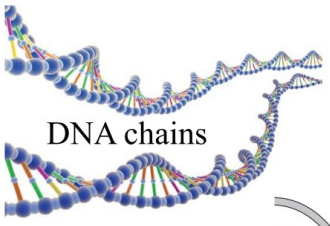
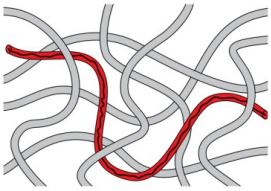
Molecules of Life: Tangled DNA

- **DNA** molecules are very long chains that store the instructions (**genes**) for how to make a specific living creature. DNA passes down **genetic information** from parent to child.
- Because DNA is a long **polymer** (chain molecule), it tends to make a **viscoelastic** (snot-like) material when all the long chains tangle together.

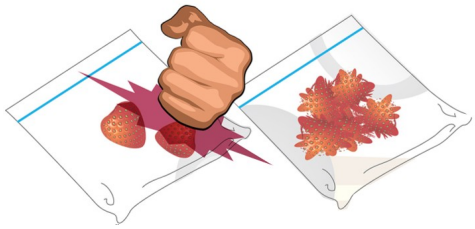




Part 1: DNA in a Strawberry

You will isolate DNA molecules from some strawberries.[1]

1. Pull the leaves & stems off 2 strawberries. If desired, do a separate bag for each pair of kids (2 strawberries in each).

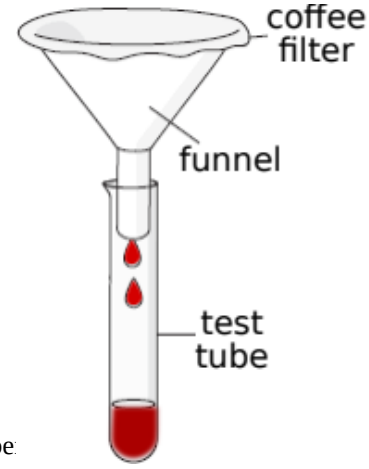


2. Put both in one ziploc bag. Seal the bag and smash the strawberries inside into a pulp, so no big chunks remain.

3. In an unlabeled cup, mix up the extraction liquid:
1 large tablespoon dishwashing fluid + 1 small teaspoon salt + ½ cup water

The detergent will break up the oily membranes surrounding the strawberry cells, to let the DNA out. The salt will neutralize the electric charge on the DNA and make the DNA strands more able to stick together.

4. Add 2 tablespoons of extraction liquid to the bag of strawberry pulp. Reseal the bag, and smash again to mix gently.



5. Put a coffee filter in a funnel and insert the funnel into a tube. Pour the strawberry liquid over the filter. Wait until about 1 inch of liquid collects at the bottom. Make sure someone is holding the test-tube at all times so it doesn't fall!

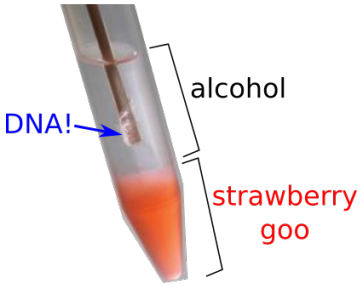
6. Remove the filter from the funnel. Slowly and carefully dribble alcohol through the funnel to the top of the tube, enough

1 DNA activity modified from: https://www.genome.gov/Pages/Education/Modules/Strawbe

to make a layer on top of the strawberry fluid about 1 inch high. Do not shake the tube or mix the layers!

7. Watch a cloudy substance form in the clear alcohol layer.
That's the strawberry's DNA! DNA does not dissolve in alcohol and instead clumps up to make the white material you see. Strawberries are convenient for isolating DNA because they have so much of it (8 copies of every gene) in each cell.

8. Use a stick to spool some DNA and pull it out of the tube. Try stretching it between two sticks to see its consistency.



How would you describe the DNA?:
liquid solid viscoelastic (snot-like)

Long polymers that tangle and stick together tend to make a **viscoelastic** material. The alcohol breaks the DNA's interactions with water molecules, and allows the salt to stick to it better. The salt makes bridges between DNA strands, forming a stretchy "snot-like" substance.

Part 2 (if you have time): Packaging DNA

If you were to take all the DNA polymers in just one of your cells and lay them out end-to-end, they would stretch out for 2 meters!

1. Cut a 2-meter long piece of yarn (for each student). The DNA in one of your cells is this long.

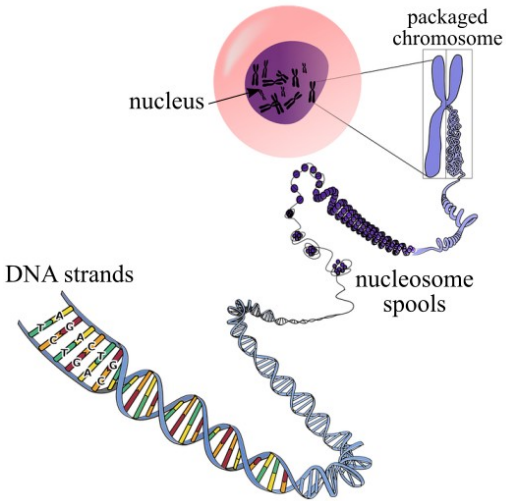
2. What is the smallest space you could fit the yarn into? What tricks can you find to package it as compactly as possible? You can use plastic, rubber bands, clay, or anything else you can think of. Measure the smallest blob you could make (size <u>after</u> you release it).

Size of smallest blob of yarn: _____

3. The **nucleus** of your cell (where DNA is stored) is only 1/100th of a millimeter across. Take a look at how long is 1mm and 1 m on the ruler

Discuss: How can 2 meters of DNA fit in such a small space?

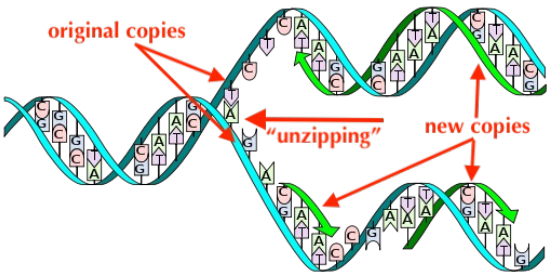
The DNA in one of your cells is the same length as your string, but much thinner so it can be packed more compactly. The DNA gets wound around spools called **nucleosomes**, which stick together (like clay) and wind into tighter structures, and so on for many levels of packaging.



4. To make a new copy, your DNA has to be separated into its individual strands. Try separating the yarn into strands while it is still packaged into a tiny ball or while free. Imagine pulling the entire yarn apart to separate it into 2 balls.

Discuss: What difficulties does the cell face when separting the strands of its DNA?

Would it be easier to separate the 2 strands if you could use a pair of scissors? How would you use them?



Cells have special machines (**enzymes**) that help pull apart and copy the strands. Other enzymes can cut and reattach the DNA strands to help untangle them and get rid of knots.