**Good Thinking! — Natural Selection: Common Misconceptions**

(DESCRIPTION)

[00:00:00.01] Logo, Smithsonian, Text, Science Education Center. A cartoon school.

(SPEECH)

[00:00:03.42] [SCHOOL BELL RINGING]

[00:00:05.37] [THEME MUSIC]

(DESCRIPTION)

[00:00:06.29] Students at desks. A teacher points to a drawing of the brain on a chalkboard. Text, Good Thinking! The Science of Teaching Science. Natural Selection. Common Misconceptions. Classroom.

(SPEECH)

[00:00:15.62] [UPBEAT MUSIC]

[00:00:18.58] Now, as you can see, the flowers of these two plants are shaped quite differently. Does anyone have any ideas about why the flowers of this orchid might look different from other types of flowers, like the ones on this cactus?

[00:00:31.51] Oh, Miss Reyes, I know. I know.

[00:00:34.36] [CLEARS THROAT]

[00:00:35.14] I think maybe Dimitri wants to be called on.

[00:00:38.71] I bet it's bright and weird-looking because it's poisonous. You know, how like poison dart frogs are crazy colors.

(DESCRIPTION)

[00:00:48.27] Book.

(SPEECH)

[00:00:48.79] It's called warning coloration.

[00:00:51.91] It's not poisonous. My mom got one of those at [INAUDIBLE] Mart.

[00:00:55.90] It is true that many species can signal with their coloration. Let's hear from some other people. Shawna, what do you think?

[00:01:04.60] Oh.

(DESCRIPTION)

[00:01:05.02] Hand to her chin.

(SPEECH)

[00:01:06.16] Maybe the orchid looks so unusual because it needs to attract attention.

[00:01:15.63] Very close, Shawna. The orchid's unique appearance attracts a very specific type of insect pollinator, which carries pollen between the orchids to fertilize them.

[00:01:25.99] But how did it to know to make its flowers look like that?

[00:01:31.14] Good question. The relationship between orchids and insects evolved over time through natural selection, which is the process responsible for nearly all of the diversity of life on Earth.

[00:01:43.23] Oh. That's what I thought.

[00:01:45.06] Oh, yeah.

[00:01:46.01] [SCHOOL BELL RINGING]

(DESCRIPTION)

[00:01:47.63] Students leave. The orchid comes to life.

(SPEECH)

[00:01:47.75] [UPBEAT MUSIC]

[00:01:50.17] Ah, what a glorious morning. I'm feeling ripe with possibility today.

[00:01:57.53] Oh, hey, Blossom. That lesson went great. So I'm feeling pretty centered myself.

[00:02:05.15] You know that I'm a big believer in following your bliss, but in this instance, we may need to take a few steps back. Natural selection is a tricky topic. It's easy to misunderstand and even easier to misrepresent.

[00:02:22.73] How about this? When the kids get back, I'll guide you through some of the rough patches.

[00:02:28.22] Sounds way groovy to me. Oh, excuse me. I'm sorry. You totally bring that out in me.

[00:02:34.58] [UPBEAT MUSIC]

(DESCRIPTION)

[00:02:34.83] An hour passes. A chart with four types of finches.

(SPEECH)

[00:02:38.36] And scientists discovered that Galapagos finches had evolved differently shaped beaks to adapt to the particular environments of different islands, allowing them to exploit the resources that were available there. The finches with short, thick beaks are adapted to feed on large seeds, while those with long, narrow beaks have evolved to feed on cactus pulp, allowing them to thrive in more desert-like conditions.

(DESCRIPTION)

[00:03:05.46] Lights shift.

(SPEECH)

[00:03:06.09] I don't know about you, but I think that went pretty well.

[00:03:10.10] Hmm. Here's an idea. Let's take a look at what Shawna took from that. Then we can see if we're heading down the right path.

(DESCRIPTION)

[00:03:18.65] A finch hovers by a cactus.

(SPEECH)

[00:03:20.18] The finches that can't reach food with their short, little beats evolved longer ones so they can.

[00:03:28.01] Gah. OK, individual organisms don't just sprout the traits they need. Natural selection whittles down existing variation over many generations. New variation can arise through mutation and genetic recombination. But even then, it's only sometimes beneficial.

[00:03:46.86] I know, my dear. You're talking to an orchid here. Hey, that rhymed. Poetry truly is everywhere.

(DESCRIPTION)

[00:03:56.39] Teacher nods.

(SPEECH)

[00:03:57.35] Anyway, when you said "the finches," Shawna, thought you meant individual finches. Of course, I know you meant their population, but the word is ambiguous. Next time, make sure you specify individual population or species and ask your students to do the same.

[00:04:16.43] And don't worry. This is thorny stuff, kind of like my friend over here.

(DESCRIPTION)

[00:04:21.23] The cactus doesn't move.

(SPEECH)

[00:04:22.63] I guess he took a vow of silence. I admire your commitment, my prickly pal. Why don't we see how a different student interpreted your lesson?

[00:04:33.19] The warbler-finch better bulk up that beak over time if it wants to use those resources.

(DESCRIPTION)

[00:04:37.99] It pecks a peanut.

(SPEECH)

[00:04:39.08] And then it can pass that new awesome beak to its babies.

