

SUBJECT 1: You're listening to *Brains On!*, where we're serious about being curious.

SUBJECT 2: *Brains On!* is supported in part by a grant from the National Science Foundation.

SANDEN So Marc, you're telling me all I have to do is push this button and I'll be able to clone myself.

TOTTEN:

MARC Yep, exactly, Sanden. I built it just like you asked. Just step into the booth, push the button, and you'll clone yourself in

SANCHEZ: seconds.

SANDEN Wow, I am impressed. I thought this was super hard to do. Good job, Marc. Let's toast to your achievement.

TOTTEN:

[POP]

[SOUND OF LIQUID FLOWING]

MARC Thanks. You know, it wasn't really that hard. I mean, the nose was tricky.

SANCHEZ:

SANDEN Well, I mean, if it's a clone, the nose would just be like mine, right?

TOTTEN:

MARC Because that nose has got to be big.

SANCHEZ:

SANDEN I mean my nose isn't that big. Is it?

TOTTEN:

MARC And it's going to be red and squeaky.

SANCHEZ:

SANDEN Is that a side effect of cloning?

TOTTEN:

MARC Otherwise, it wouldn't stand out against a full face of white makeup.

SANCHEZ:

SANDEN Wait, why would my clone have a full face of makeup?

TOTTEN:

MARC All clowns do.

SANCHEZ:

SANDEN Did you say clown?

TOTTEN:

MARC Yeah, clown.

SANCHEZ:

SANDEN I asked for a clone.

TOTTEN:

MARC A clown.

SANCHEZ:

SANDEN Clone.

TOTTEN:

MARC Clown.

SANCHEZ:

SANDEN Like, an exact genetic copy of me?

TOTTEN:

MARC Oh. This machine might not be what you expected.

SANCHEZ:

SANDEN If I step in there, it's going to turn me into a clown, isn't it?

TOTTEN:

MARC Yeah.

SANCHEZ:

SANDEN Like with face paint and a rubber nose and big shoes?

TOTTEN:

MARC Exactly. Oh boy, do I feel silly.

SANCHEZ:

SANDEN Yeah, I'm going to want my money back, Marc.

TOTTEN:

MARC Sure, that makes sense. Here, it's in my wallet. Let me just open it and--

SANCHEZ:

SANDEN Ah! Seltzer in the face.

TOTTEN:

MARC And a pie!

SANCHEZ:

[MARC CACKLES]

See ya, wouldn't want to be ya.

[HORN HONKING]

SANDEN Hey, that wasn't the real Marc. It was Marc's clown all along.

TOTTEN:

[SAD TRUMPET PLAYING]

MOLLY You're listening to *Brains On!* from APM Studios. I'm your host Molly Bloom, and my co-host today is Soleil from
BLOOM: Vancouver, Canada. Hey, Soleil.

SOLEIL: Hi, Molly.

MOLLY Soleil, you asked us a fascinating question.

BLOOM:

SOLEIL: Yeah, I wanted to know if you could clone yourself.

MOLLY So how would you explain what a clone is?

BLOOM:

SOLEIL: A clone is like an exact copy of something.

MOLLY So what made you wonder if you could clone yourself?

BLOOM:

SOLEIL: I was at my cousin's house and they really love *Star Wars*. So I was thinking about how in *Star Wars* and some other sci-fi movies, they clone themselves and I was wondering if that's actually possible.

MOLLY Yeah, there's that whole *Attack of the Clones*, the *Clone Wars*, there's a lot of clones in *Star Wars* for sure. So do you
BLOOM: think cloning yourself is a good idea or a bad idea?

SOLEIL: I would not want to clone myself, because-- I don't know, I just think that'd be really creepy to have someone the exact same as you. Like I'd like to have a twin, but not a clone.

MOLLY So if you did have a clone, what do you think your relationship with this clone would be like?

BLOOM:

SOLEIL: I think it would either be really good or really, really, really bad.

[MOLLY LAUGHS]

Because they would know everything about me and they could turn evil and then start--

MOLLY Oh!

BLOOM:

SOLEIL: --just impersonating me. But I think it could also be good, because they could be your friend and stuff.

