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DNA FINGERPRINTING

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by

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ABSTRACT

Because DNA fingerprinting is such a new and dynamic technology, many people do not understand the basics behind it and therefore panic when the topic of a DNA database is brought up, or fail to do their job as jurors. The purpose of this paper is to discuss this controversial topic for those that may not have an extensive background in biotechnology so that they can understand and accept the results of DNA fingerprinting. The authors of this project have concluded that DNA fingerprinting is a very powerful tool that when properly performed can be of great use inside and outside the courtroom.

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EXECUTIVE SUMMARY

Although the concept of DNA fingerprinting is fairly new, it has been a subject that has captured a great deal of attention in the media. DNA fingerprinting is, in a way, a new spin on the age-old concept of fingerprint identification. DNA found at a crime scene can help identify who was present at the house where a murder was committed. DNA taken from a child can be used to determine paternity or maternity. DNA may one day even be used as somewhat of an "identification card".

The concept is fairly simple; with the exception of identical twins, everyone has unique DNA. A DNA sample can be retrieved, then that sample can be tested against, let's say, the DNA of a suspect in a crime. If we find that the DNA samples match, then we can be sure that the suspect in question was present at the scene of the crime.

DNA fingerprinting was first developed in the late 1980's. It has been an invaluable tool because of the fact that its use can be found just about everywhere. When a crime is committed, the perpetrator is bound to leave behind DNA in some form. This can include skin, blood, hair, semen and saliva. If any of these can be found at the scene of a crime, then we can identify who was there.

The acceptance of DNA and forensic evidence in the courtroom has come a long way. It broke ground in the *Frye v. The United States* case, and was also very important in the case of *Daubert v. Merrel Dow Pharmaceuticals* where a mother was suing on the grounds that a drug deformed her babies.

While lesser known cases like these have paved the way for DNA fingerprinting in the courtroom, there is one case in particular that stands out above the others. Referred to as “The Trial of the Century”, the OJ Simpson case brought the concept of DNA fingerprinting right to the ‘11 O’Clock News’ on a nightly basis.

With the potential that DNA fingerprinting brings, there are also serious ethical questions that need to be dealt with. Our genome holds a great deal of our personal information, and we must make sure that our privacy and the integrity of that information are maintained especially when making a DNA database. Various ethical issues are raised concerning the use of our DNA and how it is presented and maintained.

We used all of these concepts to help us build a resource that lawyers, jurors and the layperson can read and understand, to give them a structure by which they can learn to accept the place that DNA fingerprinting tightfully holds in the courtroom.

PROJECT OBJECTIVE

The purpose of this project was to investigate the impact that DNA fingerprinting has on society. The early chapters focused on the actual description and analysis of DNA fingerprinting, and the process of forensics. The middle chapters focus on the legal cases. *The New York v. Castro* and *Daubert v. Merrel Dow Pharmaceuticals* cases represent landmark cases that paved the way for DNA fingerprinting in the courtroom. *The People of the State of California v. O.J. Simpson* case demonstrates a "sensational" case that took DNA fingerprinting and made it a household term. The following chapter discusses the various ethical issues that come into play when dealing with DNA fingerprinting. The final chapter contains conclusions from all of these individual chapters. Also, a glossary is provided, allowing the reader to understand key terms that are presented in this paper. Such terms are in **bold** type. References for all the material used can be found in the final pages of this report.

CHAPTER 1: DNA FINGERPRINTING AND TYPES

A lot of what you have read so far has been "DNA this" or "DNA that". Now it is time to get right down and discuss DNA and define what it is and the role it plays. DNA, or *deoxyribonucleic acid*, is a complicated chemical structure that forms **chromosomes**. Chromosomes are then broken up into different **genes**. Genes are what determines our characteristics, or **traits**. Such traits include eye color, hair color, etc. DNA is useful because, much like a real fingerprint, no two people have the exact same DNA.

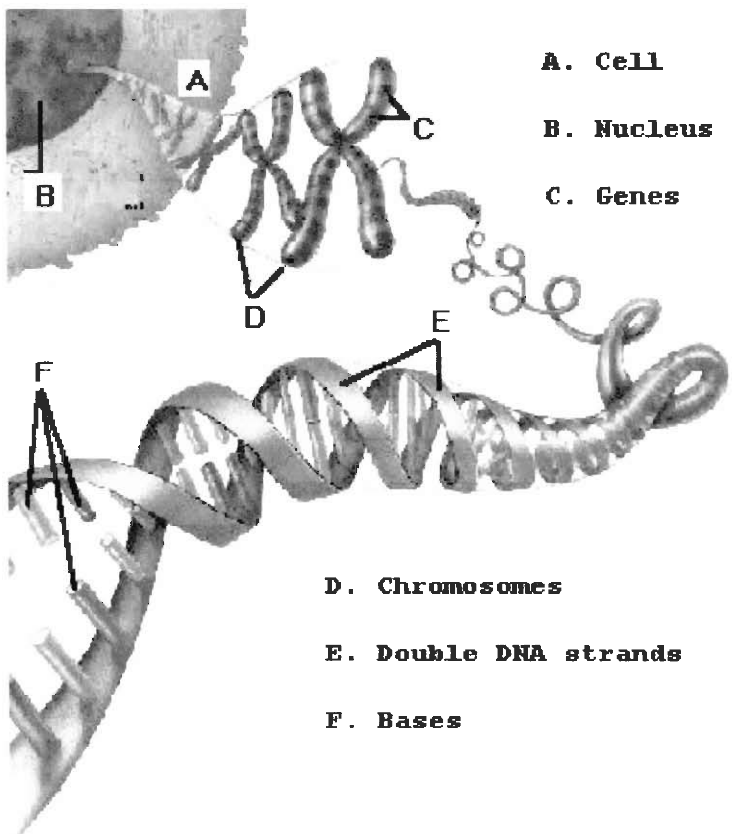

Figure 1.1: Diagram showing the relationship between DNA, genes and chromosomes, http://www.alzheimers.org/gene.html

As you can see from *Figure 1.1*, chromosomes are found in the nucleus of a cell. This figure also shows how DNA makes up the chromosome, and even shows some detail on how DNA itself is made up. The name given to the shape of DNA is "double-helix". The shape double helix resembles is that of a double spiral staircase. A better depiction of the double helix can be found in *Figure 1.2*.

