now comes in. You have to sequence the DNA out of your extinct animal so you know its code. We'll get that code, and we'll line it up next to the code of a living pigeon.

The closest relative we've identified is the band-tailed pigeon, which lives out here on the West Coast. The passenger pigeon was an Eastern United States bird.

And they're quite similar in lifestyle, but they have very different body shapes and very different color. And so we were going to take those two codes when we have them, and line them up, and be able to spot all of the differences between the two. And we'll start researching what differences actually matter and make the two birds unique.

And then we can isolate those regions of code in the computer, this is all data. And we'll go, OK, well, this code right here at this position makes the blue color of a passenger pigeon where he is a band-tailed pigeon is a more purply gray. And so we want to change that.

Then we'll take a cell-- a living cell from a band-tailed pigeon. But we'll take that cell and we have this synthetic chunk of DNA. And we're going to put two-- you can imagine these *Pacman.*

MARC SANCHEZ: From the video game?

BEN NOVAK: From the video game. A *Pacman.* And he's-- this is *Pacman* with arms, OK? So this is not just the regular *Pacman.* So he's got a right arm and a left arm. And we've got two of them. And the two of them are going to hold our DNA piece in between them.

And so they've got one hand holding the DNA, and the other hand is free. And we got to give them something in their other hand. And what we're going to give them is a piece of RNA. So that's like DNA, has a couple chemical differences, that matches the spot that we want the DNA to go.

And then the *Pacman* will bite the band-tailed pigeon DNA and chop out the chunk of band-tailed pigeon DNA. And then insert our chunk of passenger pigeon DNA in its place so that we get a completely rewritten section of that chromosome, that strand of DNA.

So if you do that over and over and over again, this cut and paste, eventually, you will rewrite the genome of the band-tailed pigeon into the same code as the passenger pigeon.

MARC SANCHEZ: And what comes out of that?

BEN NOVAK: Well, when you do it enough times, you get a cell-- a living cell in a little Petri dish, that carries the recreated genome of a passenger pigeon-- the now living genome of a passenger pigeon. If there's enough people working on it, and we really put our effort into it, I think it's not unreasonable to say that we'll have a bird that is almost passenger pigeon or passenger pigeon hatching in the next 10 years, maybe 8 to 10 years from now.

Looking forward after that, maybe by 2050, some people might get the chance to glimpse one of the first monitored flocks flying around from Ohio to Michigan.

MARC SANCHEZ: So they might be landing in a tree in your backyard in 2050?

BEN NOVAK: The passenger pigeon coming to a tree near you in 2050.

KATE WEXLER: This episode may be drawing to an end. But you can visit our website to find more about people and stories on the show.

MOLLY BLOOM: And we'd love to hear from you. What questions and ideas do you have? Tell us at brainson.org.

KATE WEXLER: This episode was produced by Molly Bloom, Mark Sanchez, Sanden Totten, and Ellen Getler.

MOLLY BLOOM: Music provided by Position Music and Christian Bjorklund. Many thanks to Kristi Curry Rogers, Sam Keenan, Ben Novak, Shannon Custer, Chris Wexler, and John Radey.

KATE WEXLER: Thanks for listening.

CHILDREN: *Brains On.*

CHILD: Woo hoo. Woo.