MOLLY Right, so it kind of depends on the personality of the clone is what you're saying, like if they're out to make some
BLOOM: mischief or if they want to help you. Well, I guess, if it's a clone of you, it just has the same DNA as you, so probably have maybe a similar personality to you, potentially.

SOLEIL: I feel like if I was like a clone myself, I would probably want to destroy the other clone.

[MOLLY LAUGHS]

So that's why I don't want to clone myself.

MOLLY You know what your clone would be thinking.

BLOOM:

SOLEIL: Yeah.

MOLLY Very smart. Yeah, so basically when you clone something, you're creating a living copy of that thing. Sometimes this

BLOOM: happens naturally in the world. There are plenty of living things that can create a copy of themselves to reproduce.

SOLEIL: Like certain plants, fungi, bacteria, even coral in the ocean. Their kids, if you call them that, are just new versions of them. They're clones.

MOLLY But humans, like a lot of other living things, make our next generation by combining stuff from two parents.

BLOOM:

SOLEIL: So instead of the kid being a copy of one parent, it's a mix of two parents.

MOLLY And that stuff that's combined is called DNA.

BLOOM:

SOLEIL: DNA is like a set of instructions for how to make a body.

MOLLY Yeah. DNA stands for deoxyribonucleic acid. And legend has it, if you say it 3 times in a dark room, the ghost of the

BLOOM: man who first discovered it, Friedrich Miescher, will appear.

FRIEDRICH That's poppycock!

MIESCHER:

[THUNDERCLAP]

SOLEIL: Ah! The ghost of Friedrich Miescher!

FRIEDRICH If I appeared every time someone said deoxyribonucleic acid three times in a dark room, I'd be popping into every

MIESCHER: lecture hall on every campus at least a dozen times a day. I don't have time for that.

MOLLY Then why are you here?

BLOOM:

FRIEDRICH Well, podcasts are different. Got to show for the fandom, am I right? #MiescherNation, #DNADaddy.

MIESCHER:

SOLEIL: So you were the first to discover DNA? How did that happen?

FRIEDRICH Funny story, I was studying white blood cells back in 1869. You know, the year 18th President Ulysses S. Grant was

MIESCHER: sworn in and the Campbell's Soup Company was created? And the first ever college game of American football was played. It was a cool year to do cool stuff.

MOLLY All that was way before cars and electricity were common. So you were working in a very different world than the one
BLOOM: we know today.

FRIEDRICH Totes. So anyway, I had this pretty sweet deal with a local surgical clinic where they would send me old, pus-soaked
MIESCHER: bandages from patients. Awesome, am I right? I was examining the cells from these crusty, used bandages under a
microscope, as one does, when I noticed a substance that was unlike anything anyone had ever seen before. I called
it nuclein at the time, because I found it in the nucleus of a cell, which is like the cell's control center.

SOLEIL: You must have been very excited.

FRIEDRICH Oh, yeah. I knew it was a #BigDeal. I quickly shared it with all my followers by writing it down, because that's how we
MIESCHER: shared things back then, #DifferentTimes.

MOLLY Then it took a lot more scientists to figure out how that cool new substance you found showed cells how to grow into
BLOOM: whatever they are supposed to grow into.

SOLEIL: Yeah, that stuff you found in the middle of the cell is the key to cloning too. Someone could use those instructions to
make an exact copy of a living thing.

FRIEDRICH Psh, yeah. All in a day's work for the Miesch-man. Not to flex or anything, but some people literally got a Nobel Prize
MIESCHER: for their work studying DNA. I set them up for that slam dunk though, if you catch my drift.

Speaking of drift, it's time for this ghostie to skedaddle. I heard there's a YouTuber who's about to talk about the
science of Jurassic park. And I have a few things to say about the DNA section, but bye!

[THUNDERCLAP]

MOLLY So the key to cloning a creature is to make it with the same DNA as the original.
BLOOM:

SOLEIL: So has it ever happened? Do clones exist?

LYDIA Yes and yes.
MOREL:

[THUNDERCLAP]

SOLEIL: Ah! The ghost of producer Lydia Morel.

LYDIA What? No, I'm not a ghost.
MOREL:

[THUNDER RUMBLES]

Weird weather we're having though, right?

MOLLY Whew! Sorry, you just surprised us. Lydia, are we wearing the same shirt?
BLOOM:

LYDIA Red with pink polka dots and tiny ice cream cones? Yeah, I guess we are.

