

The DNA Files:

Workshops and Activities



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DNA Basics Plus

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**.

Adding one of the following sections at the end of the DNA Basics Workshop (instead of the standard DNA Basics Workshop conclusion) will enable you to include an introduction to additional subject matter.

Evolution

ACTIVITY # 5

What is Evolution? (15 min.)

Education Goal: Introduce concept of mutation, and of evolution as the spread of mutations throughout a species. Introduce concept of natural selection as an important driver of evolution.

- *DNA does not stay the same over time.*
- *As your cells divide, they duplicate all the DNA ladders they have inside them so that there are 2 copies, one for each cell. Sometimes, when they do this, the cells make mistakes, which changes the DNA. Those changes are called **mutations**.*
- *Lots of things can cause the DNA to mutate—sunlight can mutate the DNA in skin cells, for example. But only the mutations that happen in sperm and egg cells will get passed on to the next generation.*
- *Over a long time, these mutations in the DNA can get passed down over generations to more and more individuals in a species, so that finally, the DNA of the entire species has changed. That is **evolution**. **Evolution** is how species change, and also how we get different species.*
 1. Show picture of white and black moth on white background.
- *These are two different color variations of the same kind of moth. Which one of these moths is easier to see? That's right, the dark one! The dark coloring is due to a mutation. Well, once upon a time, in England in the 1800's, trees used to look like this, and this kind of moth was white almost all of the time.*

- Then, people started burning a lot of coal to build machines and other things, and the trees started getting coated in soot.
 2. Show picture of white and black moth on black background.
- Which moth is easier to see now? That's right, the white speckled one! Well, the birds thought so too! And suddenly, the mutation that made the darker coloring was a big advantage. The white moths started getting eaten by birds way more often than the dark ones, and the dark moths were surviving and reproducing. Eventually, in 60 years, there were almost no white moths at all.
- There are two main ways that **mutations** in the DNA of one individual spreads to every member of a species. What happened with the moths is called "**natural selection**," because one version of the DNA was better for survival than the other. The passing-down of the **mutations** to more and more individuals is called **evolution**. **Natural selection** is a main cause of evolution.

ACTIVITY # 6

Genetic Drifting

Educational Goal: Introduce concept of natural selection and genetic drift as important drivers of evolution.

- But what happens if neither the original version of the DNA or the **mutation** is any better than the other? Well, then, the version that survives depends on nothing but chance. When talking about **evolution**, chance is called **genetic drift**.
 1. Ask for two volunteers. Have them come to the front and give them each a blue stone.
- How does **genetic drift** work? Well, imagine that there is a mutation in the DNA ladder. (Hold up model to demonstrate.) Instead of this rung being blue/yellow, there was a mutation in somebody and it became yellow/blue. (Make sure they understand this before moving on.)
 2. Take the blue stone of a volunteer and replace it with yellow. Have them place their stones on the table in front of them and hand each volunteer a die.
- Now, a few generations are going to go by.
 3. Have each volunteer roll their die twice (you may want to pause and comment after each round) and give them additional stones to represent their children and grandchildren. Alternatively, have them pull that number of other participants to stand up front with them and give each person a stone as they come to the front.
- Okay, so now we've got two families here. Who has more people, the people with the original blue/yellow rung or the people with the yellow/blue mutation? Why does (blue or yellow) have more? Is it because one is better? That's right, it was randomly decided. That's genetic drift in action. Random things affect which version of the DNA becomes more common.
- Okay, now it gets even more suspenseful. This village that we're building here is unfortunately in a place that can be flooded. Natural disasters are another chance event. I'm going to have our original people here, the grandparents, roll their die one more time, and the family that gets the higher number is the one that survives.
 6. Have everyone from the lower-numbered group sit down again.
- So, as you can see the (blue or yellow) group is the only one that's left! (IF BLUE IS LEFT:) So now, the original version of the DNA is all that's left and it's like the yellow mutation never happened, not because the mutation was worse, but just because

of chance. It could easily have been that the yellow group was left—it was all up to chance! (IF YELLOW IS LEFT:) So now, everyone in the whole population has the yellow mutation, not because yellow is better, but just because of chance. It could easily have been that the blue group was left—it was all up to chance!

- Because of chance events, more or less of a **mutation** will get passed down in a species. Eventually, one version of the DNA wins out. That is how **genetic drift** causes evolution.
- 4. Collect dice, stones and have everyone sit down.
- So, **natural selection** and **genetic drift** are two of the most important ways that **mutations** get passed on; in other words, these are the two most important ways that **evolution** happens.

Conclusion

Well, today we learned where you find DNA, what it looks like both up close, and with the naked eye. We also learned that not a whole lot of human DNA actually has instructions for building people. We also talked about changes in DNA, or mutations, and how those mutations get passed down during evolution, by natural selection and genetic drift.

Comparing DNA

ACTIVITY # 5

Who's in our club? (15 min.)

