

## Teacher Notes- “DNA Chain- The Fear-Buster”

Fear can cripple a mind quicker than anything. So how can you go from fear DNA to being at peace and understanding it in just 45 minutes? Easy- have students make a cuddly 40-foot long section of DNA with their own hands. Then, with all fear gone and their curiosity piqued, you can step in and teach the fundamentals by simply pointing, talking, and applying everything to this grand model.



This activity is a perfect compliment to another one of ours called “Chromosomes, DNA, and Genes”. If used together, you’ll have a foundation for anything you want to do with genetics.

### **Materials needed per group of 4 students:**

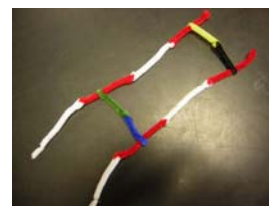
- 4-long red pipe cleaners (12” each)
- 4- long white pipe cleans (12” each)
- 2- short blue, short green, short yellow, and short black pipe cleaners (6” each)
- 4-scissors

### **Additional Teacher Materials:**

- PowerPoint-DNA Chain (see last page)
- String
- Paper clips

### **Beforehand:**

1. Buy pipe cleaner. Every student needs one red and one white pipe cleaner. Buy one of these for every student plus 25 extra (mistakes happen, right?). You’ll need half that number of blue, green, yellow, and black (this includes the extras you’ll need). Total cost: ~\$10.
2. Read through and do the lesson yourself and make an actual section of DNA yourself. Even with the PowerPoint it’s hard to visualize. Your very first class will appreciate being able to see the one you made so they know exactly what they’re supposed to end up with.
3. Cut 20 pieces of string about 2 feet long and tie a small loop at both ends of each string. Insert paper clips that have been opened up at both ends. Now hook the strings to the ceiling in your room in a meandering line at 3 foot intervals



apart (later we'll hang the DNA chain from this). The paper clip at the other end is what you'll hook the DNA chain onto later. If the paper clips at the bottom are at eye level, remove them until it's time to hang the chain so that no one gets caught on them.

4. Cut all of the blue, green, yellow, and black pipe cleaners in half with a pair of scissors.
5. When speaking today, let students know that listening is not optional. If they don't listen, students will get behind, lost, and confused. The most harmful person in the room is someone who's listening halfway, because they listen just enough to begin doing something, and then make a crucial mistake.

**Procedure:**

1. Have students get boxes with materials (6 kinds of pipe cleaner, scissors, and ruler).
2. Begin the *PowerPoint-DNA Chain*. The title slide asks the simple question "What is DNA?". Ask a few random students to make a true statement about DNA. They can say anything, as long as it's true.

You'll hear all kinds of things. Listen for the following two comments.

<i>Student Comment</i>	<i>What you respond with</i>
<b>"Everyone's DNA is different"</b>	"Yes, it's true that no one who's ever lived on earth, or ever will, has your exact DNA. But it is <i>not</i> true that no two people in the world have the exact same DNA (identical twins)."
<b>"DNA determines everything about you."</b>	"Really? What if you were raised by wild rabbits. Would you still be the exact same person?"

3. Right off the bat let them know the purpose of this project. Yes, we're making DNA, but there's more. Later we're going to interpret this DNA and see how it codes for a certain trait. If it's your first class, tell them the trait they will determine is gender. Even though students will each make a section and decide what colors will go on theirs, and how they're put on, they still have no way of controlling what it will be.
4. One last analogy before getting started. Referring to the little piece of DNA you made, or to the strand a previous class made and hung, bring up a website (maybe the one for your school corporation):

"This is the website for our school. Notice there is text here and there, the different colors along the sides and middle, and images. Now, all of that does not

magically appear out of nowhere. It's told to. A code controls everything you see. It tells everything where to be and what to look like. You see, if we click "View" and select "Page Source" you see the code, called html. This is where it all comes from. Someone who doesn't have much of a life but who makes a lot of money sat at a computer and typed in every single letter, number, slash, and bracket. And every letter and number tells something what to do. Remember that red box on the left side of the page? If we found to the line of code for that object, and changed a number or two, it might become a purple box. That's also how your DNA works. Your hair isn't just thick and brown for no reason. It's told to by your DNA.