MOREL:

MOLLY Right on, we're twinning.

BLOOM:

LYDIA Speaking of twins, twins are so amazing. I'm not a twin but I've met lots of them. The two most common types are

MOREL: fraternal and identical.

MOLLY Fraternal twins are born at the same time but they can be really different. One can be a boy and one can be a girl.

BLOOM: Even if they're both girls or both boys, they still might look pretty different. That's because they each have their own unique mix of the parents' DNA.

LYDIA Right, but identical twins do look the same and they have the same DNA. I've talked to Dr. Nancy Segal, a

MOREL: psychologist at California State University, Fullerton, who has studied thousands of twins. And she's actually a fraternal twin herself.

SOLEIL: Whoa, Nancy is a twin who studies twins?

LYDIA Yeah. She told me that identical twins are actually natural clones. The cloning happens all on its own. You see, when

MOREL: parents are having a kid, the DNA from both parents is mixed up in something called a fertilized egg.

DR. NANCY And identical twins result when a single fertilized egg divides. So these twins share all their genes in common.

SEGAL:

LYDIA Genes are sections of DNA.

MOREL:

MOLLY So there's only one egg, but for some reason it splits into two and then each one grows into a baby?

BLOOM:

LYDIA Yep. And since they started as the same egg, they have the same combination of DNA. But Nancy says little changes

MOREL: can still happen.

DR. NANCY Now, they're not exactly genetically the same because there can be changes in the gene that occur over time. But

SEGAL: nevertheless, even those twins, they are amazingly alike in looks, in behavior, in personality.

LYDIA And that's where Noah and Ken come into the story. They're identical twins who live in Los Angeles.

MOREL:

KEN: My name is Ken. I am 11 years old.

NOAH: Hi, my name is Noah. I'm also 11 years old.

LYDIA When Noah and Ken were born, they looked really similar. But as they've grown up, it's gotten easier to tell them

MOREL: apart. Here's Noah.

NOAH: He has an indent on either left or the right side of his face.

KEN: Yeah, I think-- Yeah

NOAH: And I don't, so.

KEN: Some people say that I have a more square face and he has more of a rounder face.

LYDIA Even though Noah and Ken have a lot in common, they aren't 100% exactly the same. No twins are. Nancy says that's
MOREL: because as they grow and develop, different genes act differently. Genes are part of that DNA blueprint and they create different changes in your body, depending on whether they're turned on or off.

DR. NANCY And certain environments will trigger that gene. Let me give you a very simple example. Sometimes one identical twin
SEGAL: is exposed to something that triggers a certain reaction, the twin partner is not.

LYDIA Ken and Noah are in two different bodies living separate lives. Because of this, different genes can be triggered,
MOREL: resulting in tiny differences.

KEN: Noah has a different allergy than me. He has an allergy to dust, I have an allergy to pollen.

LYDIA And here's another big one. Noah has to wear glasses to see things in the distance clearly and Ken doesn't.
MOREL:

SOLEIL: But their genes are still really similar. How does this affect their personalities?

LYDIA Identical twins are pretty similar. But you'll see a lot more differences in personality than in physical things like hair or
MOREL: eye color. Some of that may come from them just wanting to be different from each other. But some of it might come from their different life experiences too. Ken and Noah both love baseball. But besides that, they like a lot of different things, like school subjects.

KEN: My favorite thing is social studies.

NOAH: My favorite thing is reading.

LYDIA Foods.
MOREL:

KEN: My favorite dinner is pizza.

NOAH: My favorite dinner is ramen.

LYDIA And hamburger toppings.
MOREL:

KEN: He likes cheese on his hamburger and I don't

LYDIA Even if they're different in personality, identical twins are usually very close.
MOREL:

NOAH: It's nice to have an identical twin because you're never bored because you always have someone to play with.

MOLLY OK, identical twins like Noah and Ken are natural clones. So does that mean if we did clone someone, they'd be like
BLOOM: identical twins?

LYDIA Nancy said they could be. But when you clone someone, that clone starts out as a baby. So the person and the clone
MOREL: would be born in different years. They'd share the same genes, but their lives would be very different. For example, I grew up in the 2010s, and I like pop music and baggy jeans. If I grew up in the 1990s, I might like flannel shirts and grunge.

