The DNA Files:
Workshops and Activities

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Comparing DNA

TEACHER'S NOTE: Things that should be said are in *italics*; instructions are plain text (not italicized) and are numbered. Vocabulary is **bolded**. Section headings do not need to be stated and are **bold and underlined**.

Introduction

Today we're going to be talking more about DNA. We're also going to talk more about DNA mutations, and what happens when those mutations get passed down generation by generation during evolution to create different types of living things. Today, we're also going to talk more about some different kinds of living things, because we can learn all kinds of interesting things by comparing our DNA to other organisms' DNA. Along the way, we're going to learn some new words that scientists use. So make sure to ask questions if you don't understand something.

A C T I V I T Y # 1

Concept Review/Intro (5 min.)
Education Goal: Introduce concept of DNA as information in all living things

- ***DNA*** *is a set of instructions needed to make a living thing.*
- *The first time we talked, we talked about where you find DNA—does anybody remember?*

  1. Take answers, and conclude that DNA is everywhere in the body.
- *Each of your bodies is made up of trillions of cells, and almost every cell in your body has a complete copy of the* ***DNA*** *instructions for how to make* you.
- *Is* ***DNA*** *just in people? What other things might have DNA?*

  2. Make a list of their suggestions on a blackboard, whiteboard or flipchart.
- *Every single living thing has its own set of instructions made of* ***DNA*** *in its cells too.*
- *Here's a different question - why do you think we might want to compare the instructions of different living things?* (Take answers.) *A lot of the time, we compare living things to one another to learn more about ourselves.*

  Review: DNA is in every living thing, and we can compare the instructions of different living things to learn more about ourselves.

A C T I V I T Y # 2

Evolve your own (15 min.)
Educational Goal: Have participants demonstrate that evolution by natural selection results in a wide array of creatures with a lot of differences and yet a lot of common features.

1. Divide group into pairs or groups of three. Give each group some modeling clay or Play-Doh and other materials, if using.

- *In order to compare living things, we need something to compare. Each group is in charge of making a new creature.*
- *Evolution doesn't generally start from scratch, and neither will you. You will start from this life form, called a 'Sneacher' (a ball of Play-Doh with a piece of drinking straw sticking out of it), which lives by sucking berries through its snout (drinking straw).*
- *Now normally, the group of these creatures lives in happy peace in this river valley*

2. Show Sneacher Valley "before" picture.

- *But as time goes by, the river slowly floods the valley and makes a lake.*

3. Show Sneacher Valley "after" picture.

- *There are berry bushes still growing on the bottom of the lake, on the walls of the cliff, and on the plateau.*
- *Because of natural selection (remember, from the story about moths in England), some of the Sneachers will start to be better than the rest at finding food, surviving, and reproducing. Where do you think the Sneachers are going to live? What will they eat? What kind of creature do you think will result after evolution goes on for a while? Use your Play-Doh to create your new creature.*

4. Encourage creativity (wings, fins, different shapes and sizes). Give them 10 minutes, with a 3 minute warning, to come up with a new creature.

5. Have a spokesperson from each group bring their Sneachers up to the front of the room and ask them what changed about their Sneacher and why.

6. Then point out that the creatures all (or most) still have that drinking straw snout, or something else that's similar.

- *That snout must be pretty important for it not to have changed too much during this whole evolution, huh?*

Review: Real living things, look like your sneachers this way—some things have changed, either because they were better for survival, or because of chance, but at the same time, some things that are important are protected from changing.

A C T I V I T Y # 3

Compare and contrast (15 min.)
Educational Goal: To show that real-life organisms show the same pattern of some big differences, but also some shared features.

1. Put up blank compare/contrast chart.

- *Next, we're going to fill out this chart. Who can think of something that is either the same, or different for these animals?*

1. Fill in chart as per their suggestions. List a feature (ex: eyes, or covering) in the column on the left, and work across the chart from left to right, asking what that feature is like (ex. 2 eyes, fur, no covering, or feathers) for all of the organisms listed.

Review: As you can see, with real organisms we see the same thing as with the Sneachers. Some things are very different, but some things have remained remarkably the same.

A C T I V I T Y # 4

Manual evolution
Educational Goal: Have participants see what happens to DNA sequence as species diverge.

- *Remember that instructions to make everything on that chart (give examples) are in each of those animals' DNA. So we've looked a lot at whole organisms, with our Sneachers and in this chart.*

  Next we're going to look at DNA, the instructions for making animals, plants, every living thing.

