DNA Analysis

There has been a lot of news in the last few years on the subject of DNA evidence at a crime scene. What we want to do is look at what DNA analysis is, how exclusive it really is, and what evidence of one's DNA at a crime scene means and does not mean.

First you need to understand what DNA is and where it is found. DNA is an acronym for the chemical name of the material that makes up the genetic code in all living materials cells. It is the name for the chemical that directs all the rest of the chemical reactions that make it possible for all living cells to live and hence for all living things to live. When something interferes with the cell's ability to live, the organism dies. This same thing applies whether we are discussing a virus, bacteria, plant, animal, or you. The DNA is what makes up genes, which are in the nucleus of all cells. That is the cells that make up the skin, heart, liver, lungs, muscles, etc. It is not generally found in cells that are dead, such as fingernails, hair, except hair roots, etc. It is found in the body fluids which contain cells, such as saliva, blood, etc.

What scientists have discovered is that DNA is actually made up of two ribbons of material. The outside of the ribbon has the molecules that hold the whole ribbon together. Then at regular intervals along the ribbon, other molecules stick on/out. These make the ribbon look sort of like a ladder that has been broken into two pieces with the "rungs" broken all jagged. The molecules that stick out are called bases. These go together in pairs and are therefore usually referred to as base pairs. In point of fact there are only 4 of these bases. They are usually named for the first letter of the chemical name of the molecule. Therefore we have A, T, C, & G. Now A can only hook to T and C can only hook to G.

These are called base pairs. One of the pairs is on one ribbon, it's mate is on the second ribbon. When the two ribbons are together, the base pairs match up & link. See the example on your desk. There are lots and lots and lots of these bases on each pair of ribbons. Each pair of ribbons is called a gene. In most cells, there are two of each gene, one from the mother & one from the father. Each type has a different number of genes. For humans the number of gene pairs is 23. In other words there are 46 genes in each human cell nucleus. It is believed that it takes a sequence of 3 base pairs to code for a single atom in protein molecule. Some protein molecules consist of long, long chains of atoms. Therefore it requires 2 times the number of atoms in a protein to code for that protein molecule to be made. The Human Genome Project has been working for a number of years on trying to figure out the order of the sequences of the proteins on the genes. There is still a long way to go on the project.

The way they attempt to figure out the gene sequence is basically the same way that DNA fingerprinting is done. First the cells in the tissues are broken up so that the DNA can be extracted. Then the DNA is mixed with an enzyme that will recognize one particular base pair sequence and break the gene every time it finds that particular base pair sequence. In our case that is going to be GAATTC. We are going to call this an enzyme site. How many enzyme sites can you find on the DNA piece that you have labeled Example 1?

You will notice that not all the fragments are the same lengths. So the next thing we need to do is figure out how long each of the fragments are. When this is done in the laboratory, a technique called gel electrophoresis is used. This is very similar to the chromatography that we did earlier. The principle is the same. The actual materials used

are just a little different. So the lighter segments will move faster and the heavier segments will move slower with the net result that we will have separated the segments into sizes. So the next thing we need to do is count the number of base pairs in each fragment. You only need to count one side of the double strand. Not both. Put the number of base pairs above each segment.

Now we need to look at how these would spread out on a gel. Use the gel template to mark how many segments are in each section. You will notice that some sections have more than one segment and some sections have none. You will notice that it makes the template look like there will be holes or gaps between some of the sections and that some of the sections will therefore be darker than others.

When DNA fingerprinting is done in the laboratory, there are a couple more steps that have to be taken. Unfortunately the gene segments are not colored the way the pens and the juices were. Therefore the naked eye can not see where the segments are. So what is done is that a radioactively labeled molecule that will only bind to specific base pair sequences is flushed over the gel. The gene sequences react with the radioactive molecules and then a piece of x-ray film is placed on top. The radioactive part will expose the film. The more radioactive a site is, the darker the film will be in that area. So the more of a certain length of segment there is in one area, the more radioactive material will be retained and hence the darker the area will be. If you have ever seen pictures of DNA fingerprinting, this is how that is done. We will be looking at some of them tomorrow.

Today we want to look some more at how the gene patterns are broken up. You have been given a few more gene sequences to practice on. Use your enzyme to break these up into their gene segments. Then count how many gene pairs are in each sequence. Put down the number of segment in each number for the various practice genes. Compare how the various patterns would be different.

Today we will look at what some actual DNA fingerprints look like. Then we are going to practice cutting more DNA up into segments as we solve a crime one of you perpetrated! You are all under suspicion of being the thief! But only one person did it. And even I don't know whom that person is.

You will notice how different the gene segment sequences are in each of these individuals. Can you see how this is a visualization of the same thing we have been doing in class?

Now for the rest of the time we will be comparing the gene splices of members of the class to determine who stole the cookies from the cookie jar. In our case today, the cookie jar broke when the thief tried to steal the cookies. The sharp edge must have cut the thief, because there was some blood on the jar. You all have a copy of the gene found on the jar. We have gotten your parent's/guardians permission to draw a sample of your blood for comparison. You each have a sample of your own blood and two other people's in the room. This is to prevent mistakes, either accidental or deliberate. We need to identify "who dun it!" Any extra time can be spent working on any powders or other samples you wish to relook at before we attack our main crime scene.