[GRUNGE MUSIC PLAYS]

SOLEIL: Wait, where did this big book of CDs come from? And Molly, are those braces?

MOLLY What? Oh my gosh, I haven't had braces since 1997.

BLOOM:

LYDIA And why are we all suddenly wearing bootcut jeans and spaghetti strap tank tops? I must have accidentally activated
MOREL: 1990s mode when I said the magic word.

SOLEIL: Please?

LYDIA No, grunge.

MOREL:

[GRUNGE MUSIC PLAYS]

MOLLY Grunge is actually awesome. Let's rock.

BLOOM:

SOLEIL: Rock on.

LYDIA I'm outie. Bye.

MOREL:

MAN: (SINGING) Brains On!

MOLLY They may not be clones but I do have two of them. They're ears, and get ready to use yours for the--

BLOOM:

[MYSTERIOUS MUSIC PLAYS]

SUBJECT 3: Mystery sound.

MOLLY All right, Soleil. Are you ready to listen and guess the mystery sound?

BLOOM:

SOLEIL: Yes.

MOLLY All right. Here it is.

BLOOM:

[MYSTERY SOUND PLAYS]

What do you think?

SOLEIL: It sounds like something clicking. So I think maybe like a cassette tape or something, going into the thing or a CD?

MOLLY Yeah, I have no idea what this one is either. Do you want to hear it one more time?

BLOOM:

SOLEIL: Yes.

MOLLY All right, let's hear it again.

BLOOM:

[MYSTERY SOUND PLAYS]

SOLEIL: That kind of sounds like either something clicking. But now I'm sort of thinking maybe like when you open like a pop and it makes that clicking sound?

MOLLY Like the pop top?

BLOOM:

SOLEIL: Yeah, but it doesn't really spray that much. So I don't really know.

MOLLY Yeah, this is a tricky one. Well, we will hear it again and get another chance to guess after the credits.

BLOOM:

SOLEIL: So stay with us Hey friends, we're working on an episode all about friendship.

MOLLY Friendship is an amazing part of being human.

BLOOM:

SOLEIL: But that doesn't mean it's always easy.

MOLLY That's right. We want to hear from you. Have you ever had questions about making friends or how to deal with tricky
BLOOM: friendship situations? Soleil, have you ever had a problem with a friend that you didn't know how to solve right away?

SOLEIL: I remember one time, we were playing basketball at school and I accidentally broke my best friend's glasses with the basketball.

MOLLY Oh no. How did your friend react to that?

BLOOM:

SOLEIL: She was upset at first, but then she forgave me because I didn't mean to. Why would someone launch a basketball at their best friend's head?

[BOTH LAUGH]

MOLLY Yes, I'm glad she realized it was an accident. Do you have any advice for younger kids who might be dealing with
BLOOM: some friendship issues?

SOLEIL: Just try to think about how the conflict actually started. Because a lot of times, it's really easy to get carried away in conflicts just because you just get so caught up in yourself, and think about how your friend might have gotten angry or upset about that.

MOLLY
BLOOM: That is very good advice. Listeners, send us your friendship questions. We're going to ask some friendship experts for advice on this upcoming episode. And don't worry, we won't share your name when we ask your question. It can be completely anonymous.

SOLEIL: Send your questions to us at BrainsOn.org/Contact.

MOLLY
BLOOM: And while you're there, you can send us topics you'd like us to cover on *Brains On!*, mystery sounds, and drawings. BrainsOn.org/Contact is where we got this question.

MILO: Hi, I'm Milo from Auburn, Washington. And my question is, why do video games have a good grip on us?

SOLEIL: You can find an answer to that question on our *Moment of Um* podcast.

MOLLY
BLOOM: It's a short dose of facts and fun every weekday. Find it wherever you listen to podcasts.

SOLEIL: And keep listening.

MOLLY
BLOOM: You're listening to *Brains On!* I'm Molly.

SOLEIL: I'm Soleil.

MOLLY
BLOOM: And today we're answering your questions about clones. Here's the next one.

BARRETT: Hi, my name is Barrett from Redding, Connecticut. And my question is, how did scientists clone Dolly the sheep and will we be next?

