

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.

MOLLY BLOOM: Harvey, what time is it?

HARVEY: Molly, you have 30 minutes until Ivy arrives for the taping.

MOLLY BLOOM: Thanks, Harvey, you marvelous, omnipresent virtual voice assistant. Just enough time for lunch. Let's see what's in the fridge. Hmm. Should I have noodles and cottage cheese or cottage cheese and noodles?

MOLD: Molly?

MOLLY BLOOM: Ah, who said that?

MOLD: Molly, is that you?

MOLLY BLOOM: Yes, I am Molly. Who are you? Where are you? What are you?

MOLD: It's me, the mold growing on your very old fruit salad.

MOLLY BLOOM: [GASPS] You are sentient.

MOLD: Yeah, yeah, I talk, I think. So can you. No big deal.

MOLLY BLOOM: Actually--

MOLD: Just wondering if you had any plans to get me out of here.

MOLLY BLOOM: No, of course not. I would never throw you in the garbage.

MOLD: Oh, but you see, I really, really want to get out of here.

MOLLY BLOOM: You do?

MOLD: The cold in here really slows me down.

MOLLY BLOOM: Oh, right.

MOLD: And there's only so many times I can read the back of the cottage cheese container, you know? I want to get out there and see the world, let my spores free. Maybe they could find some nice fruit to grow on in an orchard, maybe make it out by the ocean. This fridge is chill and all, but it's really, really boring.

MOLLY BLOOM: Oh, gosh. OK, to the compost you go.

HARVEY: Molly, Ivy has arrived for the taping.

MOLLY BLOOM: Oh, shoot. Well, I guess you're coming to the studio with me first, then compost.

MOLD: A studio? Time for my warm-ups. (SINGING) Mycelium makes up a mold like me. Mycelium makes up a mold like me.

[MUSIC PLAYING]

MOLLY BLOOM: This is *Brains On* from American Public Media. I'm Molly Bloom. And this is Ivy from Portland, Oregon. Hi, Ivy.

IVY: Hi.

MOLLY BLOOM: We've cooked up an episode all about food and fungus.

MOLD: A perfect pairing.

IVY: Molly, you brought your moldy fruit salad into the studio, and it's talking.

MOLD: Of course she brought me. Nice to meet you. I'd offer to shake your mycelium, but, you know, you don't have that, so. But don't worry. You guys do your taping. I'll be over here making spores. [GRUNTS]

[POPPING]

MOLLY BLOOM: OK. You can listen to our last episode to learn all about fungus. Mold, like my pal over here, is a kind of fungus. So Ivy, have you ever seen mold show up in food?

IVY: There was this one time we had a thing of pancake batter in the fridge. And it was really old. And it got like kind of grayish blue on the top. And it was gross.

MOLLY BLOOM: Did it get fuzzy at all?

IVY: It was like kind of slimy looking.

MOLLY BLOOM: My favorite molds are the fuzzy ones. They're kind of cute almost.

IVY: Yeah, they kind of look like caterpillars.

MOLLY BLOOM: So mold likes food for the same reasons that we do. It digests food's nutrients and uses those nutrients as fuel.

IVY: To spread, mold sends spores out into the air like our fruit salad friend is doing right now.

MOLD: Don't worry about me. I'm doing great. [GRUNTS]

[POPPING]

Cute spore I made. [GASPS] Yes, aren't you so cute?

MOLLY BLOOM: And when those spores happen to land on something delicious, they start to grow. But can we get some ocean sounds so the mold doesn't hear this part?

[WAVES ROLLING]

MOLD: Nice ocean sounds. Love the ambiance.

IVY: Nice vibes, right?

MOLD: What?

MOLLY BLOOM: Perfect. Some of the mold that show up on food can make you sick.

IVY: So we have ways to keep fungus away from food.

MOLLY BLOOM: Containers and food wraps make it harder for spores to land on your leftover spaghetti.