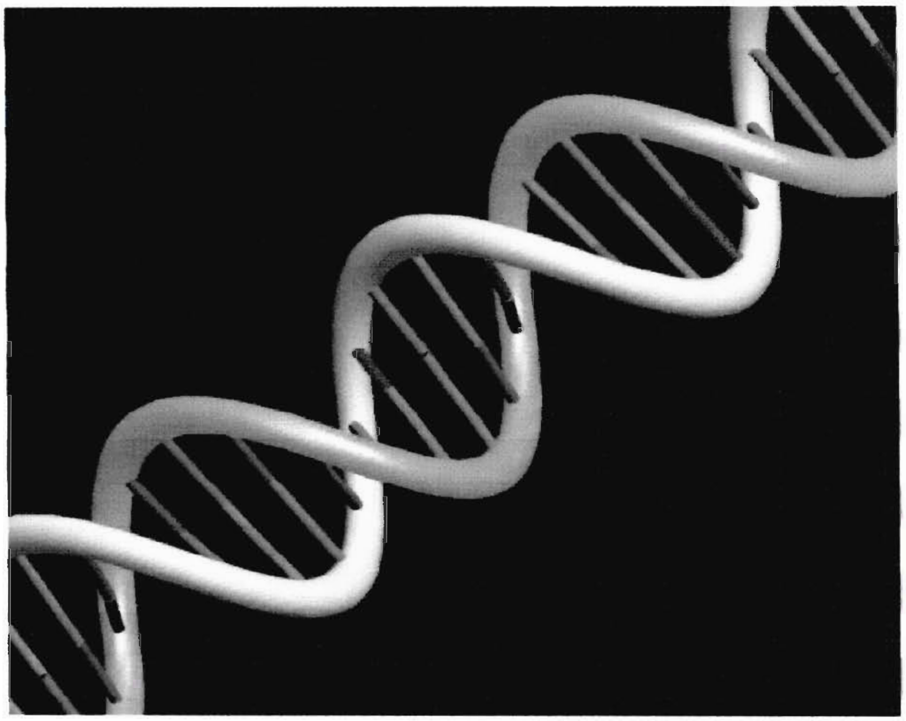

Figure 1.2: Detailed depiction of DNA's double-helix structure, http://sgce.cbse.uab.edu/ribbons/help/dna_rgb.html

The bars that you see connecting the two spirals are known as **base pairs**. These base pairs are made up of a pair of **nucleotides**. There are four types of nucleotides. They are:

Name	Symbol
Adenine	**A**
Cytosine	**C**
Guanine	**G**
Thymine	**T**

Table 1.1: The four nucleotides

There is a basic strategy to base pairing. Nucleotide A always bonds with nucleotide T. Similarly, nucleotide C always bonds with nucleotide G (*Figure 1.3)*. The nucleotides are connected to each other with hydrogen bonds. These pairs are the basis of our **genetic code**. Our genetic code acts as a blueprint for our body. It regulates cell growth and reproduction and manages the functions of cells.

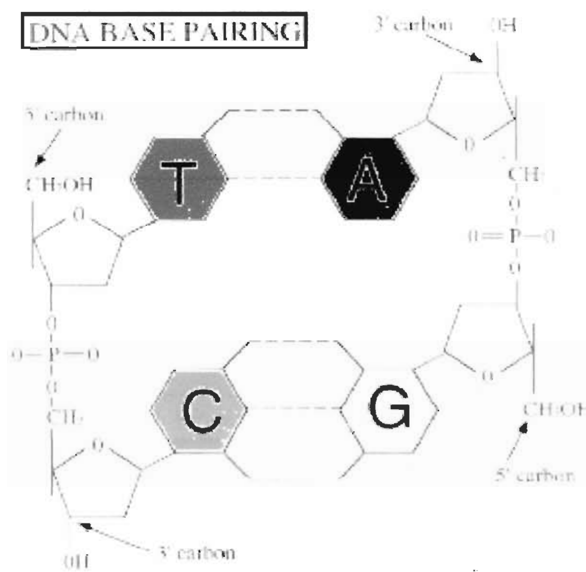

Figure 1.3: Base Pairs in detail.
http://www.biology.washington.edu/fingerprint/dnapair.gif

We have already discussed that no two people have the same DNA. What is not so well known is that despite this fact, DNA varies only slightly from person to person. As a matter of fact, the DNA sequence of a human and the DNA sequence of a chimpanzee are more than 98% identical. However, only identical twins have 100% similar DNA. It is astounding that that the unique 2% of our DNA is what makes us all different. This small fraction of DNA is the area that we want to examine closer for forensics purposes.

These unique portions are repeated over and over again in our DNA. These portions are referred to as **variable number tandem repeats**, or VNTR for short. These VNTRs are what we want to look at when performing DNA fingerprinting. These repeats are what give us our distinguishing traits and separate us from such "similar" beings such as the chimpanzee.

When DNA fingerprinting is performed, these VNTRs are isolated and examined. A method, known as "Southern Hybridization", is performed. Southern Hybridization actually arranges these VNTRs so they can be examined. This method will be discussed in detail later.

VNTR patterns are handed down from parent to child. This means that our DNA is a composite of the DNA of our parents. This is why a child may have its father's nose, or its mother's eyes.