ROSIE
DUPONT: Cloni-cloni-cloni-cloni-clones. Cloni-cloni-cloni-cloni-clones.

MOLLY
BLOOM: Oh hey, it's producer Rosie Dupont.

ROSIE
DUPONT: Oh, hi. Hi, Molly. Hi, Soleil. I was just working on my one-woman musical *Send in the Clones*. It's a clone extravaganza set to Frank Sinatra's greatest hits.

SOLEIL: That's so specific.

ROSIE
DUPONT: I know. Anyway, I thought I'd stop by to tell you about the first clone of an adult mammal. Are you ready for a story of science, secrets, celebrity animals and sensationalist media?

SOLEIL: Yeah.

MOLLY Yes.

BLOOM:

ROSIE Cool. Then let's travel back in time to the year 1996.

DUPONT:

[TAPE REWIND]

Everyone was dancing to the Macarena.

[MUSIC - LOS DEL RIO, "MACARENA"]

LOS DEL (SINGING) Hey, Macarena. Ay!

RIO:

ROSIE Tickle Me Elmo was the coolest new toy.

DUPONT:

ELMO: Elmo love you.

[LAUGHTER]

That tickles.

ROSIE And a very special lamb was born.

DUPONT:

[LAMB BLEATS]

Lamb number 6LL3 came into the world on July 5th, 1996 at the Roslin Institute in Scotland. She had a little white face and a woolly coat. And after she was born, she popped right up onto her feet.

[LAMB BLEATS]

SOLEIL: Aw, cute.

ROSIE Yes, she was cute. But mostly the scientists at the institute were stunned. Thrilled! This little lamb was a miracle.

DUPONT: Because she wasn't just any old lamb, she was a clone. A clone named Dolly. Now Dolly wasn't the first animal cloned, not even close. Scientists had cloned a frog more than 30 years earlier, in 1953.

[FROG CROAKS]

But cloning a frog isn't the same as cloning a sheep or even a dog. Every animal presents its own unique set of obstacles when it comes to cloning. And because the frog was an amphibian and not as closely related to humans, it didn't cause the same splash.

Also, after that first froggy clone, scientists had trouble repeating the process. They did succeed in cloning a mouse in 1979, but they didn't do it the way they cloned Dolly. They used an early embryo or baby cell and split it into two identical mice.

SOLEIL: That's the way identical twins are made.

ROSIE Yes, exactly. But Dolly was different. She was made from an adult cell. She was the first identical copy of an adult
DUPONT: mammal.

[SHEEP BLEATS]

Dolly was made like this scientists took a cell from a six-year-old sheep's udder then they took an egg from another sheep and sucked out all of its DNA the genetic material that makes you you Next, they stuck the udder cell and the empty egg cell together using electricity.

Then they put this combined egg inside a third mama sheep so it could develop. And that egg turned into baby Dolly. She was an exact copy of the six-year-old sheep that donated its udder cell, only a baby.

[VICTORIOUS TUNE PLAYS]

This was a huge deal because the cells in our bodies have different jobs. Our brain cells do one thing.

[ELECTRICITY ZAPS]

Our skin cells do something else.

[SOUND OF SLAPPING]

And then there are these other types of cells that are like shapeshifters. They can become every different type of cell in your body. When a baby is developing, before it's born, it's made up of lots of these shapeshifter cells. And they're busy creating every part of its body.

SOLEIL: Eyes, nose, ears.

ROSIE Exactly. And until Dolly was born, no one thought you could take an adult cell that already has a special job, like being
DUPONT: an udder cell, and turn it back into a shapeshifter cell. Figuring this out wasn't easy. The scientists at the Roslin Institute tried to make a sheep clone like Dolly 276 times before they got her.

SOLEIL: 276 is a lot.

MOLLY That's like the number of days between Valentine's Day and Thanksgiving.

BLOOM:

[TURKEY GOBBLES]

ROSIE Right. So Dolly was special. And the scientists who helped create her knew the world would go wild when they heard
DUPONT: about her. So they decided to keep little Dolly a secret until they'd published a scientific paper about how she came to be.

[LIGHT MUSIC PLAYING]

In February 1997, just a few days before the scientists at Roslin were scheduled to publish their paper about Dolly, the secret leaked and sparked a media firestorm. Some folks cracked jokes.

