Ask-a-Biologist Vol 054 (Guests: Rebecca Fisher and Elizabeth Hagen)

Bats, Bones and Biology

Here is something special you can add to your trick-or-treating this year. Find out if there are vampire bats waiting to drink your blood - or if we really have a funny bone in our body? These are just a few of the things Dr. Biology and his guests Rebecca Fisher and Elizabeth Hagen talk about on this show. You can even listen to some real bat chatter.

Transcript

[music with sound effects]

Dr. Biologist: This is Ask-a-Biologist, a program about the living world, and I'm Dr. Biology. Today, we're headed into the world that some might say or call spooky, filled with bats [sound effects], bones, [sound effects] and for this show, the biology behind them.

Sure, we can think of all kinds of creepy things. When October comes around, you can't help it. It's Halloween after all, the perfect time to think about bats flying in the air and skeletons coming out of the closet. It also makes for a perfect show. We have two scientists in the studio today who'll be able to add some biology to your trick-or-treating this year. One is an expert on bats, while the other is big on bones, and in her case, also studies some really big bones.

Rebecca Fisher is a faculty member in the School of Life Sciences and also one of the faculty in the University of Arizona College of Medicine, Phoenix, in partnership with Arizona State University. That's a mouthful, I know.

As part of her research, she has studied the skeletons of hippos and red pandas. If you've ever seen the hippo, you can imagine how big some of those bones are. I want to find out just what she's learned, and why we might want to study the skeletons of animals.

My other guest is Beth Hagen, a graduate student also in the School of Life Sciences. Beth has been spending a lot of time studying the only mammal that can fly: bats. Sure, there are animals such as birds and insects that can fly, but bats are the only mammals that can fly. Today, we get to find out if bats are really blind, and just how do they get around at night? Since this is a Halloween time of year, just what can we learn from the skeleton in the closet? Welcome to the show, Rebecca. [sound effect - door slams shut]

Rebecca: Thank you.

Dr. Biologist: And Beth, thank you for joining us.

Beth: Thank you.

Dr. Biologist: Beth, last night I was watching this vampire movie, and it's actually kind of funny, but he had a lot of bats and you know what? They had them drinking blood. So do bats really drink blood?

Beth: Most bats actually eat insects. Some eat fruit. Some even eat frogs, birds, and fish, but there are a few species that eat blood, or I guess I should say drink blood.

Dr. Biologist: Oh, OK. Do I have to watch when I'm going out at night that I don't have some bat swooping down and drinking my blood?

Beth: Not at all. So the three species of bats that drink blood, and I should also tell you that they're called vampire bats.

Dr. Biologist: Oh, perfect for Halloween.

Beth: Exactly. These bats only live in Central and South America.

Dr. Biologist: What kind of blood are these bats drinking?

Beth: Vampire bats mainly go after livestock, so they're going to drink blood from cows and sheep and horses. Vampire bats don't actually drink that much blood. What they do is they often go up to a sleeping cow or horse and make a small little cut on the foot of the cow, and drink a little bit of blood. Usually it's less than two teaspoons. Then they fly away. Well, I should say they kind of crawl away because they're pretty full after drinking two teaspoons of blood.

Dr. Biologist: OK, so two teaspoons sounds like a little bit, but if they're that full, these must not be really big bats.

Beth: They're not very big bats at all, so two teaspoons of blood for the cow is nothing. Oftentimes the cow doesn't even wake up when the bat is feeding from it. But for the bat, it almost doubles its body weight, and so it has a hard time flying after it's drank the blood from the cow.

Dr. Biologist: We're talking about these little bats. Are all bats little?

Beth: No, actually bat size is really diverse. Of course, there are some little bats.

Dr. Biologist: How little are we talking about?

Beth: We're talking the size of a human thumb. That's really small. These are bumble bee bats and they live in Thailand. These bats actually weigh less than a penny.

Dr. Biologist: Less than a penny, bumble bee bats. Hey, I like the name already. What do you think, Rebecca?

Rebecca: Does that include their wings, or just their bodies?

Beth: That's just their body when their wings are tucked close to their bodies. Their wingspan is about six inches, so they're a little bit bigger when they're flying around.