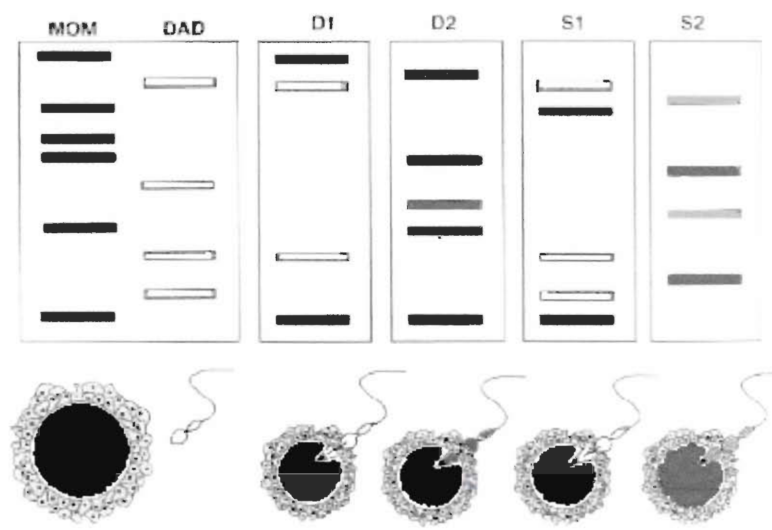

Figure 1.4: Example of parents passing VNTRs to children.
http://www.biology.washington.edu/fingerprint/dnaintro.html

In *Figure 1.4*, we can see how a child gets its traits from its parents. D1 represents the biological daughter of the mother and father. Notice that the child has VNTRs from both the mother and the father. D2 represents a stepdaughter that the mother had with another husband. The daughter has some of the same traits as the mother, but also has some traits from a father outside of this example, thus exhibiting some of the traits of her biological father. S1 represents the biological son of the mother and father. Notice that, once again, the child exhibits similarities between it and its parents. Finally, S2 represents an adopted child. Notice how this child has none of the same VNTRs the mother and the father. The adopted child's VNTRs came from his biological parents, which are not represented in this example. This is the major key in using DNA fingerprinting in determining paternity and maternity.

Up to this point we have discussed how DNA fingerprinting is applied, but we really haven't paid much attention to how the samples are processed. There are two basic methods of extracting the necessary VNTRs from the DNA sample. These two methods are Restriction Fragment Length Polymorphism Analysis (RFLP) and Polymerase Chain Reaction Analysis (PCR).

RFLP analysis involves taking the DNA strand and chopping it into smaller pieces at specific sites. This is done by using **restriction enzymes**. These restriction enzymes act as scissors, cutting the DNA at a pattern unique to each enzyme. For example, the restriction enzyme Taql cuts DNA wherever the pattern TCGA is found. Typically, around two to three restriction enzymes are used per sample. Once the "dicing and chopping" process is complete, we are left with a series of DNA fragments. These fragments then undergo the process of Southern Hybridization to isolate the DNA fragments.

Southern Hybridization is what gives us our "Southern Blot", which we use to identify the DNA sample. This process involves taking the DNA fragments and pouring them into a gel. Then an electrical charge is applied to the gel, positive charge at the bottom and negative charge at the top. DNA has a slight negative charge, so will naturally be attracted to the positive lower portion of the gel. The smaller DNA fragments will be able to travel quicker and more towards the bottom because they are slowed down less by the gel. The gel is then transformed to a piece of nitrocellulose paper and then baked to attach the DNA to the sheet. Once this is done, the Southern Blot is ready to be analyzed. *Figure 1.5* shows how a Southern Blot is made.

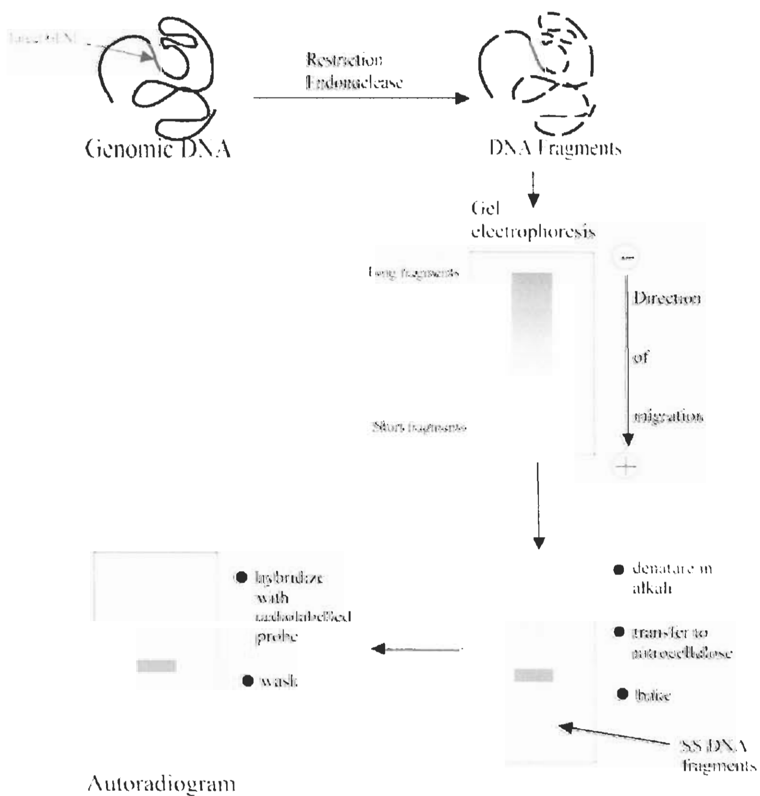

Figure 1.5: How a Southern Blot is produced.
http://users.wmin.ac.uk/~redwayk/lectures/analysis.htm

The main problem with the RFLP analysis is that it requires a relatively large DNA sample. When investigating a crime scene, it can be very hard to find a useable amount of DNA for this process. PCR analysis, however, allows the scientist to generate findings with a minimal amount of DNA. This method is able to work on minimal DNA because instead of chopping up the DNA, as is the case with RFLP analysis, PCR actually amplifies the repeated sequences by replicating them. *Figure 1.6* is an actual completed Southern Blot.