5. It's time to start building DNA. Go back to the PowerPoint. In the first few slides, students are instructed to get a red and white pipe cleaner and cut them into 4 equal pieces. The easiest way to do this is to cut them in half, and then those halves in half. It's fine if they're not all the exact same length- we won't be able to tell.

6. The next few slides (5-9) guide students through putting a small "J" hook at both ends of the red and white pieces by wrapping the ends around a pencil, and then joining them into 2 leg sections of alternating colors.

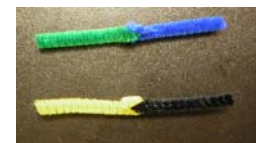


7. On slides 10-13, students are shown how to cut pieces of the other colors and then mate them up. Go slow and deliberately on step 10- it will confuse students who are not paying attention! After reading and explaining the step, rephrase it (*"In other words, you've got just one more small piece now, and it's either blue, green, yellow, or black."*)
8. This would be a good time to check back in a remind them of what's happened so far and where this whole thing is going:

"You've now got a total of 10 pipe cleaner pieces: 4 reds, 4 whites, and a total of 2 others that could be blue, green, yellow, or black.

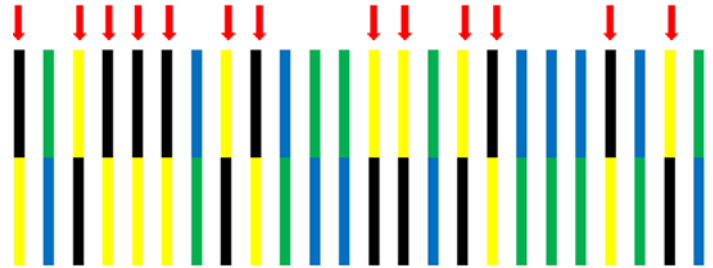
Whether or not you realize it, by choosing the color that you just did, we took a huge step forward in determining the (gender/life expectancy) of our person. We're about  $\frac{1}{4}$  of the way there. You may think that what you just chose was random, and you may not have any control over the colors that everyone else in the class chose, or how they'll arrange them on their strand, but in the end it will all mean something."

9. In step 11, all students do is cut a "mate" for each of the 2 colors they just chose. Blue goes with green, and vice versa, and black and yellow go together. Speak clearly and rephrase. As simple as that sounds, students who aren't paying attention will do it wrong.\*<sup>2</sup>



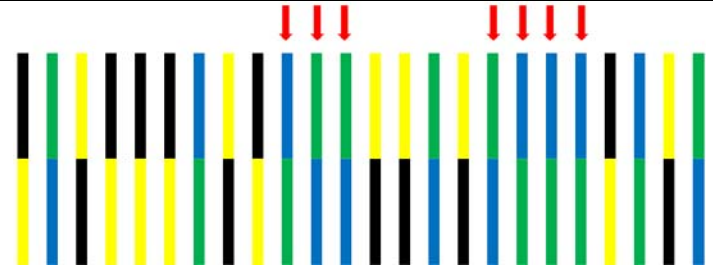


**Group 2-** will count the total number of yellow/black pairs in the section of DNA their class made. It does not matter which way the yellow and black are oriented.



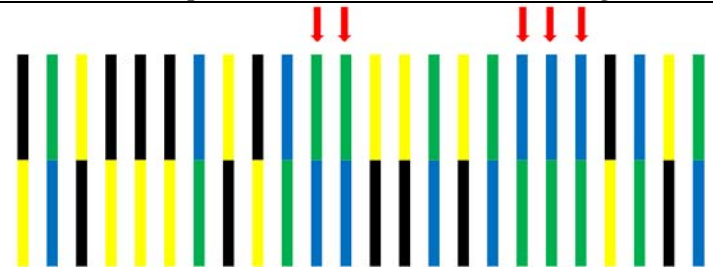
*In this example there are 13 yellow/black pairs*

**Group 3-** will count only the number of blue/greens in which the next pair is also blue/green. It does not matter which way the blue and green are oriented. A blue/green with a yellow/black on both sides of it does not count.