Dr. Biologist: I see. And so how big do they get?

Beth: The biggest bat in the world is the flying fox and their wingspan is six feet.

Dr. Biologist: Six feet!

Beth: Six feet.

Dr. Biologist: Whoa! I didn't think bats got that big. Did you?

Rebecca: I didn't, and I'm glad I've never seen one that big.

Beth: The reason you've probably never seen one is that these are Old World tropical bats. These bats live in places like Australia, the Philippines, Indonesia, places like that. Here in the United States, we're not going to see flying foxes, unless you go to your local zoo. They might have some.

Dr. Biologist: I've also heard people use the phrase "he or she is blind as a bat." Are bats really blind?

Beth: A lot of people think that bats are blind because they're active at night. This is simply not true. Bats can see quite well; in fact, some bats have excellent vision.

Dr. Biologist: Would it be better than ours?

Beth: For some bats, it might be.

Dr. Biologist: Wow, OK. Do they get around by using their vision?

Beth: They don't. So again, bats are active at night and just like humans, we can't see in the dark. Neither can bats. The way that bats get around at night, the way they find food and shelter is they use something called "echolocation."

Dr. Biologist: OK, echolocation. Is that something like sonar?

Beth: It's a little like sonar. Echolocation is basically a process where bats are producing sound waves. We call these "bat calls" and the sound waves are produced in the bat's voice box. The sound waves leave the bat's mouth and travel into the environment. If those sound waves hit an object-and that object could be an insect, a tree, a building-an echo is produced and that echo bounces off the object and comes back to the bat. Once the bat hears the echo, it gets a sense of where that object is in space.

Dr. Biologist: Wow. So they can hear these echoes. That must be really, really sensitive.

Beth: It's pretty amazing. The other thing to remember about these bat calls is that they're ultrasonic, which means they're at a frequency above what humans can hear. But the bats can hear them. Actually, the calls that the bats are making are so loud, that when the bats are producing the call, there's a muscle that closes in their ear so that they don't go deaf by their own bat call.

Dr. Biologist: That's interesting that you mention humans can't hear bats because they're ultrasonic.

Beth: That's correct.

Dr. Biologist: So, being curious, I was doing some research before the show, mainly wondering what they sound like and I found one of the USGS sites -- that's the U.S. Geological Survey site -- and they have some very nice recordings of bat calls made with a special recorder that lets you actually hear what the bat calls sound like. With their permission, I thought it would be fun to listen to some bat chatter. What do you think?

Beth: That sounds like a great idea.

[bat call played – clicking sounds]

Dr. Biologist: Alright, do they all have this clicking sound?

Beth: A lot of bats will have this clicking sound, but one thing I noticed about this bat is there were times when the clicks were pretty slow and then they speed it up. When the bat calls are speeding up, that's telling me something about what the bat is doing. It's going after insects.

Dr. Biologist: Oh, so it's zeroed in on its prey and is going after them.

Beth: Exactly.

Dr. Biologist: OK, so that's a bat that we wouldn't be able to hear without this recorder.

Beth: Correct.

Dr. Biologist: There's another bat that they had on the site, which is a Western Mastiff bat that actually has a call that's low enough in frequency that if you have good hearing, you can hear it. Let's listen in.

Beth: OK.

[second bat call played – clicking sounds]

Dr. Biologist: Now that sounds different to me than the first call.

Beth: It does. That bat is most likely not going after insects. You notice that the calls were very far apart, and so most likely, the Western Mastiff was flying through space searching for food, but hadn't found any.

Rebecca: Can other animals hear the bat calls?

Beth: There are some animals. There are actually some insects, specifically some moths and some beetles, that can hear the ultrasonic call produced by the bat.

Dr. Biologist: A lot of people might be wondering, why do we need bats? Because a lot of people are kind of freaked out by a bat. It's not their favorite thing and I suppose that's why we put them in these spooky movies. What would the world be like without a bat?

Beth: For one thing, there would be a lot more insects flying around. For example, one little brown bat can eat 1,200 mosquitoes in an hour.

Dr. Biologist: In an hour?

Beth: That's a lot of insects.