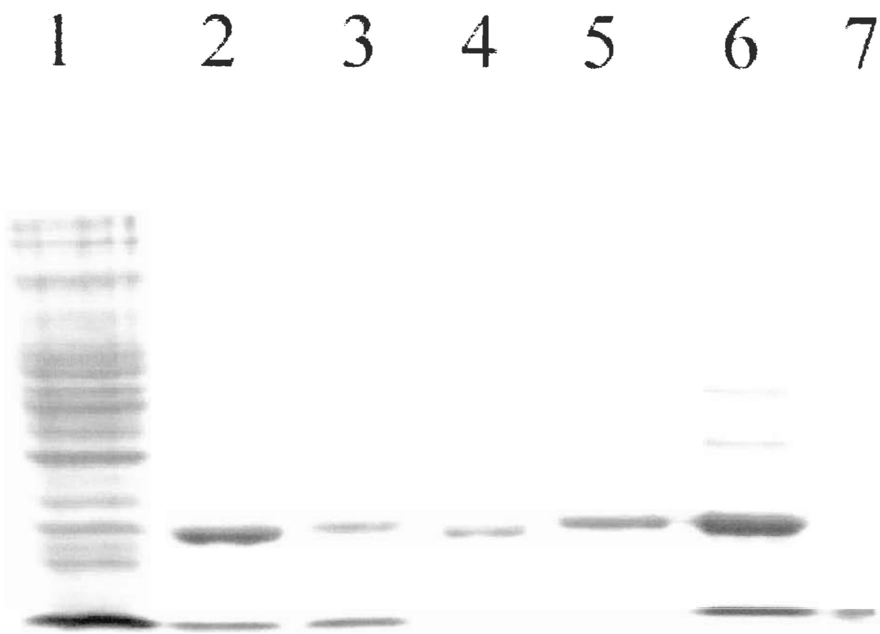

Figure 1.6: An actual Southern Blot
http://www.biotech.ufl.edu/WorkshopsCourses/mc_picture_gallery.htm

It is not necessary to completely understand every little detail about DNA and how it functions. However, the basics that have been covered so far will allow you to better understand the latter chapters of this paper. As previously stated, this paper is not intended to make a scientist out of you. Instead, we are trying to bring this information to the reader in a way that it can be understood by those who are just learning about DNA for the first time.

CHAPTER 2: FORENSICS

Forensics is what makes or breaks the case. If your evidence is collected properly then the outcome of the evidence will justify the verdict. This chapter is going to introduce the reader to the policies and procedures of DNA forensics. First, let us run through where DNA can be found. Then we will go through each one of these sources and explained how a sample is properly attained.

DNA Source	Where It Can Be Found At The Crime Scene
Blood	On body, on any surface, on the ground, on weapon on clothes, on sheets, etc.
Semen	Vaginal, anal and oral regions. On sheets and clothing. On any surface.
Saliva	On victim's skin and oral regions. On cigarettes
Hair	On victim. On the ground or surfaces. On sheets, clothing, etc. On notes and in envelopes.
Skin Tissue or Sweat	On weapon. On the victim. On the sheets or in clothing, etc. On a glass. On fingernails.
Teeth	On the ground, usually accompanied by blood.

Table 2.1: Where DNA samples can be found

Forensics is the name given to the process of collecting DNA samples. As you can see by *Table 2.1*, DNA can be found from a number of sources. If any one of these sources is found at the scene of a crime, then we can figure out who was at the scene of a crime. We will now discuss how these samples are taken:

Forensics can determine the presence or absence of blood in a stain and determine whether it is human or non-human. If it is non-human than the species can also be determined. Forensics can not determine the age or race of a person. All of these procedures should be done with latex gloves on so as to limit the risk of contamination and not to mention the possibility of transmitting diseases to the collector. Also, samples should never be stored in plastic containers. These containers promote the growth of bacteria, which can contaminate the evidence that it was supposed to protect.

Blood:

The general collection of blood requires that a qualified professional should be doing the collecting. Two five-milliliter tubes of blood in purple-top tubes with EDTA, (an anticoagulant), are what is taken by the qualified medical personnel. Drug and alcohol testing of a person is to be put into a gray-top tube that contains Sodium Fluoride. The tubes are then to be labeled each with the date, time, subject's name, location, collector's name, case number, and the evidence number. All this information is very important so that the tube(s) don't get in the wrong place at the wrong time. This ensures that this blood is there when it is needed.

Blood should be packed in styrofoam separately from each other. The blood should be refrigerated, not frozen. When shipping, the use of cold packs, not dry ice, is appropriate. A label should be put on the tube stating the following:

"Keep in a cool dry place, refrigerate upon arrival, and biohazard."

The blood should be admitted to the lab as soon as it can arrive there.

The collection process of blood involves very specific procedures so as to maintain a limited amount of contamination. For liquid blood on a person, the blood should be absorbed by a clean cotton swab or cloth. For a control, a portion of it should be left unstained. Then air dry it but be careful to not wave it in the air. Put it in a clean paper or envelope with sealed corners. Do not put in plastic. For dried blood on a person, the same procedure as with wet/ liquid blood should be performed, with one exception; the cotton swab or cloth should be moistened with distilled water so the blood can be soaked up.

Blood on surfaces can be a little different. For liquid blood or blood clots it's the same as liquid blood on a person. For blood in the snow or water, collect immediately so as to avoid more dilution of the blood. Eliminate as much snow as possible if that is the case. Put the sample in a clean, airtight container. Then freeze the evidence, and submit to the lab as soon as possible.

Bloodstains on wet garments are very simple. Air-dry the garments, and wrap the dried garments in clean paper. Do not place it in plastic or airtight containers. All debris or residue from the garments should be wrapped in clean paper or placed in an envelope with sealed corners. The garments and debris should be submitted to the lab as soon as possible. Bloodstains on wet objects are a little different. Allow the object to air dry. Avoid creating additional stain patterns during drying and packaging. Try to prevent any stain removal and abrasive action during the drying and packing of the object. Pack the object in clean paper. Do not use plastic. Once again, submit it to the lab as soon as possible.

Bloodstains on immovable objects are probably the most involved of all of these processes. A large sample needs to be cut out of the object with a clean sharp instrument. Leave a portion of the object unstained so as to have a control for the lab to compare to.

Pack in clean paper. Once again, plastic should not be used. Dried bloodstains should be collected with a clean cotton swab or cloth that has been moistened with distilled water. Leave a control of an unstained portion of the swab or cloth. Then air dry, making sure not to wave the sample in the air. Then wrap the sample in clean paper or place in an envelope with sealed corners.

