Name _____ Date _____ Period _____

Lab: DNA Fingerprinting

BIOLOGY: CHAPTER 9

Purpose: To understand the basics of DNA fingerprinting used in the Canadian courts for crime convictions and paternity suits.

Introduction: The process of **DNA fingerprinting** was developed by Professor Alec Jeffreys at Leicester University in 1984 as a form of genetic analysis. It was first used in the law courts of England in 1987 to convict a man in a rape case. It has now been used successfully in many crime and paternity cases in North America.

A strand of DNA comprises many genes with intervening sequences found between the genes. The genes along a length of DNA do not join up neatly with each other. In between the genes which code for protein synthesis are regions of bases which form a nonsense code. These are called **hypervariable regions** because they vary dramatically from one person to another. No two people, except identical twins, share the same set of regions.

In the hypervariable regions a simple sequence of ten to fifteen bases called a core sequence can be repeated over and over again. It is as if the base sequence is "stuttering" and in some places there are very long lengths where a base sequence is repeated hundreds of times. In 1984, Jeffreys made his breakthrough when he discovered that core sequences could be used as **genetic markers** for the hypervariable regions. Jeffreys isolated two core sequences of DNA and copied them many times in the laboratory to produce large quantities of markers which he labelled with **radioactive chemicals**. Now the genetic markers could be used as genetic probes. The probes can be attached to core sequences in a sample of DNA to find the position of hypervariable regions using **photographic film** to detect the **radioactivity**.

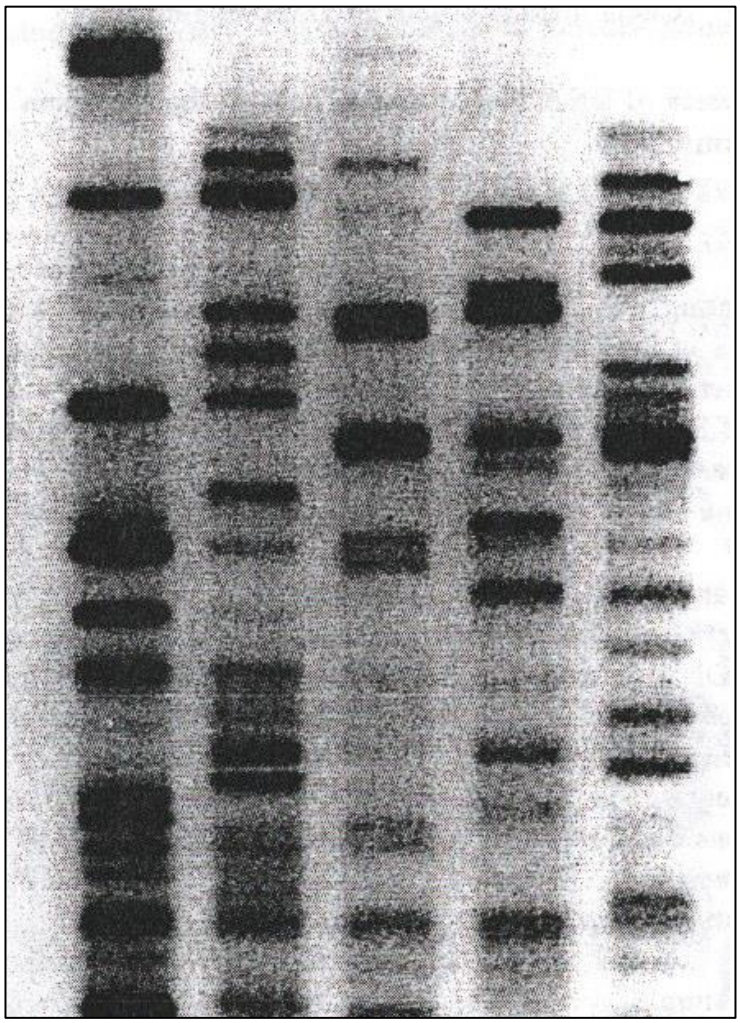
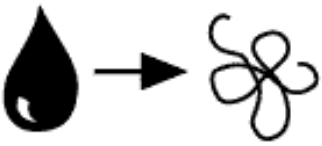


Figure I - A Photograph Of DNA Fingerprints Of Five Individuals (From Science and Technology in Society, The Association of Science Education, Hatfield, England.)

