DNA Profiling

Since 1987, forensic DNA analysis has made appearances in U.S. courtrooms. Originally known as "DNA fingerprinting," this type of analysis is now called "DNA profiling" or "DNA typing" to distinguish it from traditional skin fingerprinting.

Application of DNA Profiling

Diagnosis of inherited disorders

DNA profiling is used to diagnose inherited disorders in both prenatal and newborn babies in hospitals around the world. Early detection of such disorders enables the medical staff to prepare themselves and the parents for proper treatment of the child.

Personal identification

The U.S. armed services have begun a program to collect DNA fingerprints from all personnel for use later, in case they are needed to identify casualties or persons missing in action. The DNA method will be far superior to the dog tags, dental records, and blood typing strategies currently in use.

Paternity Testing

In cases of disputed paternity (who the father of a child is), an initial comparison between the DNA profiles of a mother and child will show which parts of the child’s DNA matches with the mother. DNA analysis of the possible father makes it possible to decide if the man in question is the child’s father. This is because the DNA from the child that does not match the mother should match the father.

Pet Identification

People are now able to send their dog’s DNA away to determine its breed. If someone rescued a dog and they aren’t sure of the different mixes of breeds their dog is, they can swab their dog’s mouth and get a DNA profile back stating the different breeds the dog is a mix of.

Forensic or criminal

FBI and police labs around the U.S. have begun to use DNA fingerprints to link suspects to biological evidence-blood, hair, or items of clothing-found at the scene of a crime. Since 1987, more than 150 cases have been decided with the assistance of DNA fingerprint evidence.
How can DNA be used to identify an individual?

Every single cell in our bodies contains DNA; the genetic material that programs how cells work. 99.9 percent of human DNA is the same in everyone, meaning that only 0.1 percent of our DNA is unique!

Each human cell contains three billion DNA base pairs. Our unique DNA, 0.1 percent of 3 billion, amounts to 3 million base pairs. This is more than enough to provide profiles that accurately identify a person. The only exception is identical twins, who share 100 percent identical DNA.

At a crime scene, DNA is everywhere. It is present in all kinds of evidence collected at the scene, including blood, hair, skin, and saliva. Scientists can analyze the DNA in evidence samples to see if it matches a suspect's DNA.

How is DNA analyzed?

On the left, you can see how DNA evidence is collected and analyzed. In the past, DNA analysis required an evidence sample at least the size of a dime. Today's techniques can multiply the DNA, producing millions of copies from tiny amounts of evidence, such as the saliva from a cigarette butt.

1. DNA is collected and replicated so there is plenty of it.

2. The DNA is cut into fragments using specialized protein “scissors” called restriction enzymes. Restriction enzymes work like scissors in that they cut the DNA at different locations. Where the enzyme cuts depends on the code within the DNA molecule that is recognized by the enzyme. The length of the fragments will vary from person to person because the code for every person’s DNA is different. Some will be longer and some will be shorter.

For example: Enzyme A recognizes the sequence CAT, so everywhere there is a CAT it will cut the DNA.

**DNA of Person #1:** GCTTTACCATGTATTTCCATAACATTT

**DNA of Person #2:** TCCATTTTTAAACTATACATCGGG

When the DNA is cut, each person’s DNA will be cut in different lengths.
DNA of Person #1: (4 PIECES AT DIFFERENT LENGTHS)
1: GCTTAC
2: CATGTATT
3: CATAA
4: CATT

DNA of Person #2: (3 PIECES AT DIFFERENT LENGTHS)
1: TC
2: CATTAAAACCTATA
3: CATCGGG

3. Then you put the fragments on a layer of gelatin and hook up an electric field to the ends of the gelatin. When you switch on the current, it attracts the fragments across the field. DNA has an overall negative charge, so it will move toward the positive end.

The agarose gel is a thick, porous jello-like substance. It acts as a molecular strainer allowing small pieces of DNA to move through easier than the larger pieces. By turning on the electric current, the positive charge at one end will attract the negatively charged DNA across the gel. When complete, the DNA fragments will be distributed in the gel according to their lengths, with the shorter ones traveling further than the longer ones.

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Identify which lines in the above gel match the DNA strands from each person. Write the number of the DNA strand (1, 2, 3, or 4) next to each line above.
Can DNA evidence exonerate wrongfully convicted prisoners?