A blood examination request letter is needed to processes the results, no matter what form of testing you are doing on the blood. This includes DNA testing, alcohol testing, drug testing, etc. The request letter must include a statement of facts, the claim(s) made by the suspect(s) as to the source of the blood, state whether animal blood is present or not and if the stains were laundered or diluted with other bodily fluids. It should also contain information regarding the victim(s) and suspect(s) health condition. Such conditions include if the person in question has AIDS, Hepatitis, etc.

Saliva and Sweat:

For the collection of saliva, one should use a clean cotton swab and rub the inside of the cheek and gums. The cotton swab should then be air-dried but avoid simply waiving the sample in the air. Place the swab in a clean paper or envelope with sealed corners. Do not use plastic or refrigerate. Submit to the lab as soon as possible.

Similarly, for sweat, the item in question, such as a murder weapon, should be swabbed with a cloth or cotton swab. Then the swabbing agent and the item should be secured in non-plastic containers and submitted to the lab.

Semen:

The collection of semen is very similar to the collecting of blood. Absorb the semen on a clean cotton swab or cloth making sure to leave a portion unstained for a control. Air-dry the sample and wrap it in clean paper or place in an envelope with sealed corners.

For semen on a small object, air dry the object making sure not to change any of the characteristics as presented at first, put in clean paper or envelope with sealed corners, and submit to the lab as soon as possible. One procedure for the collection dry semen on a large immovable object is the same as collected dry blood on a large immovable object. The other procedure is to absorb the semen onto a clean, cotton cloth or swab that has been moistened with distilled water. Leave a portion of the cloth/swab unstained for a control. Air-dry the sample, making sure to not change the characteristics of it. Wrap the sample in clean paper or place in an envelope with sealed corners.

The collection of seminal evidence on a sex assault victim is very crucial. The collection should be performed by a physician or in a hospital. A standard kit should be used to collect vaginal, oral, and anal evidence. The evidence should then be refrigerated and submitted to a lab as soon as possible.

Hair:

Hair samples should be picked up with clean forceps or tweezers. Any hair that has been soaked in fluid should be air-dried. Each hair should also be packaged in clean paper or a sealed envelope.

Tissues, Teeth, etc.:

One needs to call the lab before collecting any samples such as these. Following the authorization to collect such a sample, one should use a clean and gloved hand, forceps or tweezers to extract the sample from the crime scene. For red skeletal muscle, one to two cubic inches are needed. For long bone (femur, etc,) three to five inches of the bone is needed. There is a special order when collecting teeth which is as follows:

1. Non-restored molar
2. Non-restored premolar
3. Non-restored canine
4. Non-restored front tooth
5. Restored molar
6. Restored premolar
7. Restored canine
8. Restored front tooth

Tissues should be placed in clean, airtight containers. Place bones and teeth in separate portions of clean paper or envelopes with sealed corners. Freeze all of the evidence and place in styrofoam containers. If shipping is required, the samples should be packed with dry ice.

Forensics in Court:

There are many reasons why forensic evidence can sometimes not be admitted to court. If the origin of the sample is questioned then it will not be admitted. If it is not collected properly as discussed above then it will not be admitted. If it is contaminated somehow then it will not be admissible. If the sample is decomposing or deteriorating then it will not be admissible. The procedures described above are presented to make sure that neither contamination nor foul play will play a role in a false conviction. They need to be followed to ensure the utmost quality is put into the evidence. DNA evidence has the potential to be a very useful form of evidence when obtained correctly.

CHAPTER 3: LANDMARK COURT CASES

The acceptance of forensic evidence in the court has come a long way. It's come from its very primitive state as seen in the case of *Frye v. The United States*, where the case focused on the question of entering in evidence certain systolic pressure readings that changed as a person lied. It progressed along to the case of *Daubert v. Merrel Dow* Pharmaceuticals, where a mother was suing on the grounds that a drug deformed her babies. This chapter is a timeline of DNA and scientific evidence from its beginnings to its state today.

Frye v. United States (1923):

Frye was convicted of murder in the second degree. The question was if he was telling the truth or not. At that time scientists believed that if one told the truth then the blood pressure of the patient would stay the same. If the person were lying, then the **systolic pressure** of the person would rise dramatically. They believed that the systolic rises were caused by the patient's emotional reaction that sent a message to the autonomic nervous system. This theory basically said that people had to physically force themselves to lie and that truth was "spontaneous".

When telling the truth the highest systolic reading would be at the beginning and it would decline from there. When not telling the truth the systolic reading would rise when the conscious lying was occurring. This noticeable change in reading was evidence that was in dispute. They didn't know if this technique was accurate enough to be admitted into court. There was no other documentation of this method. Because of the lack of study and documentation, this evidence was not admitted into court.

This case shows that getting scientific evidence allowed into the courtroom depends on widespread acceptance of the technique. There is no definitive evidence that proves that this systolic pressure process was foolproof. Due to this fact, any 'hunch' created by this change in blood pressure would not be able to hold up in court. This case shows how, without proper knowledge of the processes at hand, it is easy to throw out the evidence that was presented.

New York v. Castro (1987):

A seven-month pregnant woman was found on her living room floor. She had no clothes on from the waist down. She had been stabbed more than sixty times. Her daughter was found in the bathroom. She had also been severely stabbed. She was two years old. A janitor, Jose Castro, from another building that fit the description of the suspect was interviewed by police. He was wearing a watch that looked like it had dried blood on it. Police asked to retain it so they could examine it. The blood on the watch proved to be that of the woman, Vilma Ponce, by DNA typing. The police gave the samples of blood of Castro and the two victims along with the watch over to Lifecodes Corporation. Lifecodes Corporation analyzed the blood for about a four-month period. They concluded that the likeliness that the dried blood on Castro's watch was that of Vilma Ponce was 1 in 189,200,000, a probability based on specific patterns present in her Hispanic population.

Unfortunately, the Lifecodes Corporation didn't use scientific techniques that were commonly accepted. Because of this, the evidence was deemed inadmissible. The defense had their victory in this case and because they knew how to get around it, this murderer got off.

As the years went on, Jose Castro admitted to the crimes. Thus further proving that proper techniques and DNA fingerprinting could have put this man away in the first place.

This case is important because it shows the complexity and potential errors in performing DNA fingerprinting. DNA fingerprinting has to be implemented with pure perfection and be understood thoroughly by all including the jury.

