

DNA Necklace Kit

Introduction

DNA can be considered the hereditary “code of life” because it possesses the information that determines an organism’s characteristics and is transmitted from one generation to the next. DNA is contained within the nucleus of almost every cell in the human body.

The length of DNA per cell is about 100,000 times as long as the cell itself. However, DNA takes up only about 10% of the cell’s volume. This is because DNA is specially packaged through a series of events to fit easily within cell nuclei. The basic structure of DNA is that of a twisted ladder called a double helix. In order to condense the length of this DNA molecule, the double helix wraps itself around proteins, folds back on itself, and coils into a compact chromosome.

Human beings have 46 chromosomes in the nucleus of almost every cell. Each chromosome is comprised of one long continuous stretch of DNA that has been compacted and folded around proteins. If the 46 chromosomes from one human cell were unraveled and lined up end-to-end, they would measure approximately 6 feet long!

Individual chromosomes can be studied using microscopes, but the double helix of a chromosome is so thin that it can be detected only by innovative, high-tech procedures. Chromosomal DNA from a single cell is not visible to the naked eye. However, when chromosomal DNA is extracted from multiple cells, the amassed quantity can easily be seen and looks like strands of mucous-like, translucent cotton. In this activity, you will isolate your own chromosomal DNA from a large quantity of cheek cells and fashion the DNA into the centerpiece of a wearable pendant necklace.

You will first collect a sample of intact cheek cells by swishing a small amount of sports drink in your mouth. Sports drinks contain salt (sodium chloride), and thereby are saline solutions compatible with the osmotic environment of the cells. The sports drink prevents the cells from breaking open and releasing their DNA before they are collected.

You will then lyse (rupture) the phospholipid membranes of your collected cheek cells with a detergent-based cell lysis solution. This solution dissolves the phospholipid bilayer of cell membranes by forming water-soluble complexes with them. Once the cell membranes are degraded, the cell contents flow out and create a soup of dissolved membranes, cellular proteins, DNA, and other contents. This “soup” is called the cell lysate. DNA is soluble in the cell lysate and is not visible to the unaided eye.

However, DNA is insoluble in ethanol. Therefore, you will apply a layer of ethanol on top of the cell lysate to visualize the DNA. Once the ethanol hits the cell lysate, DNA will precipitate out of the solution, forming a translucent cloud of fine, stringy fibers at the point where the ethanol and cell lysate meet. The salinity of the sports drink neutralizes the charge on DNA and allows the strands to clump together as they precipitate. You will then transfer your precipitated DNA to a pendant tube and fashion a DNA necklace with colored string.

Instructions

1. Using a marker or label provided by your teacher, write your name or initials on your 15-mL tube.
2. Pour the sports drink from the small plastic cup into your mouth (do not swallow) and swish it around for 1 full minute. As you swish, gently and continuously scrape the insides of your cheeks with your teeth to help release the cheek cells.
3. After 1 minute of swishing, spit the sports drink with collected cheek cells back into the small plastic cup.
4. Carefully pour the contents of the small plastic cup into your labeled 15-mL tube. Discard the cup.
5. *This is an optional step that will not affect the results of the procedure but allows collected cheek cells to be visualized. You may be instructed to perform this step or to skip ahead to Step 6.*

If time allows, you can watch your collected cheek cells settle out as a pellet in the bottom of your 15-mL tube. Place your tube upright in a test tube rack or beaker and let it stand undisturbed. After 5–10 minutes, you will begin to see the cells collect in the bottom of the tube. Maximum settling will occur after 20–30 minutes. Hold the tube up to the light to better see the cells sinking to the bottom of the tube. Some cheek cell samples will pellet more tightly and quickly than others and some will have a higher percentage of cells than others. This variation is a normal byproduct of the procedure.