SUBJECT 3: My son told me he didn't understand cloning. I told him, that makes two of us.

[CANNED LAUGHTER]

SUBJECT 4: Why did scientists clone Dolly? They wanted some sheep thrills.

[CANNED LAUGHTER]

ROSIE But it also caused a lot of people to worry.

DUPONT:

SUBJECT 5: Dolly. She may look ordinary but she's the stuff of science fiction.

SUBJECT 6: Which brings us to the fundamental question. Should we be applauding a mind-boggling scientific breakthrough or be nervous about where it might lead us?

ROSIE Everyone was asking the same question. If it was possible to clone an adult mammal, wouldn't human clones be next?

DUPONT:

SUBJECT 7: If a lamb, why not a man?

SUBJECT 8: But it's no doubt that human beings will be cloned.

ROSIE But how soon and what did that mean?

DUPONT:

[DRAMATIC MUSIC PLAYS]

Turns out human clones were not right around the corner. People are a lot harder to clone than sheep. For one, cloning takes a lot of tries to get right. So we need to experiment on a ton of human eggs. And this idea makes many people feel uncomfortable and upset. What's more, other primates, like monkeys, are tricky to clone. So it'd likely take a long time and lots of mistakes to figure out how to clone humans.

SOLEIL: So has it ever been done?

ROSIE No. To this day, no one has cloned a human from an adult cell.

DUPONT:

MOLLY And what ended up happening to Dolly?

BLOOM:

ROSIE Well, once the media attention calmed down, she had a pretty regular life. She partnered with a Welsh mountain ram

DUPONT: named David and had six little babies named--

[LAMBS BLEATING]

Sally, Cotton, Lucy, Bonnie, Darcy, and my favorite, Rosie. When she was six, Dolly got sick with a lung infection, common among sheep, and sadly, passed on. Healthy sheep often live 10 to 12 years. So there was some talk that she may have had a short life because she was a clone.

But that idea was proved wrong. Dolly was perfectly normal in every way. Today, if you want to see her, she's been stuffed and put on permanent display at the National Museum of Scotland. And that's the story of the world's first clone of an adult mammal.

MOLLY Wow. I wonder if Dolly the sheep ever had a sense of what a big deal she was.

BLOOM:

SOLEIL: Yeah, she might be the most important sheep ever born.

ROSIE For a little sheep, she was truly the GOAT.

DUPONT:

MOLLY Well said. Thanks for the info, Rosie.

BLOOM:

ROSIE Oh, no problem. All right, I should get back to working on my musical. (SINGING) Where are the clones? Send in the

DUPONT: clones.

[SPEEDED UP RECORDING]

[GROUP CHANT]

MOLLY So after Dolly was successfully cloned, a lot of scientists were wondering the same thing you were, Soleil.

BLOOM:

SOLEIL: Could I clone myself or my grandma or my best friend?

MOLLY Right. But in addition to figuring out whether or not something is possible, part of being a scientist is also thinking

BLOOM: about whether or not something is responsible.

SOLEIL: So not just could I but should I.

MOLLY Exactly. This question of should is a question of ethics. Ethics is a way of thinking about whether something is right or

BLOOM: wrong. We deal with ethics all the time.

SOLEIL: Yeah. Sometimes, it's pretty simple. It's ethically wrong to go around jumping on people's toes for no reason.

Sometimes, it's trickier.

MOLLY Here's an example of an ethical question. Imagine two kids walking to school.

BLOOM:

KID 1: So then I said, no way, you're in my house. You'll eat your thrice battered ham my-- oh, my gosh. Did you see that?

KID 2: Wow, it looks like someone dropped their lunch money, a lot of lunch money.

KID 1: Moo-la-la, we're rich, rich I tell you.

KID 2: What? No, we can't keep it.

KID 1: What do you mean we can't keep it? We found it. Finish this sentence. Finders--

[CRICKET CHIRPING]

Wow, you really just kept me hanging there.

KID 2: Come on, this is probably really some kid's lunch money. What if they've been really excited about loaded tater tots and now they won't be able to get any?

KID 1: But that kid's probably long gone now. Besides, if we turn the money in, how do we know the person who lost it will even find it? If someone's going to keep it, it might as well be us.