The People v. Wesley (1987):

George Wesley was convicted with murder in the second-degree, rape in the first-degree, attempted sodomy in the first degree and burglary in the second degree.

On September 15, 1987, Helen Kendrick was found dead in her Albany apartment. She was seventy-nine years old at the time. Helen was a patient of Albany City Hostel, which was a service that helped mentally disabled people. George Wesley was also a patient. During a check of Wesley's apartment, evidence was found; bloody garments, including a bloody t-shirt with gray and white hairs on it, bloody underpants, and bloody sweatpants.

The defendant's story as to this incident changed all the time. He told a professional that he had not known Helen when he was seen conversing and visiting her in the past. He had three different stories as to how his shirt became bloodstained. The fact that he gave very different stories proved that he was not telling the truth from the beginning. He also mentioned things that the police had not told him about the death of the victim. He stated that he "didn't choke her" when that information hadn't been released. Also he had claimed that he did not have sexual intercourse with Helen even though that information hadn't been offered to him at any point either. Wesley's statement was "I didn't do it. I turned my head and somebody else did it."

The DNA evidence against the defendant was that the blood from the defendant's T-shirt matched that of the victim, and the blood of the defendant was different than that of the victim.

A hearing was then scheduled to discuss whether or not the evidence would be admissible in court. The evidence was deemed admissible for the fact that DNA fingerprinting was now an accepted scientific practice that when practiced correctly the scientific community accepted it. *Frye v. United States* came up in the hearing as to the admissibility of scientific evidence. The following quote from *Frye v. The United States* was considered during the hearing:

> "Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the eventual force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs (emphasis supplied)."
> www.law.harvard.edu/publications/evidenceiii/cases/frye.htm

During the trial of Wesley, expert testimony about the process of DNA fingerprinting was allowed. The results of the evidence were also put forth to the jury. The jury may not have fully understood it but they did find the defendant guilty as charged. Wesley was clearly guilty not just by DNA fingerprinting but it was a triumph for the scientific world to have a case that successfully had this procedure implemented.

Daubert v. Merrel Dow Pharmaceuticals (1993):

Jason Daubert and Eric Schuller were minor children born with very serious birth defects. The parents of these children sued Merrel Dow Pharmaceuticals because of the alleged effects that a drug called Bendectin had on the mother of these children while bearing them. Bendectin is a prescription anti-nausea drug marketed by Merrel Dow Pharmaceuticals. Merrel Dow moved for summary judgment in this case on the grounds that they believed that the plaintiff would not be able to find enough information on whether this drug does in fact cause birth defects while in the womb. In support of this in the summary judgment, an affidavit of Dr. Steven H. Lamm was filed stating that he had reviewed all of the literature and studies of Bendectin in humans and found that there was no correlation between birth defects and Bendectin. This included more than thirty studies involving over 130,000 patients.

In response to the summary judgment, the plaintiff filed a motion with it's own expert's testimony which included eight experts; they stated that Bendectin could cause birth defects. The testimony was based on the "in vitro" and "in vivo" studies of this drug in animals. This study showed that there was in fact a link between birth defects/

birth malformations and the drug Bendectin. The "reanalysis" of the human studies was also included in this motion.

The court ruled that the expert testimony presented by the plaintiff could not be admissible in court for the reason that the studies were not done in humans. The "reanalysis" done by the experts was deemed inadmissible also because of the fact that the analysis of the published works stated that there was no clear correlation between Bendectin and birth defects/ birth malformations.

In this case there was no clear scientific evidence supporting the plaintiff's conclusion so the evidence was disallowed. The general scientific community just didn't accept the notion yet and there were very many conflicting opinions.

CHAPTER 4: STATE OF CALIFORNIA vs. OJ SIMPSON

The Scene:

It was June 12, 1994. The crime that led to the infamous "The Trial of the Century" was committed. There were two victims, Nicole Brown Simpson and Ronald Goldman. Neighbors who had noticed that the Simpson dog was acting weird had found both victims. When the dog was looked at closely, the fur on the belly of the dog had blood on it. One of the neighbors agreed to take care of the dog and tried to calm the animal down but the animal was just too restless. To try to calm the nerves of the dog, the neighbor took the dog for a walk. The dog led him back to the Simpson estate. The dog stopped down the path from where Nicole and Goldman lay in their blood. The neighbor peered down the dark path and could make out the outline of Nicole lying in her own blood. The police were then called.

Figure 4.1: Bloody scene at Nicole's place.
http://www.crimelibrary.com/classics4/oj/2.htm

When the police came they discovered a scene of blood and dead bodies. Nicole was partially under the fence. To her right, lay Goldman in a little garden with his eyes open and lying in his blood. The officers who arrived on the scene made sure to be careful to not contaminate the area. They stayed six feet away from the bodies at all times. They also made sure not to step in any of the blood.

Paramedics finally arrived and confirmed that both people were indeed dead. At 5AM in the morning a couple of police officers decided to go over to O.J.'s residence to collect his children who were sleeping in their beds. As the police officers approached his residence they noticed a 1994 white Ford bronco parked half on the curb and half sticking out into the street. They tried buzzing the occupants inside but there was no answer. One of them went over to the car to briefly inspect it and he found what looked to be like a blood spot near the driver's side door handle. They obtained the telephone number of O.J.'s residence and called it repeatedly. They still got no answer.

At this point, the police officers decided that they had cause to enter the property: two dead bodies two miles down the road, bloodstain on the bronco, and no answer from O.J.'s house. They decided to enter. O.J. was not to be found but "Kato" Kaelin was.

Kaelin was then interviewed. They discovered over time from O.J.'s older daughter making some phone calls that O.J. was in Chicago. A good friend called O.J and informed him of what the situation was. He was on the next flight back. In the garden of O.J.'s residence the match to the glove found at the murder scene was found covered in blood. They did not touch this glove. It was left there for inspection and collection.

On further investigation, blood spots were also found all over the estate of O.J. Simpson, leading up to the doorway of the bungalow, to the back of the car, in the car, etc.