IVY: Stashing food in the fridge also makes it harder for mold to grow. Water and nutrients travel around slower in the cold, so it can't grow that fast.

MOLLY BLOOM: Preservatives like salt and other chemicals also make it harder for mold to take hold.

IVY: So if mold does start growing on food, is it best to toss the whole thing?

MOLLY BLOOM: That's mostly true for foods that are wet and spongy. Fungus can spread all the way through these foods, making them unsafe to eat.

IVY: Think bologna, bread, burritos, and breakfast casseroles.

MOLLY BLOOM: But for firm fruits and veggies like carrots or hard cheese like Parmesan, it's OK to chop off the moldy chunk and use the rest. OK, I think mold can hear the rest of this now. Even though there are some kinds of fungi you definitely don't want to eat, there are lots of kinds that are safe for humans to eat.

IVY: Those mushrooms in your stir fry, they're fungus that's safe and delicious to eat.

MOLLY BLOOM: And there are lots of other foods that you eat where you might not realize fungus is involved, but it's actually a key ingredient.

MOLD: That's what I like to hear.

IVY: Yeast is a fungus that makes bread rise.

MOLLY BLOOM: Some cheeses use molds for flavoring.

IVY: And fungus helps ferment lots of other foods, including chocolate, tempeh, and pickles.

MOLLY BLOOM: So how did humans figure out which fungi are safe to eat in the first place? *Brains On* producer Menaka Wilhelm looked into this for us.

IVY: Hi, Menaka!

MENAKA WILHELM: Hello! Let's start with mushrooms. It's kind of surprising that we started eating them.

STEPHANIE SCHNORR: Fungal species can do a lot of really nasty things to us too. They can make us sick. They have toxins. Certain species attack other animals.

MENAKA WILHELM: Stephanie Schnorr studies what humans have eaten throughout history. And because there are some not so fun fungi out there, you've got to be able to pick which mushrooms to eat and which to leave alone. But that's never stopped us. Some of our earliest mushroom-eating evidence is 49,000 years old in Neanderthals. Neanderthals were a human species similar to ours. Let's listen into the Savory Tooth Tiger Cafe, where a Neanderthal is about to eat a meal.

[BELL DINGING]

SUBJECT 3: Yes, hello. I'll have a woolly rhino and sheep burger with extra mushrooms. Oh, and do you have a Neanderthal discount?

SUBJECT 4: No. One burger, extra mushrooms coming right up.

MENAKA
WILHELM: OK, so Neanderthals didn't eat burgers specifically, but we do know they ate stuff like this. Laura Weyrich is the person who discovered that Neanderthals ate woolly rhino, ancient sheep, and mushrooms. And she found a clever way to do that.

LAURA
WEYRICH: So we actually go into old skeletons, and we clean their teeth.

MENAKA
WILHELM: I love a story where ancient tooth gunk becomes knowledge. Laura actually analyzed very old DNA to figure out that mushrooms were part of that tooth gunk. She would also like to point out Neanderthals were really smart. They use tools. They had complex societies.

LAURA
WEYRICH: They took care of old people. They shared knowledge.

MENAKA
WILHELM: And sharing knowledge is a huge part of mushroom eating. A long time ago, there were no stores or even farms. So humans had to eat what they could find in the wild. But if people shared tips about what was safe to eat, everyone got better meals. So people ate what their families and neighbors were into depending on where they lived.

And different traditions around mushrooms popped up all over the world. Like if you think about Japanese food or Chinese food, lots of mushrooms. People in East Asia also passed around info on using mushrooms for medicine.

Over in England, people didn't eat nearly as many mushrooms. Mushrooms still grew there, but maybe people were just into other foods. So less fungal knowledge spread around. In other parts of Europe like Italy and Russia, lots of old recipes feature fungus. And even now, eating mushrooms kind of connects us to our hunter-gatherer origins. We can farm some mushrooms, but other mushrooms grow in such specific ecosystems that they really only exist in the wild.

STEPHANIE
SCHNORR: And so you still have to forage for them. So they still are a wild component of our diet.