Taken and modified from http://www.docstoc.com/docs/70348964/E-Bio-Worksheet

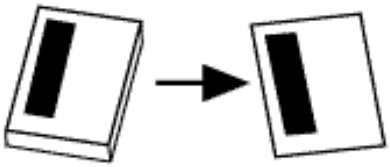
Part I - The Fingerprinting Process

1. The process begins with a blood or cell sample from which the DNA is extracted.



2. The DNA is cut into fragments using a restriction enzyme. The fragments are then separated into bands by electrophoresis through an agarose gel.

3. The DNA band pattern is transferred to a nylon membrane.



4. A radioactive DNA probe is introduced. The DNA probe binds to specific DNA sequences on the nylon membrane.

5. The excess probe material is washed away leaving the unique DNA band pattern.

6. The radioactive DNA pattern is transferred to X-ray film by direct exposure. When developed, the resultant visible pattern is the DNA FINGERPRINT.

The sample to be tested has the **DNA** removed from the cells that are available. The DNA molecules are cut by **restriction enzymes** into millions of small fragments. The enzymes do not cut the hypervariable regions which keep their original length. The DNA fragments are put in a well in a specially prepared **agarose gel**. The molecules are negatively charged and so when an electric field is applied they move towards the opposite end of the gel which is positively charged. Smaller fragments move faster than larger ones with the result that the DNA fragments are separated by size. This is a slow process and can take a number of hours. The DNA fragments are then transferred to a nylon membrane which is incubated overnight with the **radioactive genetic probes**. The probes bind to the DNA containing hypervariable regions. The unbound probes are left to wash off and the membrane is dried. A sheet of **X-ray film** is placed next to the membrane in a lightproof cassette. Radiation from the DNA probes irradiate the film so that it is exposed beside all those places where the probes are bound to be the matching fingerprinting sequences. When the film is developed the exposed areas appear as **bands** along the track of the DNA pattern. These bands are the **DNA fingerprint**. It appears as a series of light and dark bands much like a bar code.

Part II- The Paternity Suit

By comparing the DNA fingerprints of a mother and her child it is possible to identify DNA fragments in the child which are absent from the mother and must therefore have been inherited from the biological father. If a claimant is the father, then all of the child's paternal bands should be present in the DNA fingerprint. The chance that a randomly picked man would accidentally contain all of these paternal bands has been estimated to be 30,000 million to 1. Found in Figure III on the evidence sheet are the DNA fingerprints for TWO paternity cases. **The M stands for mother, F for father and C for child.**

Taken and modified from http://www.docstoc.com/docs/70348964/E-Bio-Worksheet

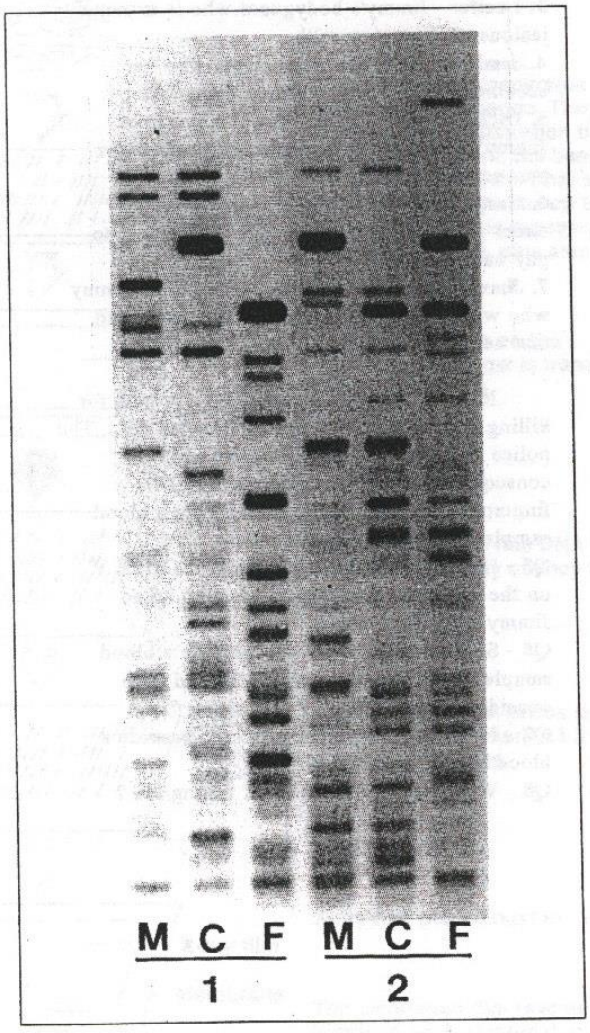
1. Case 1
A young woman claimed that her son was born as the result of an extra-marital affair with a famous athlete who was a multimillionaire. The athlete denied paternity, so the woman took her case to court, and sued for an extremely generous child support payment. The three individuals gave blood samples for DNA analysis, and the fingerprints are shown in Group 1 of Figure III.