Educational Goal: Have participants understand that by studying organisms with the same conserved piece of DNA, we can tell what parts of our DNA are important

- How do you think scientists know which parts of our DNA ladder are important, and which parts are gibberish? The main way they can tell instructions (hold up the wooden and rounded cylinder beads) apart from the gibberish is because they find almost identical sequences in the DNA ladders of other living things.
- If we share almost the exact same DNA rung sequence with other living things, it makes sense that it's pretty important. Sequence we share with other living things is called **conserved** DNA. You all want to see what I mean by **conserved** DNA?
- Okay, we're going to play a matching game. (Hold up DNA ladder.) When scientists talk about DNA, they usually only read half of the rungs. That's because if you say that this half is (say colors for several rungs, in order), because of the way the rungs match up, that automatically means the other half has to be (read the other half) so you don't have to say both—does that make sense? But remember, scientists use letters: A, T, C and G instead of colors.
- So, everybody, take a strip of paper—these are DNA sequences from a whole bunch of different living things. Every one of these sequences matches one of a few sequences in human DNA, which I have here.
 1. Distribute paper slips with DNA sequence on them.
- Find the one that matches yours and then hang out to see what other kind of living things also have the same sequence. (If this seems confusing, you can pair up with someone and just use one sequence.)

2. Give them time to find groups, and then ask the groups to come up with something everyone in their group has in common.
 5. Go around the room to each group, first, asking for each person in the group to say what living thing they have. Then ask the whole group if they can guess what they have in common.
- *Okay, so we've got a group of just primates, apes and monkeys, and humans—and we've got a group that's all animals with a backbone, right? And there's another group that seems to have everything that's alive! Humans have the same DNA as a lot of other living things. Some we share with just primates, some with just vertebrates (things with a backbone) and some DNA is **conserved** between us and every single other living thing out there, even one-celled living things.*
 - *The point of all this is to show you that even though we might not know what a given DNA sequence does, we can tell that it's important by looking at what other living things we share it with.*

Conclusion

Well, today we learned where you find DNA, what it looks like both up close, and with the naked eye. We also learned that not a whole lot of human DNA actually has instructions for building people. We know what small part of our DNA has important instructions because we share that DNA sequence with all kinds of other living things.

Genetics of Climate Change

A C T I V I T Y # 5

Climate Change (5 min)

Educational Goal: Introduce concept of climate and explain why and how our climate is changing.

- *Have you heard the word **climate** before? What do you think of when you hear the word **climate**?*
 1. Take answers. (No need to write them down.)
- ***Climate** is an average of weather patterns over a certain period of time. It's what you expect the weather to be like year after year, based on what the weather has been like in the past.*
- *Right now, the Earth's **climate** is changing.*
- *Earth is a planet. Just above the surface of Earth, all around the globe, there's a layer of gases that we all call "air." And there's no air out in space. You can think of this air as being like the clothes we wear—the clothes you have on right now keep you from being too cold in this room, right? That's because they trap your body heat. The same thing happens with the air around Earth. Some of the gases in the air trap heat around the Earth, and keeps our planet from being too cold.*
 2. Ask for a volunteer. Wrap the volunteer in the blanket.
- *Unfortunately, people are adding more of the gases that trap heat into the air around Earth. Which is kind of like wearing too many clothes, or, like the planet is now wearing a thicker blanket.*

3. Pause for a second and glance at the volunteer.
 4. Ask the volunteer how they feel in there. If they don't offer, ask them if they feel warm.
- *As we change the air around Earth to trap more heat, it is becoming a hotter place to live.*
 - *And that is going to affect the types of weather we expect.*
 - *Climate change will affect all of the living things on the planet.*
5. Let the volunteer sit down.

A C T I V I T Y # 6

Generation times

Educational Goal: Introduce concept of generation time and that the generation time is a factor that affects the speed of adaptation to a change in the environment

- *What does this have to do with DNA? (Hold up DNA model.) Well, DNA does not stay the same over time.*
- *DNA changes a little at a time, across **generations**. The trick is that some living things have a shorter **generation time** than others, and so will be able to adapt faster to changes in the environment. It takes about 15 years for people to reproduce, which is a pretty slow **generation time** compared to, say, mosquitos, which can reproduce when they're about 2 weeks old. Can you think of living things with a short **generation time**? What about a long **generation time**?*
 1. Get participants' help in making a list of living things with a short generation time (insects [weeks-months], bacteria [minutes], mice [3 months], most vegetables [less than a year]) and a long generation time (people [15 yrs.], bears [4-5 yrs.], sea turtles [20 or more years], redwood trees [60 years])
- *Partly because of differences in generation time, the DNA of some living things (Indicate lists you just made) will be able to change faster in response to the changing climate.*
- *But lucky for us, there are other, non-DNA-based ways to adapt.*
- *Lots of living things are moving to different places, learning to eat different foods—and in the case of people, building better technology to help us protect other living things and adapt to a warmer world.*

Conclusion

Well, today we learned where you find DNA, what it looks like both up close, and with the naked eye.

We also learned that not a whole lot of human DNA actually has instructions for building people.

*As Earth becomes a warmer place to live, a lot of things are going to change. An important thing to remember about how fast DNA can change to adapt is **generation time**. Shorter generations mean faster adaptation of DNA. But there are other ways that living things, including people, can adapt, too.*