- *In this activity, we are going to fast-forward evolution of a piece of DNA by hand.*

  1. Pass out magnetic strips of DNA sequence and spinners, one each per participant.

- *We can talk about DNA in different ways. These DNA strips are a sequence of letters, A, C, T, and G. Those letters match up to the 4 colors we used when building our DNA models. Scientists use these four letters, A, C, T and G, instead of the colors, to represent the four different tiny molecules that make up the rungs of the ladder.*

  2. Show diagram of bases.

- *Because A only pairs with T, and C only pairs with G, you only have to read half of the ladder to know what the other half says. So the magnetic DNA sequence strips you just got look just like what scientists deal with every day, it's just a string of letters.*

- *This is how this game works: You each start with the same sequence. And some of the letters are protected by natural selection, because they (like a Sneacher's snout) are really important. Those are inside these black boxes.*

- *Watch me first. You are going to spin your spinner, like so (demonstrate). Whatever letter it lands on, you pick one of those from your sequence, and choose a different letter to replace it (demonstrate). But you aren't allowed to change the letters in the black boxes.*

  3. Let participants practice with their spinners briefly.

  4. Give them 2 minutes to mutate their sequences, with a 10 second warning.

- *Okay, stop. Now this much mutation would usually take millions of years for most animals. But we fast-forwarded and did it in about two minutes.*

  5. Have participants bring their new sequences to the front and align them with one another. Point out that the black-boxed letters, because they were protected, are still all the same. Point out that the rest of the letters have undergone some changes.

  Review: What we see at the DNA level is the same thing we saw with whole organisms. Some things change, either because of chance, or because of natural selection. But because of natural selection, some things, like these letters in the black boxes, are important enough to be protected. They stay the same over time. This DNA in the boxes that is important enough to stay the same over time is called ***conserved DNA****.*

A C T I V I T Y # 5

Which of these things is most like the other? (10 min.)
Educational Goal: Have participants observe, using actual DNA sequence, that conserved DNA is very similar across species.

- *But we did the last activity backwards from how it's done in the laboratory. Scientists don't know what letters of the DNA sequence are **conserved** before evolution happens. Scientists take the DNA from a bunch of different organisms and by comparing it they can figure out what must important by seeing what gets protected.*
- *Now, you are all going to try it that way. Flip over your worksheets.*
- *There are two sequences here, Sequence A and Sequence B. Each row is actual DNA sequence from a different animal. Draw a black box around a column every time the letters are identical for all the different species, like in the example. A dash means that that letter is missing. If there's a dash, that DNA has not been **conserved**.*
- *Which sequence is more **conserved**, has changed less, during evolution? Which sequence do you think is more important?*
- *How many of you are surprised that there are sequences of DNA like this that we have that are almost identical to those in a chicken? Turns out, some DNA sequence is so important that every single living thing has it, from people to plants, and bacteria.*

  *Review: **Conserved DNA** is probably important for some function, and you can see how it gets protected from evolution by looking at the sequence.*

A C T I V I T Y # 6

The apple of your eye… and your everything else too. (5-10 min.)
Educational Goal: Illustrate the information composition of the human genome, point out that knowing what is conserved DNA is how we know what's important.

- *Remember when we separated beads to talk about what kinds of instructions are in human DNA? This time, we'll pretend that this apple represents all of human DNA.*

  1. Cut the apple in half and hold half up.
- *Remember, almost half of human DNA is really repetitive.*

  2. Set aside that half of the apple, take the other half and slice off about a tenth, and hold up the bigger piece.
- *And this part of our DNA doesn't seem to have any information at all, as though this much of our DNA were literally just gibberish.*

  3.Set that chunk aside too.
- *This last sliver is the part of human DNA that scientists think has all the useful instructions for how to build a person. It includes the instructions from all our genes about what to make, but most of it is other sequence that tells your cells when, where, and how much to make.*
- *All of this is **conserved DNA**. This piece represents all of the DNA that we could draw a black box around.*

*Review: The reason we think this **conserved DNA** is important is because we see the same kinds of sequences in other living things, being protected from changing during evolution.*

4. Pass out pre-cut apple slices.

Conclusion

Today we learned that as evolution goes on, organisms become more different, like the Sneachers. But some important things stay the same. We looked at that by talking about animals, and then showing that it was true with actual DNA sequence.

*Finally, we learned that DNA sequence that stays the same over time is called **'conserved'** and that comparing our DNA to the DNA of other organisms can tell us a lot about what parts of our own DNA is important.*