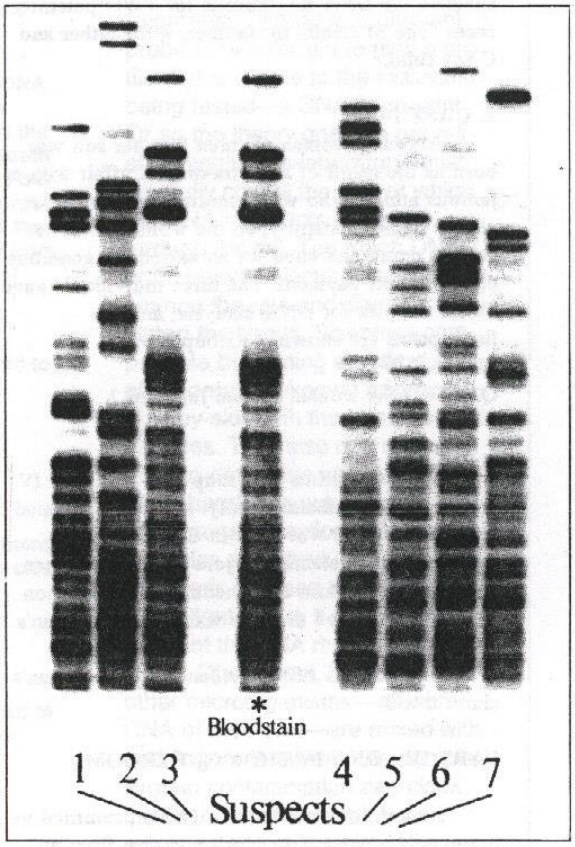
Q1. Was the woman's claim justified?

2. Case 2
The fingerprints of Group 2 of FIGURE III are from a Guatemalan family. A woman claimed that her daughter was born in Canada and emigrated to Guatemala to join her father. When she wanted to return to Canada, the immigration authorities claimed that she was not the woman's real daughter.

Q2. On the basis of the evidence is the woman's claim true?

Figure III – Paternity Cases Figure IV – Murder Case





Taken and modified from http://www.docstoc.com/docs/70348964/E-Bio-Worksheet

PART IV - DNA IN THE COURTROOM

Jimmy Solo. a famous rock star, returned to his remote upstate New York mansion from an appearance in Toronto. As Jimmy entered the side entrance he noticed a great mess in the living room and den. Drawers had been emptied ; couch cushions ripped open; the furniture was in disarray and the wall safe in the study was open. He stormed upstairs to see if his expensive jewelry collection had been touched and upon doing so heard someone in his bedroom. He grabbed a small metal statue and rushed into his bedroom surprising the thief. In the ensuing struggle the thief's gun discharged killing Jimmy instantly. The next day the housekeeper found Jimmy dead on the floor and immediately contacted the police. The subsequent investigation identified seven possible suspects. They were:

1. Willie James - lead guitarist in Jimmy's band who was constantly upstaged and underpaid by Jimmy.
2. Samantha Smith - Jimmy's former girlfriend who was dropped by him following three years of cohabitation..
3. Lucifer - Jimmy's bodyguard who is extremely jealous of Jimmy's wealth.
4. Jamie Waite - Jimmy's manager who has accumulated massive gambling debts.
5. Dicky Schultz - a former acquaintance of Jimmy's who claims he is owed thousands for past services.
6. Casparina - Jimmy's new girlfriend who is under pressure from former friends to pay back large loans.
7. Jimmy The Weasel - a former friend of Jimmy who was promised a position in Jimmy's band that never materialized.

It was established that all had a motive for killing Jimmy and none had an ironclad alibi. The police realized they had a problem and consequently decided to undertake a DNA fingerprinting of all suspects and from a blood sample taken from the crime scene.

Q3. Using the DNA fingerprint in Figure IV on the evidence sheet, determine who killed Jimmy solo. Who was it?

CONCLUSION QUESTIONS:

1. If all humans share 95.5% or more of their DNA, how can a DNA fingerprint differentiate between to individuals?

2. What are DNA fingerprints currently used for?