The Innocence Project at New York's Benjamin N. Cardozo School of Law aims to clear prisoners wrongfully convicted of crimes. The project uses DNA profiling evidence to support the re-evaluation of criminal cases. But DNA evidence alone is not enough to get a person out of jail: the case must be re-examined by a judge, along with lawyers representing both sides of the case. Since 1992, the Innocence Project has exonerated over 100 prisoners, including eight who were on death row - one of whom was only five days from execution.

Thirty-three states restrict the time for post-trial submission of DNA evidence to six months or less. New York and Illinois, on the other hand, will reconsider cases with compelling DNA evidence regardless of when the trial ended. Unfortunately, the evidence from some cases has been lost or destroyed, making DNA analysis impossible.

Is this technology used appropriately for justice?

DNA profiling can be a powerful tool in criminal investigations. When used correctly, DNA profiling is a powerful forensic tool. It can be used to quickly eliminate a suspect, saving time in searches for perpetrators. And it can provide compelling evidence to support a conviction and, most importantly, reduce the chances of a wrongful conviction.
ROCK A BYE BABY
Jennifer and Steven Barker had been married for five years. They had a good relationship but they began to drift apart. They decided to get a divorce. Everything was relatively civil, and the assets from the marriage were divided equally between the two. However, there was a disagreement about the car -- a Mercedes Benz purchased after the wedding with joint funds. Both Jennifer and Steven loved the car and neither would give it up. The judge in the case, Judge Tomson, decided Steven would get the car.

Several months after the break up, Jennifer discovered she was pregnant. She claimed Steven was the father and demanded he pay child support. Steven denied he was the father. He claimed Jennifer was just trying to get back at him for keeping the car and refused to pay any support for her baby. The legal battle went on for months, until well after baby Andrew was born. As with the dispute over the car, Judge Tomson again had to settle the case. She ordered DNA fingerprinting done on Jennifer, Steven, and Andrew.

Take a look at the DNA fingerprint analysis.

- M is the mother, Jennifer Barker.
- C is the child, Andrew Barker.
- AF is the alleged father, Steven Barker.

Remember, to conclude that the alleged father is truly the father, every band in the child's fingerprint that does not match in the mother's fingerprint must match in the father's.

Is Steven Barker the father or not? __________ Explain how you arrived at your answer.

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A FAMILY DISEASE
The Rieser family had a long history of a strange disease. The earliest known case of the disease occurred in Jeb Rieser back in 1765. Originally from a small village in England, he was the first member of the family to come to America. When he was about thirty-five years old, Jeb developed problems walking and coordinating his fine motor movements. He deteriorated rapidly, losing all muscle movement, and died several years later. He left his widow with five children, none of whom developed the disease.

As the years passed and the family grew larger, many other cases of this strange disease were noted. In 1896, a doctor diagnosed the disease as Jenkins neuromuscular disorder (JND), naming the disease after himself for having discovered it. Dr. Jenkins had no cure and no treatment for the family but he did recommend that no member of the family have children until they were over thirty-five years old to ensure the disease would not spread. Few followed his advice. Most of the Riesers were farmers and needed help with the land. Large families were needed. They could not wait until late in life to have children.

One day in 1989, a descendent of old Jeb, Alex Rieser, was watching TV and heard a news report. It seemed that doctors could now do a DNA test to determine if someone could inherit a disease called Huntington disease, which was very similar to JND. Alex was twenty-nine years old and recently married. He very much wanted to start a family but did not want to take a chance of passing on the deadly disease. Alex decided to contact a genetic counselor at the local hospital. The counselor told him there was a chance the disease could be diagnosed with a genetic test. The test would require DNA fingerprints from individuals in the family who had the disease and individuals who were over thirty-five and didn't have the disease. Alex's relatives decided to help.

On the next page is a picture of DNA fingerprints of eight members of the Rieser family. Individuals 4, 6, and 8 have JND. The other family members do not have the disease.

Is there a particular fragment of DNA that is associated with individuals who have the disease? If so, which one is it?

Could you determine if Alex Rieser will develop this disease? How?

As it turns out, Jeb Rieser had several brothers and sisters back in England. Some of their descendants also developed this strange disease. Could this test be used to determine if a member of the English side of the family will come down with JND?
In the family below, one child is the mom’s from a previous marriage and one child is adopted.

Which child is from the mom’s previous marriage? __________________

Which child is adopted? __________________