Finally at 7:10 am, Dennis Fung, a LAPD criminalist, and Andrea Mazzola, a SID trainee began collection and documentation of all of the evidence. They were told to document all of the blood spots, collect both gloves, and have the bronco towed over to the garage for further investigation and documentation of the blood spots.

The media was now coming at full charge. So Detective Tom Lange arranged to have the body covered by a blanket from inside the house. This was one of the mistakes that would contribute to the defense of O.J. Simpson. Another mistake was when the video was taken of the crime scene, Fung collected the socks prior to the taking of the video. O.J.'s defense team played that as if the police had planted the socks them themselves.

Both autopsies had been performed by June 14th at noon. They were both performed in the presence of the two lead detectives.

The Bodies:

Figure 4.2: Photo of Nicole Brown Simpson
http://www.crimelibrary.com/classics4/oj/2.htm

The autopsies showed that Nicole had suffered from four fatal wounds including a slash across the neck from left to right suggesting that the murderer was a right-handed man. A large contusion on the back of her head was also discovered. There were also slash wounds to the hands, which suggests that she was trying to fend off the killer.

Figure 4.3: Photo of Ronald Goldman
http://www.crimelibrary.com/classics4/oj/4.htm

Goldman had suffered from slashes across the face and a large contusion on the back of the head as Nicole did. Both victims seem to have been hit in the head from behind. Goldman suffered from nineteen slash wounds in all. Four of them were deep fatal wounds.

The kind of knife that was used in the slayings of these people had been purchased by O.J just the day before.

The Blood:

The Bloodspots were found to be the most difficult part of the trial to understand by the public and by the jury. Jurist #98, Carrie Bess, a postal officer worker, said this of the technical evidence:

> "We heard how people watching the DNA testimony on television found it difficult to keep track of details. Our sentiments exactly."

http://www.crimelibrary.com/classics4/oj/index.htm

The defense's strategy as to the blood was that the blanket over Nicole could have contaminated the blood leaving a doubt of the evidence collected. Also another point was why wasn't the Bronco sealed off as evidence from the very start. This leaves the chance that someone could have contaminated or planted the evidence against the suspect. Another big issue was why junior criminalist Andrea Mazzola was the one collecting most of the evidence and why Fung didn't do it himself. Being a junior criminalist this left the jury with the feeling that she could have made a mistake in the collection of the evidence. On the stand, Fung also admitted to putting the bloodstains in plastic bags, which was a "temporary" solution to the collection of evidence. As discussed earlier, putting blood in plastic harvests bacteria, which distorts the test results. This again put doubt in the mind of the jury.

Andrea Mazzola was next on the stand and she admitted that Fung had not supervised her for the most part during the collection of the evidence. Fung had claimed that he had looked over the collection of all the evidence. This showed a discrepancy that tainted the case once again. Video was also shown that she did not always collect the evidence correctly. She dropped cotton swabs, rested her hand on a dirty footpath and then wiped tweezers with that dirty hand. She stated that she did not deliberately alter the evidence.

In conclusion, the collection of the blood was not done correctly. Procedures were done very sloppily. This left room for much error and much time to plant evidence leading the jury to have a doubt as to what to believe on top of not fully understanding what fingerprinting and forensics is all about.

DNA analysis:

Doctor Robin Cotton was next called to the stand. Doctor Cotton was the laboratory director of Cell Mark Diagnostics in Germantown, Maryland. Cell Mark Diagnostics is the largest DNA specialist unit of it's kind in America. This company did most of the DNA testing of the blood obtained from the crime scenes.

Doctor Cotton explained all of the workings of DNA analysis from RFLP analysis to PCR. Doctor Cotton also said that the DNA tests determined that Simpson's blood matches that of the blood found at the crime scene leading away from the bodies. Also DNA testing showed that the blood on the socks found in O.J. room were indeed that of Nicole's. The statistic that the blood could be anyone else's was stated as one in 1.7 billion.

The fact that the blood wasn't collected properly and was in fact contaminated was the main defense to this response so it could have altered the DNA test results. This diminished the effect that the DNA fingerprinting could have had on the jury.

Such testimonial was given over and over again, and the statistical odds got up to one in 21 billion, which flew right over the jury's heads. But all this precision was meaningless if the DNA could have been contaminated. The defense just kept on the fact that DNA fingerprinting could be wrong if the evidence was not collected properly and was indeed contaminated.

The Gloves:

Figure 4.4: *"The glove does not fit, you must acquit!"* O.J. Simpson trying on the evidence gloves during the trial.

http://www.crimelibrary.com/classics4/oj/index.htm

The gloves were the most touchable piece of evidence that the prosecution had. The gloves were a very specific kind of glove that Nicole had bought for O.J. They were his size as claimed by Richard Rubin, president of Aris Gloves, the maker of the glove. Earlier before the actual trial that day, prosecution had had a man try on a pair of gloves that were the same as the evidence gloves. The man had the same kind of hands as O.J. right down to the same thickness of fingers. The gloves fit great. They slipped right on. The suggestion during the trial was that O.J. was to try on the evidence gloves. With a pair of latex gloves on, O.J. attempted to put the gloves on. They were in fact too small to put on as seen by the courtroom and the jury. When inquiring about the trying on of the gloves later, Simpson's main defense attorney stated, "I don't think he could 'act' the size of his hands. He would be a great actor if he could 'act' his hands larger." Rubin then testified that the gloves could have shrunk due to the drying of the blood on them. The image of O.J. trying on those gloves were in the juries find forever.

EDTA found in sampling:

EDTA was found in the blood that was on the sock and blood found on the gate of Nicole's place. EDTA is an agent found in laboratory testing tubes to stop the degradation of blood. It is also found in laundry detergent and paint. The fact that the blood found on the sock had a higher content of DNA proved that it couldn't have been planted because of the fact that Nicole's autopsy blood had dropped therefore the blood from the socks had to be from the actual crime.

The jury could not understand all of that. They only could understand the fact that EDTA was present in the samplings which further lead to the fact that contamination of the crime scene was definitely a consideration in the jury's mind.

The evidence that was collected was not collected in a manner that goes by the books of forensic science. There is a procedure to be followed and because that wasn't followed no one was brought to justice when the signs clearly pointed to O.J. Simpson as presented by the prosecution. Because of reasonable doubt, Nicole and Goldman's death is still unjustified.

