[MUSIC PLAYING]

MOLLY BLOOM: You're listening to *Brains On* from MPR News and Southern California Public Radio. We're serious about being curious. I'm Molly Bloom. The other day here in Minnesota, it snowed, and the flakes were big and fluffy. Looking out the window, it was like we were living in a snow globe. From a distance, snowflakes may all look the same, but they are not.

In fact, there are lots of different shapes of snowflakes. Not just those classic shapes you might try to replicate by making paper cutouts.

MAN: Simple prisms.

WOMAN: Solid column.

MAN: Sheathes.

WOMAN: Scrolls on plate.

MAN: Cups.

WOMAN: Hollow columns.

MAN: 12 branched stars.

WOMAN: Bullet rosettes.

MAN: Capped columns.

WOMAN: Skeletal forms.

MAN: Radiating dendrites.

WOMAN: Arrowhead twins.

MAN: Crossed plates.

WOMAN: Graupel.

MAN: Irregulars.

WOMAN: Simple needles.

MAN: Simple stars.

MOLLY BLOOM: These are just some of the kinds of snowflakes you might see if you were to look at them under a microscope. All different shapes and sizes. Which brings us to our first question.

LUCY: Hi. My name is Lucy, and I am six years old.

SAM: Hi. My name is Sam, and I'm eight years old. And we're from Colorado. And our question is--

LUCY AND SAM: Why are snowflakes all different shapes?

MOLLY BLOOM: To find the answer, we talked to Ken Libbrecht, a physicist from Caltech who is an expert on snowflakes. First, we have to understand how snowflakes form up in the atmosphere.

KEN LIBBRECHT: It starts out as a water droplet in the cloud. Clouds are made of mostly water droplets. Even when it's below freezing, clouds are often water droplets. They don't freeze yet. But when the cloud gets colder, the droplets start to freeze. But they don't freeze all at once. They start to freeze one at a time.

And when a single droplet freezes, it starts to grow by absorbing water vapor from the air. Water droplets are liquid water. So it's just like liquid water on the ground, except in small droplets. But when the water evaporates, it turns into a gas. So the molecules are all separate. And that water vapor is supplied by the other droplets that are still liquid, and those evaporate. And it ends up about 100,000 water droplets evaporate in the process of making one snowflake.

MOLLY BLOOM: And when the water molecules form snowflakes, they're actually forming crystals. In crystals, molecules line up in a nice, orderly fashion.

KEN LIBBRECHT: Crystal is a solid in which all the molecules or atoms are lined up in a regular array. So just think of them as building blocks, and the blocks all stack together a certain way. And that's what a crystal is.

MOLLY BLOOM: And the kind of crystals that water molecules like to form are six-sided. Those are called hexagonal crystals.

KEN LIBBRECHT: The molecules are not themselves hexagonal, but they tend to hang on to one another. And the way they like to stick together is the hexagon. It's not the only way molecules can stick together. Sometimes they form cubic structures. Salt is a cubic structure. If you look at the grains of salt that come out of a salt shaker, they're little tiny cubes. And you can see that if you just use a magnifying glass. And with snowflakes, it's hexagonal. So it's just the way the molecules like to hang on to one another.

MOLLY BLOOM: So snowflakes are hexagonal. But that doesn't mean they all resemble stars. Some are long and skinny and look like needles or columns. Others are flat like plates. And some branch to make those pretty star shapes. So back to that original question.

LUCY AND SAM: Why are snowflakes all different shapes?

KEN LIBBRECHT: We don't actually even understand that exactly yet. They'll make a rod or a column. The ends grow faster than the middle. And the opposite is true for a plate or a star. That behavior depends on temperature. For example, if you want really nice stellar snowflakes, those tend to form only when the temperature is around -15 Celsius. Columns like needles and things grow at minus 5. So temperature plays a big role.

Humidity also affects things. The higher the humidity, the faster the crystals grow. And just the nature of the cloud and whether there are a lot of droplets in the cloud. Whether the crystals form low to the ground or way up high in the atmosphere. It all affects the way they look when they fall on your sleeve. And it just has to do with how the water molecules stick to the ice. And this is something we still don't understand very well, oddly enough.

MOLLY BLOOM: But we understand the answer to this next question a little better. It was sent to us by Oliver, who lives in Thailand.

OLIVER: I want to know why two snowflakes are never the same.

MOLLY BLOOM: Ken will share the answer with us in just a bit. But first, we must interrupt this very important snowflake discussion for the mystery sound.

[MYSTERY SOUND CUE]

WHISPERING VOICE: Mystery Sound.