KID 2: Yeah, but--

KID 1: Think of it this way, remember how we wanted to save up for that Berry Smiles concert? This gets us like 0.025% of the way to our goal.

KID 2: Listen, I have to get to math class. I know you'll do the right thing. What would Berry Smiles do?

[SCHOOL BELL RINGING]

MOLLY So that's just one example of an ethical dilemma. But you're probably wondering, what does all this have to do with

BLOOM: Dolly the cute little cloned lamb that we heard about? Well, after Dolly was born, some people were really worried about the ethics of cloning. Would scientists try to clone humans next? And even if they could should, should they?

SOLEIL: So even though cloning a human would actually be way more complicated than cloning a sheep, scientists and even some people in the government wanted to prepare.

MOLLY Bill Clinton, who was president of the United States at the time, got together a group of experts to study the ethics of

BLOOM: human cloning and make recommendations about what laws should be put in place. Lots of state governors did the same thing. California was the very first to ban human cloning, meaning, it was illegal there.

MARIA And so we as a state, California responded by looking at the consequences of the reality of that type of science

QUINTERO: coming true.

MOLLY That's Maria Quintero. She's a lawyer in San Francisco, California. She was part of a group of people who studied the

BLOOM: possibility of human cloning and wrote a government report on it back then.

SOLEIL: Maria remembers hearing about Dolly the cloned sheep. She said the question of ethics came up for her right away.

MARIA My initial reaction was, I don't think it's right. But then part of me thought it was kind of cool that we could do it. And

QUINTERO: so I had these two competing parts of myself. There's this excitement whenever anything unexpected happens, or there's a breakthrough. But then the other part of myself said, but wait a second? Why would we want this? Why would we need this?

MOLLY There were other questions too.

BLOOM:

MARIA The main one initially was safety. Is it safe?

QUINTERO:

SOLEIL: To clone a human, you probably use a process like the one used to create Dolly, two cells, one with DNA, and one with its DNA emptied out would be smashed together using electricity. But it's actually really hard to get this process exactly right. Sometimes, you get extra DNA that you didn't intend to.

MOLLY This could cause the cloned embryo to fail like it did the other 276 times scientists tried to create Dolly. If the embryo
BLOOM: was able to be born, this extra DNA could cause health problems later that would be hard to predict.

MARIA And so that was number one reason they gave for saying no at this time, because it just not proven to be safe.
QUINTERO:

MOLLY Also, there just weren't any good medical reasons to clone a person. A lot of the experts found themselves asking,
BLOOM: why would we do this? What's the reason behind it? And they weren't able to come up with any good answers.

SOLEIL: People have a lot of wrong ideas about what cloning would be like. Like people say, I wish I could clone myself so that I could do my homework and play video games at the same time. But cloning isn't like clicking copy and paste. Even if you could make a clone of yourself, you'd be getting the baby version.

MOLLY And that baby version might grow to be physically identical to you, but they would still be their own person with their
BLOOM: own unique personality, just like Noah and Ken, the twins we met earlier in the episode.

SOLEIL: Maria explained that another ethical problem with cloning could be that people wouldn't realize this and would expect things from the clone that are unfair.

MARIA So you could be a mom or a dad saying, I want to have a human son just like their first son. Let's just say it's Joe,
QUINTERO: because Joe is a good basketball player. Joe is a good student. Joe always does his homework. And they want that same person.

MOLLY But what if the new kid, the clone has a hard time being like Joe? Like we talked about earlier, even twins with the
BLOOM: same DNA don't end up the same. This clone would be under a lot of unfair pressure to be a certain way because that's what their parents want and expect.

MARIA And so the creation of a society where you can choose what you want to see in a kid and what you think that kid's
QUINTERO: going to become as an adult, that was something that as a whole, most not just scientists, but also just people said no, that's not a world that we want to live in. That's not a world that we want to see.

MOLLY So scientists are pretty unified that cloning a full human being is a bad idea.
BLOOM:

SOLEIL: Yeah, so you might see clones in movies, books, and TV shows, but not in real life. Some things are best left to science fiction.

[MUSIC PLAYING]

- Brains,
brains,
brains.