MENAKA
WILHELM: Forage means to go looking for something. And to forage, we still need shared knowledge to know which mushrooms are good and where to find them, not so different from the Neanderthals. Because edible mushrooms can look pretty different from other foods.

Take morel mushrooms. They're all wrinkly like they're trying to copy undersea coral. Or have you ever heard of the bearded hedgehog? It's worth a Google. It's an edible mushroom that looks like its namesake. You might not know you could eat it unless someone told you.

IVY: Bearded hedgehog? Oh, also called lion's mane.

MOLLY BLOOM: Wow. That is an interesting fungus.

MENAKA Yeah. And besides mushrooms, there are lots of other yeasts and microscopic fungi that we figured out how to eat. People probably discovered those by accident when little, tiny fungi just landed in their food and they shared it. For example, anthropologists think at some point wild yeast floating around in the air landed on a mixture of grain and water, and then people cooked it. And voila, early bread.

And this is still how people make sourdough starters today. And with that, I've got to scoot. I hear chanterelle mushrooms are out, and I've got to go find some.

IVY: Bye, Menaka.

MENAKA See you, Ivy.

WILHELM:

[BIKE BELL DINGS]

SUBJECT 5: Brains, brains, brains.

MOLLY BLOOM: All right. Ivy, are your ears ready to forage for the answer to the--

[ETHEREAL SOUNDS]

SUBJECT 6: (WHISPERING) Mystery sound.

IVY: Yeah.

MOLLY BLOOM: All right. Here it is.

[PLASTICKY GRATING SOUND]

What do you think, Ivy?

IVY: I think it might be either a balloon or when you're in a chair and you scoot it backwards, and it makes that sound.

MOLLY BLOOM: Those are both really good guesses. So sort of like the sound of a chair leg rubbing against the floor.

IVY: Yeah.

MOLLY BLOOM: And for the balloon, what are you imagining there?

IVY: There's sometimes when you blow into a balloon with your mouth and it vibrates, and it makes that noise. And also, when you have a blown balloon and you don't tie it, and you let it go.

MOLLY BLOOM: Totally. Both excellent guesses. We'll be back with another chance to guess and the answer in just a bit.

Hey, Ivy. Guess how long our Sun has been hanging out with the same planets.

IVY: Hmm. Four and 1/2 billion years?

MOLLY BLOOM: Yes, that is exactly right.

IVY: Seems like the Sun might be ready for some new friends.

MOLLY BLOOM: I would be. So Ivy, if you could add a planet to our solar system, what kind of planet would you add?

IVY: It would probably have to be a smaller planet. And I think it would be cool to have a planet with aliens on it or some type of life. I think that'd be really cool.

MOLLY BLOOM: That would be really cool. What would the atmosphere of that planet be like if you visited it? What would it feel like?

IVY: Kind of like Earth, but maybe a little bit less global warming, climate changey thing.

MOLLY BLOOM: Maybe a planet that those aliens hadn't messed up.

IVY: Exactly, a non-messed up planet.

MOLLY BLOOM: I like it. Well, listeners, we want to hear your answers too.

IVY: Send us a quick recording at brainson.org/contact.

MOLLY BLOOM: That's also where you can send mystery sounds and questions like this one.

AKIL: My name is Akil. I am from Georgia. And my question is, how do wood sticks make fire?

IVY: We'll answer that one at the end of the show.

MOLLY BLOOM: And we'll read the latest group to join the Brains Honor Roll.

IVY: So keep listening.

IVY: You're listening to *Brains On* from American Public Media. I'm Ivy.

MOLLY BLOOM: And I'm Molly. Let's take a listen to that mystery sound one more time.

[PLASTICKY GRATING SOUND]

Any new thoughts? Last time, you were thinking balloon or like a chair scraping the ground.

IVY: I have a new guess. There's like those dog toys that are like pigs that make that noise. So maybe like a pig dog toy thing.

MOLLY BLOOM: I love it.