Dr. Biologist: That's great, because who wants to get bitten by a mosquito, right?

Beth: Exactly. Think of all the bug spray you wouldn't have to use.

Dr. Biologist: How many kinds of bats are there?

Beth: There are about a thousand different kinds of bats.

Dr. Biologist: A thousand?

Beth: A thousand.

Dr. Biologist: So we know about the smallest and we know about the largest. Is there a really strange bat?

Beth: There are actually a lot of pretty weird-looking bats. I guess my favorite weirdest bat would be the spotted bat that lives here in Arizona. You can find it flying around the Grand Canyon. This bat has huge ears, about half the size of its body. It also has dark black hair with big white spots. I just think it's a very interesting-looking bat.

Dr. Biologist: What's different between the skeleton of a bird and that of a bat? What makes them different and why are bats the only mammals that can fly?

Beth: One thing that bats have that other mammals don't have is their hand and their arms have evolved into wings. It's pretty interesting if you look at the bones in a human and a bat, we have the same bones, except in the bat, they look very different.

So the bat will still have four fingers and a thumb, but the fingers are going to be really, really long. The fingers are actually going to be longer than the forearm. With that, you have a skin membrane that's basically covering their arm and their fingers that will form the wing, which will allow them to fly.

Dr. Biologist: When we talked about the bird bones, they're hollow. They're not hollow like a tube or a straw. They're hollow in the way they're kind of, I wouldn't say honeycombed, but there are air pockets and that keeps those bones really, really light. Bat bones, they are like our bones basically.

Beth: They are.

Dr. Biologist: But they're just really tiny.

Beth: They are really tiny, so bats overall are pretty small animals. We've talked about the flying fox that has a six foot wingspan, but most bats are going to be pretty small. The bats here in Arizona that I've captured range anywhere from five grams to 20 grams. That's not very heavy.

Dr. Biologist: These bats have bones that are very similar to what you and I have. This is the other part of our story today, are the bones. Rebecca's been so great. She's been sitting here, asking you a few of the questions, and you've been learning with me too, haven't you?

Rebecca; I have. It's very interesting, thank you, Beth.

Beth: Oh sure.

Dr. Biologist: This is the thing about science, of course. Just because you're a scientist and an expert in one area, you're not an expert in every area. It's kind of fun to share these things. What I'd like to know is, I got down to the studio to do this podcast and I was able to walk down here.

I have a skeleton, and most of us know without that, we would be just this big blob of goo and we wouldn't really be able to do anything. We probably couldn't even be a good couch potato. What I'm curious about, besides allowing us to move around, what are bones doing for us?

Rebecca: Bones actually do a great many things for you. First of all, they're helping to protect all of your organs. Your skull is protecting your brain, your thoracic cage with your ribs and vertebrae are protecting your heart and lungs as well as some of your abdominal organs like your liver and your stomach and spleen.

Protection of our organs is a huge part of what our skeletons do for us. They also do some very cool things, like the bones in your ear. We have three tiny bones in both of our ears which help convey the sounds that are incoming, which are sound waves, and our brains will interpret these to help us listen to our environment.

Dr. Biologist: Without those bones, we wouldn't be able to hear.

Rebecca: Without our bones in our middle ears, we wouldn't be able to hear.

Dr. Biologist: What else do bones in our body do?

Rebecca: Bones are also very important for storing minerals-think of calcium when you think of bones. So our bones really are storage places for calcium that can then be released when our bodies need it.

Also, another very important function of bones have to do with the cavities within the bones, which have bone marrow. Bone marrow is very important for our bodies because red blood cells and white blood cells and platelets are all produced in the bone marrow cavities.

Dr. Biologist: Wow, that's a lot of work.

Rebecca: It is. They're busy.

Dr. Biology: Alright. Well, you do a lot of research with bones.

Rebecca: I do. I'm a paleontologist.

Dr. Biology: Yeah. And so, you are really interesting in not just in the bones but also the muscles and the tendons and everything the way they all fit together.

Can you tell us just a little bit about what you do? Every day you walk in and start picking up a bone and playing with it?