MOLLY BLOOM: Here it is.

[RATTLING]

Any guesses? Let's hear it again.

[RATTLING]

We'll be back with the answer after this.

[MUSIC PLAYING]

We want to let you know about a giveaway that we're having. If you head to our Facebook page, you can find a link where you can enter for a chance to win your very own Brains On pocket-sized whoopee cushion. The perfect size for stealthy hiding and noise making at your convenience. The deadline to enter is January 31st, and we will pick 10 people to win. Head to our Facebook page to find the entry link with more information and the official rules.

You can also email us any time with questions, mystery sounds, and high fives. Our email address is brainson@m-- as in Minnesota-- pr.org. Or if you'd rather send us an actual letter through the post, you can find our mailing address at our website, brainson.org. While you're there, you can also find all our past episodes, too.

And now is the time in every episode where we honor the curious kids who keep this show going with their ideas, creativity, and high fives. Here's the latest group of kids to be added to the Brains Honor Roll.

[MUSIC PLAYING]

[LISTING HONOR ROLL]

(SINGING) Brains Honor Roll. High five.

MOLLY BLOOM: Now back to that mystery sound. Let's hear it one more time.

[RATTLING]

Here's a hint. You might keep these on a chain or a ring. Ready for the answer? Here it is.

ERIN: That was the sound of a key turning in a lock. I like that sound because when we hear it, my brother and I both know our mom or dad is home. I'm Erin, and I'm six years old. And my brother Ezra is 1 and 1/2, and we're from Mountain View, California.

MOLLY BLOOM: Thanks, Erin. Now back to this question from Oliver.

OLIVER: I want to know why two snowflakes are never the same.

KEN LIBBRECHT: When they grow in the clouds, the way they look depends on the path they take to the clouds, because the growth changes with temperature and other things. And so since no two snowflakes all have exactly the same path, no two snowflakes really look exactly alike. There's a lot of things that can happen up in the sky. And they all do at some time or another.

For example, the water droplets can combine to form raindrops, which are big. And they're big enough to fall. And then the raindrops can freeze on the way down. And those are called sleet particles. And they're not at all like snowflakes. They look like frozen drops of water, which is what they are. What makes the snowflake special is that it forms from water vapor. And yeah, the water molecules attach to the ice a certain way, and that's what gives them their structure.

MOLLY BLOOM: And Ken's research is all about better understanding how snowflakes and crystals grow.

KEN LIBBRECHT: Well, I really got into this from the science end, which is just trying to understand how crystals grow. Just a question of how the world works. I mean, we see these things growing all the time. And we don't really understand all the details. And we'd like to. I mean, the more you understand about how things work, the more you know, the more can do.

Right now, we use crystals for all sorts of things, like making computers and cell phones. But we don't really understand a lot of the details. When we see them, we can make them. It's a little like cooking. You can have a recipe and you can make something. And that's not the same as understanding how it works. But the more you understand, then you can try different recipes.

MOLLY BLOOM: And even though we don't know everything, Ken understand snowflakes really well.

[MUSIC - IDINA MENZEL, "LET IT GO"]

In fact, he understands them so well, that he was the snowflake consultant on the movie *Frozen.*

KEN LIBBRECHT: You know, Disney was very good. They knew there'd be a lot of snowflakes in the movie, and they wanted to make sure they got them right. And I showed them a lot of pictures of snowflakes. And I guess I convinced them at least to make them all six-sided, which not everyone does. And they did, so I was pleased with that.

(SINGING) The snow glows white on the mountain tonight, not a footprint to be seen.

MOLLY BLOOM: Ken is based in Southern California, where it doesn't really snow. So he makes his own snowflakes in the lab.

KEN LIBBRECHT: Get a freezer, something cold. And just some water. And I'll heat the water up, and water vapor will come off and cool down the water vapor. And it automatically starts to grow as ice. And so it's really just a question of controlling that process. But the crystals form all on their own. You really just have to get the cold and water together, and you start to form ice crystals.

MOLLY BLOOM: If you head to our website, you can see some really cool photos of snowflakes that Ken has taken and get some ideas for some cool snowflake related activities you can do, even if you don't live in a cold climate. You can preserve snowflakes in glue, make ice spikes, or cut some scientifically accurate paper snowflakes. Ken also has a book out featuring some of his gorgeous snowflake photos. Find the link at our website, brainson.org.

That's it for this episode of *Brains On.* Thanks to Matty Mehan and Phil Pacardi for lending their vocal talents. We'll be back soon with more answers to your questions. Thanks for listening.

[VOCALIZING]

MUSIC CUE: Brains On.