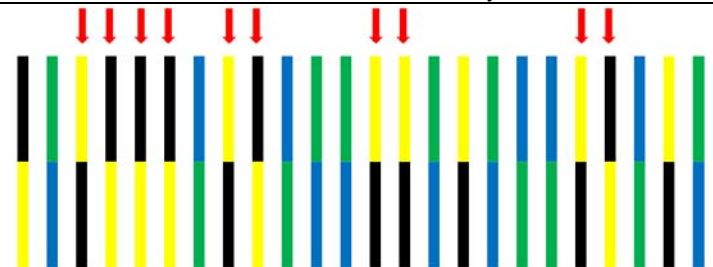
*In this example there are 7 consecutive blue/greens*

**Group 4-** will count the number of blue/greens in which the next pair is also blue/green AND oriented the exact same way.



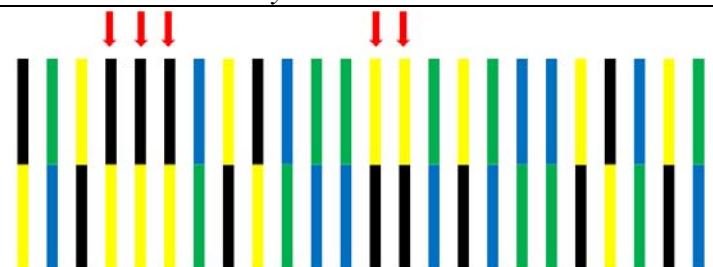
*In this example there are 5 consecutive blue/greens oriented the same way*

**Group 5-** will count only the number of yellow/blacks in which the next pair is also yellow/black. It does not matter which way the blue and green are oriented. A yellow/black with a blue/green on both sides of it does not count.



*In this example there are 10 consecutive yellow/blacks*

**Group 6-** will count the number of yellow/black in which the next pair is also yellow/black AND oriented the exact same way.



*In this example there are 5 consecutive yellow/blacks oriented the same way.*

15. Assign groups of students to do each task. Everyone in the group needs to do it, so we make sure it's done properly, and write their number of the board. Add up all the numbers to see the gender.
16. (Using the examples above, you would total  $11 + 13 + 7 + 5 + 10 + 5 = 51$ . The gender here would be a boy.)
17. Your other 3 classes will go through the same counting methods to determine life expectancy, height, and eye color (slides 18-20)
18. As the classes come and go and contribute traits, students will become interested in what this "person" that they're creating turns out to be. We almost feel like we know him, maybe because everyone has had small part in creating him. And without every one's contribution, he'd have turned out differently. Genetics is like that also. So many possibilities. And that's now easy to point out when you're looking at the DNA strand hanging from the ceiling that your students made. Why is this 5-pair sequence just like it is? Chance? It could have been 50 other ways, but it's this way. And it applies to the entire rest of the strand.\*<sup>3</sup>
19. Refer to your strand whenever possible the next few days.\*<sup>4</sup>
20. We also included a bonus activity that deals with asexual and sexual reproduction. Use it if it will help you cover that material. It takes about  $\frac{1}{2}$  of a period to do.
21. Whenever you decide to take it down, unhook the DNA chain and stuff it in a plastic grocery sack (for "just in case" next year), and put the strings and paper clips into separate zipper-seal baggies.