Rebecca: No, in my laboratory we study living mammals. We study their muscles and their bones in order to help us understand how they get around the landscape, for example. And then paleontologists, who only have the bones to work with can use this information that we collect on living mammals to help interpret how fossil mammals lived.

Dr. Biology: So what the largest bone or skeleton you have studied?

Rebecca: I think the largest that I have spent the most time with are the hippos. Hippos are very large land mammals. I studied them in Africa where they are living today. But I've also worked with elephant bones which are a great deal larger than hippos. Elephants are the largest terrestrial mammals.

Dr. Biology: So how big a bone are we talking about?

Rebecca: An elephant skull would probably be the same size as the circular kitchen table.

Dr. Biology: And can you pick it up.

Rebecca: Absolutely not. [laughs]

Dr. Biology: OK.

Rebecca: They're heavy. Especially the fossilized skulls that I work with which have been turned to stone. So they are no longer the light weight bones or our bodies they are now fossilized.

Dr. Biology: Since we are speaking of large, I'm going to guess the largest bone of a living animals is going to belong to an elephant?

Rebecca: For the terrestrial animals that is true. However, the largest living animals are in the ocean. The whales, and in particular, the blue whale is the largest of the whales.

Dr. Biology: OK.

Rebecca: The largest bones on the planet today are found in the blue whale and in particular their lower jaw bone, which is called the mandible.

Dr. Biology: Wow. OK, what about the smallest bone?

Rebecca: The smallest bone we have already talked about will be those bones that are in the ears of mammals. So smaller mammals like rodent will have very small bones in their ears. And these are called ossicles.

Dr. Biology: Ooh, that's a cool name.

Rebecca: That's a very cool name.

Dr. Biology: Ossicles. So these are the bones in the middle ear.

Rebecca: That's correct.

Dr. Biology: We're not talking about some ear that's between your two ears that is in the middle of your forehead or something?

Rebecca: No, anatomists describe the ear as having three parts. The external ear is the ear you can see on the outside of your body. The middle ear is where our ossicles are and it's an air filled space with these three bones. The inner ear is going to be filled with fluid.

And it's cells in the inner ear that the central nervous system, your brain, are going to interpret as sound.

Dr. Biology: when you talk about bones, it's not unusual to have experienced a bump on the elbow. And it's not always pleasant. It's kind of a sharp pain and it's also pretty common for someone to say, oh, did you bump your funny bone.

It's not feeling very funny to me. So is there a funny bone?

Rebecca: There is not a funny bone in your body. I have often thought that was the wrong way to describe what is happening because it does hurt, not very funny. Your elbow is actually composed of two bones in your forearm, a radius and an ulna.

When you hit your elbow on the surface of a table you are actually pinching a nerve that is passing next to the ulna. And that's what that sensation is. You are actually pinching that nerve as it passes through that area.

Dr. Biology: I was always wondering if it had to do with the bone that runs from the elbow into the shoulder.

Rebecca: The humerus.

Dr. Biology: Which isn't very funny.

Rebecca: [laughs] Good one, Dr. Biology. [laughter]

Dr. Biology: So I thought that hey, you know, you have this humerus and even though it is not very funny when you bump it, it could be that someone is playing on words.

Rebecca: It could be. That's a good hypothesis.

Dr. Biology: OK, well.

Rebecca: That nerve is very close to your distal humerus as well as the ulna.

Dr. Biology: You know another little bit of trivia. You were talking about the three bones in each of our ears, the middle ear. And though I am not really big on memorizing numbers. I don't think that is really important.

If you are out and you are trying to impress your friends if this is the way you impress your friends and someone says, how many bones are in the human body? It's a really easy number. You always remember this because if you add those three bones in each ear it's 206.

So it's kind of an easy way to remember how many bones are in the human body. And speaking of number of bones in the human body, boy I'll tell you, one of the popular questions for Ask-a-Biologist is how many bones are in the human body but not the adult human body, which is what we were talking about. They want to know how many bones are in a newborn or a baby.

This is a tough one to answer but I'm going to have you work through it because I think people would like to know what's going on. Because you have a lot more than 206 when you are born. So the question is did they disappear?