6. Bring your 15-mL tube to the solution station. Using a plastic pipet, add 2 mL of cell lysis solution to your collected cheek cells. Use the graduations marked on the plastic pipet to measure the 2-mL amount.
7. Cap your 15-mL tube tightly and invert it 5 times. This action mixes the cell lysis solution with the collected cheek cell sample. Allow the tube to stand for 2 minutes.
8. Bring your 15-mL tube to the solution station. Hold the tube at an angle and, using a plastic pipet, carefully add cold 70% ethanol by running it down the inside of the tube. Add the ethanol until the total volume reaches 12–13 mL (use the lines on the side of the tube to help you measure). You should have two distinct layers. **Do not mix the cheek cell lysate layer with the ethanol layer.**
9. Watch closely as wispy strands of translucent DNA begin to clump together where the ethanol layer meets the cell lysate layer. The DNA will look like a cobweb extending up from the lysed cheek cell layer. Tiny bubbles in the ethanol layer will appear where the DNA precipitates.
10. Place your 15-mL tube upright in a test tube rack or beaker and let it stand undisturbed for a minimum of 10 minutes. During this time, DNA will continue to precipitate out of solution and extend like a ribbon through the entire ethanol layer. DNA yields will naturally vary within the class and not all DNA samples will extend through the entire ethanol layer.
11. Tie the ends of your embroidery string together with a knot to form a loop. Make sure the loop can fit over your head, as this will become your necklace string.
12. Use your plastic pipet to transfer your precipitated DNA out of the 15-mL tube and into the pendant tube (see Figure 1). Begin pipeting the DNA from the end of the most extended strand in the ethanol layer. As you pipet from this point, the DNA will be drawn up together. You should not move your pipet tip down into the cell lysate layer. If some of the DNA remains attached to the cell lysate layer, draw your pipet up until the DNA in your pipet detaches from that in the cell lysate layer. You do not need to transfer the entire precipitated DNA sample into your pendant tube. Before you expel your DNA into the pendant tube, allow it to sink to the tip of the pipet so that it will enter the pendant tube first. If the DNA does not sink, release ethanol into the 15-mL tube dropwise until the DNA is in the pipet tip. Expel the DNA into the pendant tube and fill the remaining space dropwise with ethanol. Do not overfill.

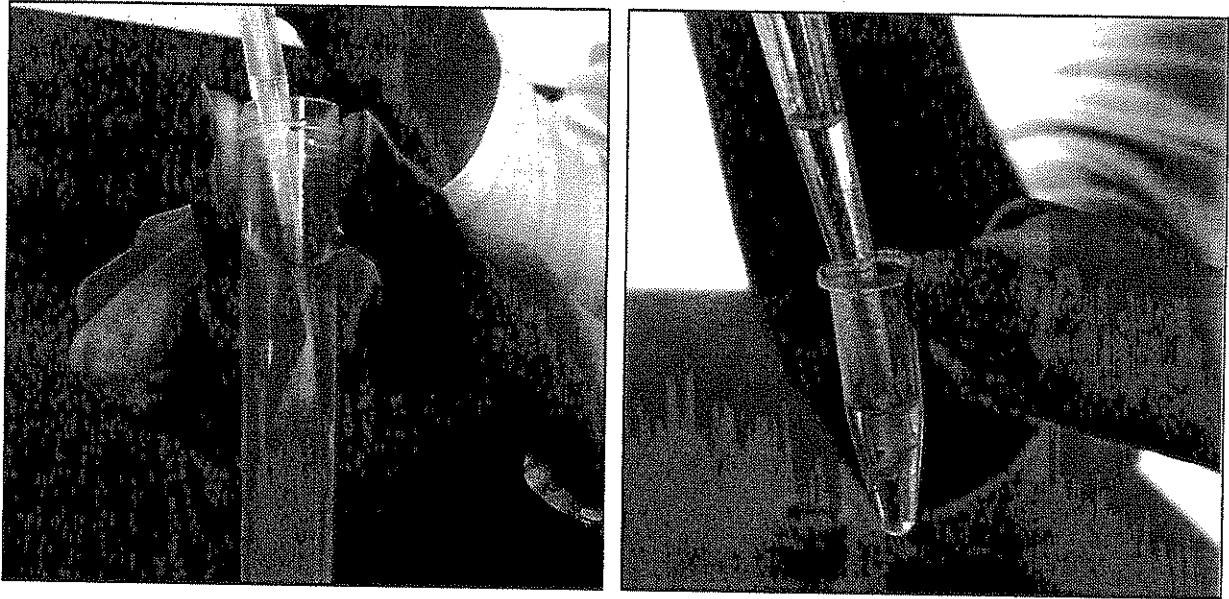


Figure 1. Transfer of precipitated DNA

13. With the pendant tube open, place the loop of your embroidery string around the cap hinge. Close the cap and put on your DNA necklace! Invert your pendant tube to see your DNA move through the ethanol.

Questions

1. Describe how long strands of double-helical DNA fit into the nucleus of a single cell.
2. Why is a sports drink used to collect the cheek cells instead of water?
3. What does the cell lysis solution do to the cells' membranes?