IVY: Yeah.

MOLLY BLOOM: All right, are you ready for the answer?

IVY: Yeah.

MOLLY BLOOM: Here it is.

THEO: My name is Theo.

PALOMA: And my name is Paloma.

THEO: We live in Clinton Corners, New York. And that was the sound of opening and closing a board game.

PALOMA: Box.

THEO: Board game box.

MOLLY BLOOM: OK, so you know when you open a board game box and the sides are stuck together?

IVY: Yeah.

MOLLY BLOOM: Yeah, and it makes that noise.

IVY: That's a good mystery sound.

MOLLY BLOOM: Yeah, it is a good mystery sound. I could see why you would think that was a chair because it's also a rubbing-- two things rubbing against each other.

IVY: Yeah.

MOLLY BLOOM: That's a tricky one. Nice work.

[MUSIC PLAYING]

We started thinking about food and fungus when we heard questions like this one.

LILLIAN: My name is Lillian from Cambridge, Massachusetts. My question is, what is yeast made out of, and why does it make bread rise?

MOLLY BLOOM: But Ivy, you wrote to us about something that goes well with bread-- cheese.

IVY: Yeah. I wanted to know how they make different flavors of cheese.

MOLLY BLOOM: And we can't let that question go unanswered. A cheesemaker's main goal is to break milk down. So besides milk, they add salt and enzymes that turn milk into curds. Then they make different flavors by adding different tiny living things called microbes and also by following slightly different recipes. So for example, Parmesan comes from adding specific bacteria that are different from the bacteria used to make cheddar.

IVY: What about mold? Does that show up in any cheese recipes?

MOLLY BLOOM: It does. So for blue cheeses like Gorgonzola, cheesemakers add mold to the inside of a cheese wheel as it ages. So the blue stuff in blue cheese, yep, that is mold. And the white, soft rind on the outside of brie or Camembert, that's also mold, and it's delicious. But it's not just cheese. Mold and other fungi help make lots of foods.

IVY: Yeah, they're amazingly talented chefs.

MOLLY BLOOM: Wait, like chefs?

IVY: Yeah, they're behind some of the most famous foods ever. Don't you watch *The Fungal Table*?

MOLLY BLOOM: My TV queue is already really long.

IVY: Here, let's watch an episode right now.

[MUSIC PLAYING]

SUBJECT 7: Small chefs, big flavors, average-sized forks and knives-- this is *The Fungal Table*.

GUY I'm Guy Bumbershoot, host of the show and a very good eater. I've been practicing all my life, and most of it
BUMBERSHOOT: ends up in my mouth. Who doesn't need a bib anymore? This guy, most of the time.

Today, our top chefs are going head to head-- hmm. Do fungi even have heads? But anyway, our top chefs are going mycelium to mycelium. That's good.

It's the final fungal face-off on *The Fungal Table*. Let's meet our first contestant, Chef Penicillium. What are you making today, Chef?

CHEF Well, I figured this is my last chance to impress the judges. I need something with pizzazz, something with
PENICILLIUM: oomph, something so scrumptious it grabs your taste buds by the tail and whips them into a tornado of tastiness that'll knock your socks off and start you singing. Know what I'm saying?

GUY [LAUGHS] Nope, but I'm smiling and nodding anyway.

BUMBERSHOOT:

CHEF I decided to make my signature dish, salami.

PENICILLIUM:

GUY Ah, yes, salami, sometimes called spicy meat tube or pork and beef chewy stick.

BUMBERSHOOT:

CHEF Literally no one calls it that. Salami is a cured sausage that tastes great on sandwiches.

PENICILLIUM:

GUY And terrible on cake. Well, tell us, how do you plan to prepare it?

BUMBERSHOOT:

CHEF Well, have you ever seen a splendid salami in a deli or at a store?

PENICILLIUM:

GUY Indeed, I have.

BUMBERSHOOT:

CHEF And you know how it's covered in a fine, white powder? That's actually me, Penicillium. First off, yes, I'm
PENICILLIUM: supposed to be there. I'm totally safe to eat. And actually, I'm delicious.