CHAPTER 5: ETHICS

We have already discussed how DNA fingerprinting is a very powerful tool that can be of great use to those who know how to use it. Unfortunately, when dealing with something this powerful, there is the possibility of going too far. Would you want your genetic information, including such facts as any genetic disorders that you may have, passed freely among whoever wants such information? Would you feel violated if doctors "played god" with your DNA without any knowledge of what was going on? In this chapter we plan to discuss the ethics and social concerns that are raised by the process of DNA fingerprinting.

Probably one of the most interesting cases involving the ethics behind genetic information involves the sale of the entire genome of the residents of Iceland. Now a number of ethical issues are raised here. First off, there is the issue of consent. Under United States law, it is required for people to be asked for their permission to disclose any of their personal information, especially for the sake of "making a buck". Iceland, however, managed to take a different approach. Instead of polling each individual and asking them for consent, which is next to unfeasible, they were able to simply request that people express the fact that they do not wish to have their information disclosed.

The question that immediately springs to mind is "do these people know what exactly they are getting themselves into?" While the information that they provide may prove to be useful, they may be unknowingly divulging information that they would like to keep private. These people do not know if they are helping forensic science or if they are merely catering to corporate interests. They also do not know if their agreeing to these studies could bring forth information that could mar the image of their people.

Take, for example, the scenario that would occur if the findings of this experiment showed that the people of Iceland were biologically more prone to a certain type of retardation. If this information was to reach the general public and taken in the wrong light, then some may be so bold as to stereotype Icelandic people as "retards". People need to know what they are getting into before they sign their secrets away. There is no evidence that shows that the people of Iceland were fully informed of the repercussions that could occur from this experiment.

In all ethical cases regarding genetics and DNA fingerprinting, there is one underlying tradeoff. This tradeoff is the conflict between advancing science and increasing safety versus maintaining the privacy of the general public. We could have everyone's DNA recorded on file and easily identify a suspect in a crime, but that also means that we have to give up a number of intimate details. Where do we draw the line between our well-being and our right to privacy?

Fortunately, there is an organization that was formed to help protect our privacy while still moving forwards in technology. The DNA Data Bank Advisory Committee, consisting of representatives of the police, judicial, bioethics, genetics and human rights communities ensures that the laws regarding the use of DNA stored in data banks are enforced. They also give advice on how this technology can be moved forward and upward.

The DNA data bank advisory committee is responsible for maintaining laws that keep all samples examined anonymous. This is very important because if the scientist knew who the person was or what crime they were suspect for, than the scientist could have some sort of bias towards or against the person in question. The scientist could alter

DNA evidence that could land an innocent man in jail, or let a criminal run free, and none would be the wiser.

These laws are not only useful in protecting our immediate privacy, but also prevent the inevitability of "going too far". I'm sure that you may have seen or heard about some science fiction movie where people are bar-coded and traced. Their every move is monitored and privacy becomes somewhat of a luxury. However, what was once science fiction can very well become science fact.

Only a matter of decades ago, space travel was a concept that people would laugh at and simply pass it off as "impossible". Science moved on and proved the impossible to be possible. Similarly with DNA fingerprinting, people felt that it was 'impossible' to identify the person by a tiny 'code' that was invisible to the human eye. In this case, the tiny 'code' is our genetic code.

Space technology has been used to explore our surroundings, but it has also led to the creation off weapons of mass destruction. What if DNA fingerprinting led to the creation of a new type of biological weapon? With proper education, people can voice themselves and protect their privacy and the safety of themselves and those around them.

CHAPTER 6: CONCLUSIONS

There are many threads in the science of genetics that most people do not understand. We feel that we have somewhat opened the doors of our minds, and of the minds of those who read this, to the entity that is DNA fingerprinting. Hopefully as you rest this paper down you will feel more enlightened, and more prone to acknowledge and respect the validity behind this remarkable forensic tool.

Furthermore, we hope that you, the reader, understand the process of retrieving the DNA evidence. The proper forensic methods have been described in great detail and are very 'step-by-step' like. This allows a sort of ease in the courtroom. The forensics chapter can be used as somewhat of a checklist to make sure that the sample is as contaminant free as humanly possible. It can also be used as a guide by which one can detect some foul play.

The cases described in the paper provided a framework by which one can reference cases involving DNA fingerprinting and other robust technologies. Relevant cases can be a great legal asset if used properly. These cases are the pathways that DNA fingerprinting has taken on its road to being admissible in court. In short, everyone needs to have the general knowledge of the effect that DNA fingerprinting can have in a court. If practiced properly then it can have the very outcome that is needed for the verdict to be justified.

The O.J. Simpson case is a 'textbook' example of when forensics goes wrong. The evidence that was collected was not collected in a manner that goes by the books of forensic science. There is a procedure to be followed and because that wasn't followed no one was brought to justice when all signs clearly pointed to O.J. Simpson.

Finally, we discussed how it is important that people understand what our genetic code says about us. It is obvious that we must protect our genetic identity, but must also leave some slack so that science can move forward an upward.

GLOSSARY

Base Pair:
A combination of two of the nucleotides that forms a 'bar' that connects the two portions of DNA. This is what gives DNA its 'staircase' look.

Chromosomes:
Wound up strands of DNA that are divided into portions known as genes.

Forensics:
The use of science and technology to investigate and establish facts in criminal or civil courts of law.

Genes:
Portions of the chromosomes that hold the hereditary information that is essential for cell life.

Genetic Code:
The biochemical basis of heredity and nearly universal in all organisms. It is simply a sequence of paired nucleotides (base pairs).

Nucleotide:
The basic building block of DNA. Its order determines one's genetic code.

Restriction Enzyme:
'Atomic Scissors'. Used to cut DNA strands into fragments and defined patterns.

Systolic Pressure:
The blood pressure of the heart when the left ventricle contracts.

Trait:
A distinguishing feature or characteristic. Usually defined by one's genetic code.

Variable Number Tandem Repeats (VNTR):
Repeated segments of a DNA sequence that are produced by using restriction enzymes to cut the DNA.

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