(DESCRIPTION)

[00:04:43.24] Chick hatches with large beak.

(SPEECH)

[00:04:44.78] Oh, another misconception. Beaks aren't like biceps. They can't just change size because an organism works at it, and the traits organisms acquired through experience or practice are almost never passed down to their offspring. This is tricky.

(DESCRIPTION)

[00:05:03.42] They close eyes.

(SPEECH)

[00:05:04.74] [EXHALES DEEPLY]

(DESCRIPTION)

[00:05:06.35] Open palms.

(SPEECH)

[00:05:06.96] Go to your happy place.

[00:05:09.54] Yes. I always thought evolution was pretty straightforward. Darwin, the Galapagos, survival of the fittest. What's to misrepresent?

(DESCRIPTION)

[00:05:20.48] Sips drink.

(SPEECH)

[00:05:20.97] A lot, unfortunately. When you said they adapted, Justine thought it was something the finches were actively trying to do, like when you adapt to a new school after a move or when you put on a coat in the winter. You and I know that adaptation has a special meaning in biology, but students who haven't learned this stuff yet will rely on the definitions they already know.

(DESCRIPTION)

[00:05:44.91] Another drink.

(SPEECH)

[00:05:45.87] Shall we dive back in?

[00:05:48.03] OK.

(DESCRIPTION)

[00:05:48.44] Back in classroom.

(SPEECH)

[00:05:49.69] Natural selection is sometimes called survival of the fittest. The fittest individuals in a population are most likely to survive in the environment and, therefore, most likely to pass on their genes to their offspring. In this way, populations can become more and more fit over time.

(DESCRIPTION)

[00:06:11.99] Dimitri imagines this concept with snakes and spiders. They go from small, to medium to giant and scary.

(SPEECH)

[00:06:13.41] [UPBEAT MUSIC]

[00:06:18.58] This is horrifying.

[00:06:20.05] I know. Dimitri doesn't yet understand that sometimes it can be an advantage to be small or spindly. Say, if it makes it easier to hide from predators or find enough food when there are limited resources.

[00:06:32.83] No. I meant all the snakes and spiders. I'm going to have nightmares for a month.

[00:06:38.47] Understanding where your students are losing their way is a powerful thing. If they don't understand the definition of the word "fitness" in an evolutionary context, they might think you mean big, healthy, and strong as it's used in normal conversation. While we're on the topic, I'd steer clear of that "survival of the fittest" bit. It's quite misleading.

[00:07:01.42] But I've been hearing that phrase my whole life, even from scientists. How can it be wrong?

[00:07:08.17] Yes. Unfortunately, even experts sometimes use it as shorthand, but they often don't realize it can be misleading to students. That's because the process of natural selection is really all about reproduction, not survival. An organism that lives a long time without reproducing doesn't contribute its genes to the next generation and, therefore, isn't really that fit at all, biologically speaking.

[00:07:36.34] Well, speaking of fit, getting my students to understand how some individuals can be better adapted than others if they're all the same species might just put me on the edge of having one.

[00:07:49.13] That is another tricky one for sure. The whole process of evolution hinges on the natural variation that occurs between individuals in a population and between populations of a species. Just ask your students to look carefully at what they see out the window, in the world around them. You can see it everywhere. No two oaks in a park, pigeons on a wire, or kids in a classroom are exactly the same.

[00:08:16.75] In an evolutionary context, these differences give individuals advantages or disadvantages in different environmental conditions, which affects their ability to survive and, most critically, to reproduce. Let's go back in time and try it again.

[00:08:33.76] Can we do that?

[00:08:34.69] Can an orchid talk?

(DESCRIPTION)

[00:08:35.99] A wall clock rewinds. Back to Shawna.

(SPEECH)

[00:08:36.19] [UPBEAT MUSIC]

[00:08:38.98] Maybe the orchid looks so unusual because it needs to attract attention?

[00:08:45.86] You may be on to something, Shawna. Can you explain what you mean by "attracting attention"?

[00:08:52.10] Maybe it's good for the orchid if bugs hang around it. So it makes itself look stranger so the bugs will come.

[00:09:00.97] It's so clear now. Shawna is thinking about the orchid the same way she was thinking about the finches. She thinks individual organisms can choose to develop whatever traits they need to thrive in their environment. Looks like I'm going to have to watch my wording and my assumptions.

[00:09:18.19] Isn't it wonderful? By asking the students questions throughout the lesson and having them explain their thinking, you're learning what their misconceptions are and gaining the tools to help correct them.

[00:09:30.20] This is great.

[00:09:31.33] And we've only just scratched the surface. There are also misconceptions about common ancestry, phylogenetic trees, deep time and--

[00:09:39.37] Blossom, Blossom. OK, I guess there's still a lot to learn, but at least I'll never be bored. Are you up for another lesson?

[00:09:46.42] Of course, my dear.

(DESCRIPTION)

[00:09:48.00] To cactus.

(SPEECH)

[00:09:48.61] Hey, you want to take the next one?

(DESCRIPTION)

[00:09:50.68] The cactus just sits there.

(SPEECH)

[00:09:52.36] Ah, well. I tried.

[00:09:56.84] To discover more about how kids learn science and the types of misconceptions they might have, visit us online at scienceeducation.si.edu/goodthinking.