I'm added to salami to coat the casing. I grow wild and free all over that sausage, creating a nice, white, whimsical coat. That does two things.

First, it stops other harmful fungi or bacteria from growing there. Because I'm all, hey, that's my turf. Back off, bacteria. Forget about it, other fungi. Second, my coating adds extra flavor. Because like I said, I'm delightfully delicious and decidedly devourable.

GUY Whoa, fungi that makes spicy meat tubes even tastier. Well, that's a winning combo.

BUMBERSHOOT:

SUBJECT 8: Oh, yeah.

GUY Our next chef is already hard at work. Chef Yeast, what are you making today?

BUMBERSHOOT:

CHEF YEAST: Hey, Guy. As you can probably tell from the flour and water all over my workstation, I'm making bre--

GUY Bresagna.

BUMBERSHOOT:

CHEF YEAST: What?

GUY You're making bresagna, right?

BUMBERSHOOT:

CHEF YEAST: No, I'm making bread. What even is bresagna?

GUY It's lasagna cooked in a brassiere.

BUMBERSHOOT:

CHEF YEAST: Oh, Guy, you're so funny.

GUY [LAUGHS] I actually eat that.

BUMBERSHOOT:

CHEF YEAST: Ha, good one. I'm making bread. I'm a yeast fungi. We're single-celled living organisms and a key part of a lot of baking. You see, when you add yeast like me to your flour and water mixture, I start gobbling up sugars in the flour. Of course, all that noshing makes me a little gassy.

GUY Who can relate to that?

BUMBERSHOOT:

[TOOTING]

This guy.

CHEF YEAST: Ha, good one. So I start releasing a gas called carbon dioxide. And what does that gas do? It rises.

So the gas I make makes the bread rise. It creates those delicious tiny pockets of air in bread that give it a light, fluffy texture. Plus, my yeasty goodness can add aromas and flavors to the finished product.

GUY My gas also gives off aromas. It makes my cat leave the room.

BUMBERSHOOT:

[MEOWING]

CHEF YEAST: You're such a nut, Guy.

GUY Actually, I'm allergic to nuts. OK, our final contestant, *Aspergillus oryzae*. Wow, nice to meet you.

BUMBERSHOOT:

ASPERGILLUS We've literally met 10 times before.

ORYZAE:

GUY No, the pleasure's all mine. Now, tell me, what are you concocting here on *The Fungal Table*?

BUMBERSHOOT:

ASPERGILLUS Well, I'm working on a very old recipe, one that dates back over 2,000 years. It's soy sauce.

ORYZAE:

GUY Ah, yes, a brown sauce made of fermented soybeans and roasted grains. It's believed to have originated in the

BUMBERSHOOT: Western Han dynasty in ancient China. And it's famous for its strong umami flavor.

[BELL DINGS]

ASPERGILLUS That's actually correct.

ORYZAE:

GUY Who's just as surprised as you are that he knew something? This guy.

BUMBERSHOOT:

ASPERGILLUS Anyway, as you mentioned, soy sauce is made from soybeans and grains. In soy sauce preparation, fungi like me

ORYZAE: are added to the mix.

GUY Some soy sauce makers even let fungi from the air around them settle into the mixture.

BUMBERSHOOT:

[BELL DINGS]

ASPERGILLUS Wow. Again, correct. Maybe I misjudged you. As fungi, we help break down the grains and create proteins and

ORYZAE: simple sugars. Other microorganisms also get in on the action too.

GUY Like the bacteria *Lactobacillus*, which can add acidity to the brew.

BUMBERSHOOT:

[BELL DINGS]

ASPERGILLUS Right. Wow, you really know your stuff, Guy. And together, we turn those grains and beans into a delicious, salty,

ORYZAE: savory sludge. Then you just squeeze out the liquid from that sludge, and you've got yourself the tastiest sauce the world has ever known, soy sauce.