FREDDY Sup, y'all? It's your fave ghost and 19th century DNA discoverer, Freddy Miescher Welcome to my new podcast *DNA*
MIESCHER: *Dogs*, where me and my buddies talk all things DNA. Ain't that right ghost of Austro-Hungarian-born American biochemist and DNA researcher, Erwin Chargaff?

ERWIN That's right.

CHARGAFF:

[PARTY HORN BLOWS]

If it's ribonucleic, you know we're going to slay it.

FREDDY And of course, we've got the bussin' Russian, Fiba Slovene.

MIESCHER:

FIBA I put the gene in genius, y'all.

SLOVENE:

FREDDY And let's get this podcast party started.

MIESCHER:

ERWIN Oh, yeah, whoo!

CHARGAFF:

[MUSIC PLAYING]

FIBA Yeah.

SLOVENE:

ERWIN D-N-A. D-N-A. Whoo!

CHARGAFF:

[MUSIC PLAYING]

[ELECTRONIC MUSIC]

SOLEIL: Cloning is creating a copy of a living thing by giving it the same DNA as the original.

MOLLY In nature, lots of living things clone themselves reproduce. And identical twins are like natural human clones.

BLOOM:

SOLEIL: Scientists have cloned some animals, including a sheep named Dolly. But

MOLLY It's pretty much agreed that cloning humans is not ethical and we shouldn't do it. That's it for this episode of *Brains*

BLOOM: *On.*

SOLEIL: This episode was produced by Rosie DuPont, Nico Gonzalez Wisler, Molly Bloom, and Anna Goldfield.

MOLLY We're bidding adieu to our fabulous intern, Lydia Morel. We can't wait to see what she does next. Our editors are
BLOOM: Shahla Farzan and Sanden Totten. This episode was sound design by Rachel Brees, and we had engineering help from Jess Burg and Brooklyn Filtniss. Special thanks to Amy Skamahorn, Charlie, Coco, Brant Miller, Andy DuCett and Josh Savageau. Our executive producer is Beth Pearlman. And the executives in charge of APM Studios are Chandra Kavati, Joanne Griffith, and Alex Schaffert.

SOLEIL: *Brains On!* is a nonprofit Public Radio program.

MOLLY There are lots of ways to support the show. You can tell your friends about us.

BLOOM:

SOLEIL: Hey friends, have you heard *Brains On?*

MOLLY Buy our books.

BLOOM:

SOLEIL: They're fascinating.

MOLLY Donate or subscribe to our Smarty Pass.

BLOOM:

SOLEIL: Ad free episodes just for you.

MOLLY Just head to brainson.org to subscribe. OK, Soleil, are you ready to hear that mystery sound again?

BLOOM:

SOLEIL: Yes.

MOLLY OK, here it is.

BLOOM:

[MYSTERY SOUND]

SOLEIL: I think it's still like either a can clicking open, but maybe like not a fizzy drink because it wasn't fizzing, or something clicking, like maybe a cassette player or something, or a video game. I don't know.

MOLLY OK. So we hear the clicking. Are you ready for the answer?

BLOOM:

SOLEIL: Yes.

MOLLY My name is Alanna, and I'm from Annandale, Virginia, and that was the sound of me rubbing the bristles on my hairbrush.

SOLEIL: What?

MOLLY What?

BLOOM:

SOLEIL: That sounded nothing like that.

MOLLY That is not what I was thinking. [LAUGHING]

BLOOM:

SOLEIL: I mean, I rub the bristles on my hairbrush, but that does not sound like that.

MOLLY [LAUGHING] I wonder what those bristles are made of.

BLOOM:

SOLEIL: It must be like those bristles with like the little circles on top of them.

MOLLY Yes, yes, I think, yes, I think you're correct. That was a tricky one. I was thinking maybe like cards being shuffled. But
BLOOM: yeah, hair bristles, good job tricking us, Alanna.

[HAIR BRUSH BRISTLES]

Now it's time for the *Brains* honor roll. These are the incredible kids who keep this show going with their questions, ideas, mystery sounds, drawings, and high fives.

[LISTING HONOR ROLL]

[MUSIC PLAYING]

This is our last episode of the year. We've had so much fun answering your questions, reading your fan mail, and listening to your mystery sound submissions. We'll be back next year with another big batch of episodes made especially for you.

SOLEIL: Thanks for listening.