Rebecca: No, we don't have any bones that go missing as we grow older. What's happening is our bones are developing in a fetus as cartilage first. So we have cartilage models which are then going to be replaced by bone as we grow older.

However, when that bone is being laid down it happens in different locations. So for example, in your thigh bone which is called the femur, you are going to have multiple centers of bone formation.

Dr. Biology: Oh. So when you are born you actually have multiple bones that are making up what we call the femur.

Rebecca: That's correct. you're going to have different ossification centers which are separated by cartilage. That cartilage is very important. Without having the cartilage between the bony centers that are developing, we couldn't grow our bones.

Dr. Biology: Oh. I get it. so that's the way for us to grow bigger bones. That's good. Mm.

Rebecca: Yes, that's very important. And eventually those bony ossification centers will meet with each other and all of that cartilage will be replaced by bone and we'll be left with a single femur.

Dr. Biology: Right. And if you want to know where some cartilage is on your body, you can actually touch some very quickly. Just go to the ear, but you can also go to the tip of your nose.

Beth: This is actually very interesting. My research because one of the ways I can tell if a bat that I capture in the field is a juvenile or an adult is I spread their wing out and I look to see if their finger bones have ossified.

And so, if I can shine a light through, basically it's their knuckle and if the light comes through then I know it's a juvenile bat. But if that bone has already ossified, then I say it's an adult.

Dr. Biology: so we've talked about cartilage and we've talked about bone and we've used the word ossification. Let's talk just a little bit about this. What is cartilage and what is bone?

Rebecca: Both are connective tissues. However, the bone has more mineral content than your cartilage.

Dr. Biology: Oh, I see. So that's the main difference.

Rebecca: Yes.

Dr. Biology: That's more rigid, right?

Rebecca: Yes.

Dr. Biology: OK.

Rebecca: They are much more supportive for our body once it has become bone.

Dr. Biology: Right. But we need the cartilage because it's the thing that connects grows and expands.

Rebecca: Exactly.

Dr. Biology: How cool is that! Kind of like a transformation. You are a transformer on your own. We were transformers before there were transformers.

Rebecca: And some of our listeners are transforming right now and your bones are being formed as we speak.

Dr. Biology: Ooh, even when you're sleeping.

Rebecca: Even when you are sleeping.

Dr. Biology: What does it take to have really strong bones.

Rebecca: Drink a lot of milk or dairy products in your diet and get a lot of vitamin D which is important for the absorption of calcium in your body. The best way to get Vitamin D is to go out into the sunshine.

Dr. Biology: Right. And this has been a real problems because we have been taught not to go out in the sun because we are trying to avoid getting skin cancer. So, they say, don't do that or if you out put on your sunscreen. And we've done such a good job of it that some of us are deficient in Vitamin D.

Rebecca: That's correct.

Dr. Biology: So you do need to talk to your doctor about that. that's one thing to think about. Well, on Ask-a-Biologist, my biologists never get out of here without me asking three questions.

I'll start off with Beth. When did you first know that you wanted to be a scientist or a biologist?

Elizabeth Hagen: Wow, that's a good question. I think even when I was a little kid I knew I wanted to be a biologist. I spent a lot of time camping and hiking with my family and I was always picking up rocks to see what was living underneath. I was always asking my questions about things I saw in nature.

So I think even as a little kid I knew that I would be a biologist when I grew up.

Dr. Biology: Not unusual. You probably didn't even know what the word biologist meant.

Beth: Probably not. But I knew that I loved to be outside. [laughs]

Dr. Biology: OK, Rebecca, an a-ha moment for you.

Rebecca: I do remember having an a-ha moment. As Beth described I also loved to be outdoors and I had a dog and we used to just play outside all the time and study rocks and plants, but really when I started going to school I thought I was going to be a writer.

And I was very dedicated to this. I wanted to write novels and poetry. But then I took a class in college and it was an anthropology class. It was about archaeology, which is the study of ancient civilizations.

And that professor inspired me to consider archaeology as a career. And I ended up that summer going on an archaeological dig in New Mexico. On that dig we found a human skeleton. That was my a-ha moment.

