Module Overview

In this lab, students will break open the cells from strawberries or peaches and isolate the DNA from the cell nuclei. After this lab, students will be able to answer questions like: Is there DNA in your food? How do you know? and If DNA is so small it fits in one cell, how are we able to see it with our eyes after extraction?

Goals

There are three main take home messages we hope the students come away with. Before the hands on portion, take some time to discuss what they will be doing, and why it is valuable. Please refer to the online video for some suggestions on how this conversation might go, and a demonstration of the experiment.

1. ALL living things have DNA-it is the blue print from which all living things are built.

You can try getting this point across by first asking if anyone knows what DNA is. After taking some of their answers, make sure to describe that our DNA is found in the cell nucleus, and is what encodes our genes, which determine things that make us unique from other people, like our hair color and our eye color etc. Interestingly only about 0.1% of our DNA is actually different! However, because we do have these unique differences, DNA can be a useful tool for many things: crime solving, predicting illnesses, identifying family members and more.

The study of genes, the DNA that makes these genes, and the differences people have because of those genes, is called genetics.

2. ALL cells within an organism have the same amount of DNA, wound up within a certain number of chromosomes found in the nucleus.

This has to be true because all of us (and all other living things) first start out as only one cell, with all the information needed to become an entire being. This cell divides to create billions of cells, which make up our bodies. When a cell divides, the two resulting cells (daughter cells) each contain a copy of the same DNA that was in the nucleus of the first (parent) cell. The cells eventually become different (for instance the cells in your eyes are different form the cells in your lungs) by expressing

different genes (encoded by areas of DNA) and not expressing others.

3. Science is accessible and useful!

We are using everyday products to extract real DNA from real cells. Even in crime labs the concepts are the same, and the ideas are simple.

Background information

DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms, including plants, fungi, animals, and bacteria. DNA contains the biological instructions that make each species unique. DNA, along with the instructions it contains, is passed from adult organisms to their offspring during reproduction. Nearly every cell in a person's body has the same DNA.

Most DNA is located in the cell nucleus (where it is called nuclear DNA) surrounded by a wall, called a nuclear envelope. The nucleus sits in the middle of a cell. The whole cell is surrounded by a plasma membrane, which serves as a barrier keeping the cell's contents inside protected from the outside environment. Because the cell is very small, and because organisms have many DNA molecules per cell, each DNA molecule must be tightly packaged. This packaged form of the DNA is called a chromosome. DNA spends a lot of time in its chromosome form. But during cell division, DNA unwinds so it can be copied and the copies transferred to new cells. DNA also unwinds so that its instructions can be used to make proteins and for other biological processes.

Nucleotides and the Double Helix

The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Human DNA consists of about 3 billion bases, and more than 99 percent of those bases are the same in all people. The order, or sequence, of these bases determines the information available for building and maintaining an organism, similar to the way in which letters of the alphabet appear in a certain order to form words and sentences. DNA bases pair up with each other, A with T and C with G, to form units called base pairs.

Each base is also attached to a sugar molecule and a phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called

a double helix. The structure of the double helix is somewhat like a ladder, with the base pairs forming the ladder's rungs and the sugar and phosphate backbone molecules forming the vertical sidepieces of the ladder.

Replication, translation and the cell

An important property of DNA is that it can replicate, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell. Specific chunks of the DNA sequence, called genes, can be translated into proteins, generating all the components required for a cell to function and live. Each gene is like a word in the sentence (or paragraph!) that is a chromosome. It is thought that humans have 30,000 to 40,000 genes in the human genome.

There are normally 23 pairs of chromosomes in the human genome. Cells are the basic building blocks of all living things. The human body is composed of trillions of cells. They provide structure for the body, take in nutrients from food, convert those nutrients into energy, and carry out specialized functions.

DNA fun facts

- There are about 2 meters (6 feet) of linear DNA in each cell of your body! Think of how much in all your cells combined!!

- James Watson and Francis Crick are often credited with "discovering" the structure of DNA, but their "discovery" would not have been possible without the work of a third scientist, Rosalind Franklin. She took X-ray pictures of DNA molecules, providing the key to solving its structure.

- If the DNA from all the cells in your body was streched out, it couuld reach to the sun and back 700 times!

- Any two individuals differ in about three million - 3 x 10 6 bases (0.1%).

References for more info

Cells Alive-how big is a cell? http://www.cellsalive.com/howbig.htm

The Mad Scientist Network http://www.madsci.org/

The Exploratorium http://www.exploratorium.edu/

Send your friends a DNA-o-gram http://www.dna2z.com/DNA-o-gram/

National Human Genome Research Institute http://www.genome.gov/25520880

NCBI's Science Primer http://www.ncbi.nlm.nih.gov/About/primer/index.html

Experimental overview

In this lab, students will break open the cells from strawberries or bananas and isolate the DNA from the cell nuclei.

Break open the cells. Physically mashing up the produce breaks open the cells. This allows us to access the DNA that is in the nucleus of the cell.

Get rid of proteins: Adding the soap (a detergent) and salt breaks open proteins and dissolves the cell membranes. Detergents, like soap, are used ALL the time to denature or breakdown proteins and lipid membranes.

Filter unwanted material: Cheese cloth is used to filter out other parts of the cell. Cells are complex and if you only want DNA you need to eliminate the proteins and other cellular components.

Precipitate DNA: Alcohol is used to precipitate the DNA. DNA is soluble in water but not alcohol, so by adding alcohol, you can see the DNA come out of solution

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