GUY And you can brush your teeth with it.

BUMBERSHOOT:

ASPERGILLUS And he's back.

ORYZAE:

GUY That's how I get my teeth so sparkly brown. See? Eee!

BUMBERSHOOT:

ASPERGILLUS I'm just going to go work over here far from you. And go to the dentist! Teeth shouldn't look like that.

ORYZAE:

GUY So who will win? Which fungal chef is the best of the best? Let's see what the judge says.

BUMBERSHOOT:

JUDGE: It's delicious!

CHEF YEAST: Which one?

JUDGE: This salami and soy sauce sandwich on freshly baked rolls. Whoever made this one is the clear winner.

ASPERGILLUS I think she combined our meals.

ORYZAE:

CHEF CHEF YEAST: Those were definitely destined to be distinct dishes.

PENICILLIUM:

JUDGE: No. They definitely taste better together. Everyone wins, especially me. I get to keep eating.

GUY There you have it, a surprise three-way tie here on *The Fungal Table*. And remember, sometimes it takes a

BUMBERSHOOT: microorganism to satisfy a mega appetite.

JUDGE: Oh, you know what this would go great with? A hot bresagna.

GUY Right? So delicious. I love bresagna.

BUMBERSHOOT:

[MUSIC PLAYING]

IVY: Mold likes food for the same reasons we do. Covering your food and refrigerating it can help prevent mold from eating our food before we do.

MOLLY BLOOM: Some fungi are not safe for us to eat, but lots are. In order for us to know which ones are safe, humans had to do a lot of learning and then pass along what they learned.

IVY: Humans eat some fungi whole, like mushrooms, but we also use them as an ingredient, like yeast in bread or mold in cheese.

MOLLY BLOOM: That's it for this episode of *Brains On*.

IVY: It was produced by Marc Sanchez, Menaka Wilhelm, Sanden Totten, and Molly Bloom.

MOLLY BLOOM: We had production help from Ruby Guthrie, Christina Lopez, and Rose Dupont. Engineering help from Veronica Rodriguez. Special thanks to Adam and Gretchen Risdale, George Wong, Sam Choo, Micah Keidan, Jennifer Lai, and Alex Flood.

IVY: *Brains On* is a nonprofit public radio program. You can support the show at brainson.org/fans.

MOLLY BLOOM: There, you can find links to donate, or join our free fan club, or check out our new *Brains On* merch.

IVY: We now have *Brains On* shirts, baseball hats, and face masks.

MOLLY BLOOM: And you can buy the *Brains On* book there too. That's brainson.org/fans.

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

[PEOPLE UM-ING]

AKIL: How do wood sticks make fire?

VERA: For two wood sticks to make fire, they have to get hot enough to create gases that can catch on fire. Hi. My name is Vera. And I study fires.

To get from rubbing two sticks together to a flame, what happens is as you rub the sticks together because of friction, everything seems to get hot. It's like rubbing your hands together really fast to get your hands warm. It creates that heat. And as you keep generating more and more heat, it starts to break apart the bonds or the molecules inside the wood so that they start to, what we say, evaporate or vaporize.

And that's what creates the fuel for the fire. You have to go through this process of taking a wood stick, getting it hot enough that you can break apart the molecules inside of it so it can create hot gases, and keeping it hot enough that those gases also catch on fire. That's why when you look at a match or even just a stick of wood burning, you can see that the stick really isn't on fire, that the flame is actually slightly above the wood stick.

[PEOPLE UM-ING]

MOLLY BLOOM: This list of names is hot. It's time for the Brains Honor Roll. These are the incredible listeners who shared their questions, ideas, mystery sounds, drawings, and high fives with us.

[LISTING HONOR ROLL]

Brains On will be back soon with more answers to your questions.

IVY: Thanks for listening.

MOLLY BLOOM: All right, mold buddy. You've been so patient. To the compost you go.

MOLD: I'm free! Ta-ta, Molly. Oh, look, bananas.