When I saw that human skeleton probably had been buried for hundreds and hundreds of years, it really inspired me to learn more about skeletons in general and study our ancient history.

Dr. Biology: And these skeletons have some very interesting stories that they can tell, still.

Beth: They do. The bones speak.

Dr. Biology: The bones speak. I love it. The next thing I'm going to do is take it all away from you. You can't be a biologist. You can't be a scientist. You can use your imagination, even if you don't think you have the skills, you get to be whatever you want or do whatever you want.

What would you do or what would you be if you weren't a scientist?

Rebecca: I think I would be a rock star.

Dr. Biology: A rock star. Well, you mean a musical rock star.

Rebecca: Yes.

Dr. Biology: because there are rock stars of science. So Beth how about you? What if I take it all away from you? Now, you are a graduate student so you have barely gotten started but I'm going to take it all away. You have to pick a different career, what are you going to do?

Beth: You know, one thing I like to do is I really like to cook a lot. And so I love to find new recipes with interesting ingredients that I have never tried before and see what I can come up with.

So I think I might go that route and maybe go to chef school and become a chef, open a restaurant, something like that.

Dr. Biology: Yes, well, I can see that. And I'll let you get away with it but that sounds like experimentation to me, which is what we all are doing whether we are scientists or not. So it fits beautifully.

Rebecca, what advice would you have for someone who wants to be a scientist?

Rebecca: I think the most important thing is to keep an open mind and to keep learning and to try new things. If I hadn't had that open mind I might never have switched my career path from a writer to a scientist.

I think you have to be ready to explore your world and don't have any preconceived notions of what you are going to be when you grow up.

Dr. Biology: Now, do you still write in your spare time?

Rebecca: This is the good thing about being a scientist. Writing is incredibly important for what we do. We write papers. We write books. We write grants to get money to do our research. So yes, writing is still very much a part of my life.

Dr. Biology: Now, Beth, you are just starting out in your career.

Beth: I am.

Dr. Biology: What advise would you have and it should be really close to home. What would you say to someone that says, you know, I think I want to be a scientist? I really love my biology class.

Beth: I think the advice that I would give is to figure out what you're passionate about. What fascinates you? What keeps you up at night, because you are just so excited about learning about whatever that subject is and pursue that, because if you love it then you're going to enjoy what you are doing.

And it's easy to make a career out of something that you absolutely love.

Dr. Biology: Right, passion. We hear that a lot on Ask-a-Biologist. Not to be underrated. Professor Fisher and Beth Hagen, I want to thank you both for being on Ask-a-Biologist and helping me with the Halloween "Bats, Bones and Biology" show.

Beth: Thank you.

Rebecca: Thank you, Dr. Biology. Happy Halloween.

Dr. Biology: Are you going trick or treating, Beth?

Beth: I think I might stay and pass out candy.

Dr. Biology: Pass out candy? How about you, Rebecca?

Rebecca: I'm going to do the same and carve some pumpkins.

Beth: Ooh, that sounds like a good idea.

Dr. Biology: OK, well if you are going trick or treating character I can see Beth. She would go as the bat.

Beth: I have dressed up as a bat before.

Dr. Biology: Have you? How about you, Rebecca? Have you been a skeleton?

Rebecca: No! I haven't. I like Beth's bat idea. I might do that one year.

Dr. Biology: Well, you have been listening to Ask-a-Biologist and my guests have been biologists Rebecca Fisher and Beth Hagen from the ASU School of Life Sciences.

For those who might like to color or know someone else who is hooked on coloring pages, we have a fun bone-related coloring page on the Ask-a-Biologist website. It's called yoyo skeleton and can be downloaded for free from our Experiments and Stuff page.

We also have a brand new article called "Bats" and it's by Beth Hagen. So you will want to check that out.

The Ask-a-Biologist podcast is produced on the campus of Arizona State University and is recorded in the Grass Roots Studio, housed in the School of Life Sciences, which is an academic unit of the College of Liberal Arts and Sciences.

Remember, even though our program is not broadcast live, you can still send us your questions about biology, using our companion website. The address is http://askabiologist.asu.edu. Or you can just Google the words Ask-a-Biologist. I'm Dr. Biology.