**Accessories:** Other sub-topics you can add for more length and depth.

\*<sup>1</sup> On the eye color slide (20), copy and past a sample picture of eye colors.  
[http://en.wikipedia.org/wiki/Eye\\_color](http://en.wikipedia.org/wiki/Eye_color)

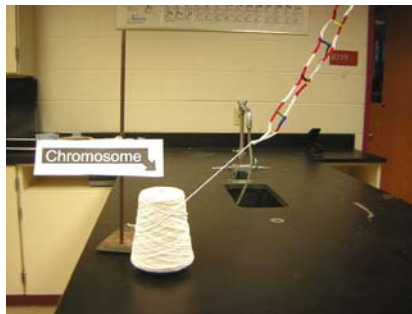
\*<sup>2</sup> Inevitably, someone made a base pair consisting of blue and black, or green and yellow. If your students are really talented, somehow a purple one ended up in there. We'll leave those alone and call them mutations. You've got an excellent opportunity now to explain what those are.

\*<sup>3</sup> In case you or your students are wondering, the possible number of different human beings is about  $10^{3,500,000,000}$ . To give you students a feel for how many people we're

talking about here, go to your board and start writing zeros. If you wrote one zero per second, it would take you about 111 years to finish writing this number!

\*<sup>4</sup> Three examples:

- Genetic engineering. Since you've got the DNA strand hanging right there, bring up the formula used to calculate gender or height, or life expectancy. Genetic engineering is where we take out a section of DNA and replace it with something else that we want, so that it codes for what we want.
- Draw comparisons between our strand and real DNA. In real DNA, a gene (section of DNA that codes for a trait) is about 3,000 base pairs long. Ours was about 60. That means ours needs to be 50 times longer just to code for one gene, if it's just as long as the real thing. And that's just one gene. The DNA in most chromosomes codes for hundreds, and many thousands, of genes. Mind boggling!
- Print off the PDF "Sign-Chromosomes, DNA, and Genes". Cut and tape them to the Chain as shown below. This will *completely* clear up what these 3 terms means.



**Chromosome**-DNA wound up (tie the end of your DNA into a ball of string or yarn)



**DNA**-the strand itself



**Gene**-a section of DNA; we ran a piece of green yarn over a section to illustrate



All 3

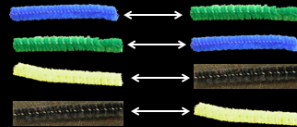
Come back and visit [InteractiveScienceTeacher.com](http://InteractiveScienceTeacher.com) to upgrade this lesson with:

**PowerPoint-** lead your students through the lesson click-by-click

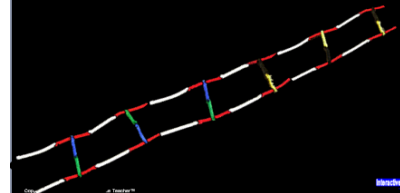
1. Get 1 long red and 1 white pipe cleaner
2. Cut the red into four equal sections



9. Cut a 7 1/2 cm piece from one of the 4 remaining colors
10. Now choose and cut one other piece. It can be the same or different color.
11. Each piece needs a mate: green goes with blue, and yellow with black.



13. Attach them to a section of red; either one can go either way
14. Now hook the ends of your DNA chain to those of the people next to you...



### Signs To Put On Chain

Chromosome



### QuickNotes

Teacher *Quick* Notes- "DNA Chain"

**Materials per group of 4 students:**

- 4-red pipe cleaners (12")
- 4-white pipe cleaners (12")
- 2-short blue and green and yellow and black pipe cleaners (6" each)
- 4-scissors

**Additional Teacher Materials:**

- PowerPoint-DNA Chain
- String
- Paper clips

**Procedure:**

1. Begin the *PowerPoint-DNA Chain*. Use it to lead your class through the activity.
2. Have students cut the red and white pipe cleaner into 4 equal pieces.
3. Put a small "J" hook at both ends of the red and white pieces by wrapping the ends around a pencil, and then join them into 2 leg sections of alternating colors.
4. Cut 2 pieces of the other colors (black, yellow, green, blue) and then mate them up.
5. Cut a "mate" for each of the 2 colors they just chose. Blue goes with green, and vice versa, and black and yellow go together.

