Witness: Constance Fisher

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Day 1 of 1 for this witness

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Direct Examination by David Harris

HARRIS: Doctor Fisher, who are you employed by?

FISHER: I'm employed by the DNA 2 unit in the FBI Laboratory, which is part of the Federal Bureau of Investigation.

HARRIS: You say DNA 2. What does that stand for?

FISHER: We have two DNA units. First one does what we call Nuclear DNA Unit. Performs Nuclear DNA analysis. The second DNA 2 does Mitochondrial DNA analysis.

HARRIS: And is that the -- one of the areas that you specialize in is Mitochondrial DNA?

FISHER: That is my area of expertise, yes.

HARRIS: How long have you been employed by the FBI?

FISHER: For about seven and a half years.

HARRIS: When -- just go through this. What is specifically your job title with the FBI?

FISHER: I'm a Biologist Forensic Examiner.

HARRIS: And to be a Biologist Forensic Examiner, do you have any background, education or training that allows you to do that?

FISHER: Yes. I have education. I have a Bachelors in Biochemistry from the Pennsylvania State University. I also have a PhD in Biochemistry from the University of North Carolina, in Chapel Hill. I have experienced post-doctoral molecular biology work, which are techniques which are used in Mitochondrial DNA analysis. Once I joined the FBI, I received training in how to do Mitochondrial DNA analysis and was qualified by the FBI Laboratory.

HARRIS: Let's go -- a lot of stuff there. I want to go back through some of that. First of all, when we're talking about the FBI doing Mitochondrial DNA analysis, can you briefly tell us what you mean by that?

JUDGE: Well, are you going to qualify her as an expert first, before we get into this?

HARRIS: I was going to have her give a few -- brief overview of what she does. I'll finish qualifying her.

JUDGE: Go ahead.

HARRIS: Hold on, let me change questions. You are talking about the degree that you have, or the degrees that you have, being part of, or having courses in what you are doing with the FBI at this point in time. I want to talk about that. What is it that -- try this one again. Your experience with testing Mitochondrial DNA, is Mitochondrial DNA something that's part of the sciences?

FISHER: Yes, it is.

HARRIS: And what sciences is it based on?

FISHER: It's based on general biology, molecular biology, which is part of biochemistry and genetics.

HARRIS: You were telling us what your background was. You said some of the courses, or some of your experience, your education, had some connection to that. Can you tell us what it is that you have done in terms of your education -- we'll just start with that -- that allows you to do Mitochondrial DNA analysis?

FISHER: My education gave me the background foundation for the science and the methodologies that we use in doing Mitochondrial DNA analysis.

HARRIS: I guess what I'm -- is Mitochondrial DNA just something that happens in a forensic laboratory?

FISHER: No, it doesn't. It's actually used in many other -- some academic pursuits. For instance, anthropologists use it to track how people have migrated throughout the world. Evolutional biologists look at it to see how different species have evolved from each other. It's also very -- in humans, very helpful in looking at diseases. As I mentioned, we'll be getting to -- Mitochondrial DNA is maternally inherited. And a lot of maternally-related diseases have been linked to Mitochondrial DN

HARRIS: You are saying that some of your educational background allowed you to do this. As part of the degrees that you have, did you receive training in basic chemistry and biology?

FISHER: Yes, I did.

HARRIS: And the basics, starting from the very simple, basic building blocks of chemistry and biology, is that part of the foundation of DNA and DNA analysis?

FISHER: Yes, it is.

HARRIS: You also indicated that you have had some post-doctoral work. Did you do work in DNA or in genetics after your graduation?

FISHER: Yes. In my second post-doc, I have done -- my first post-doctoral was at the National Institute of -- I'm sorry. National Jewish Center for Immunology and Respiratory Medicine in Denver, Colorado. I did a very limited amount of DNA work there. Following that, I spent five years at the National Cancer Institute, which is part of the National Institutes of Health. There I did solely molecular biology work, which deals with DNA and manipulating DN

HARRIS: You also mentioned that you have been with the FBI for a number of years now. As part of your employment with the FBI, do you also continue your education as it relates to Mitochondrial DNA?

FISHER: Not only -- well, not really as it relates -- not specifically as relates to Mitochondrial DNA. But, again, the foundation and the techniques that we use in Mitochondrial DNA, I attend meetings where Mitochondrial DNA is discussed, and discuss that with other scientists. I review the literature. There is lots of papers published in the field. I also attended some classes in methodology, statistics, and in basic forensic DNA -- forensic DNA techniques.

HARRIS: The specialized education that you get from the FBI, is that part of the process of education? Or do you also do hands-on experience or training as well?

FISHER: In the training period to become an examiner, you actually do the hands-on laboratory work as well.

HARRIS: How long of a process is that?

FISHER: About a year. It can vary. But for me it was about a year.

HARRIS: Have you also testified as an expert in the area of Mitochondrial DNA before?

FISHER: Yes, I have.

HARRIS: And approximately how many times?

FISHER: About fifteen times.

HARRIS: That would be in multiple states?

FISHER: Multiple states, both federal and state court.

JUDGE: Mr. Geragos, any cross examination as to her qualifications, the witness's qualifications?

GERAGOS: No, not -- Doctor Fisher and I have chatted before.

JUDGE: I have heard -- the Court will accept Doctor Fisher as an expert in Mitochondrial DNA, qualified to give an opinion accordingly. Go ahead.

HARRIS: Like to have marked next in order a hard copy of a Power Point presentation. Counsel has seen this.

JUDGE: It will be number 220.

HARRIS: Doctor Fisher, I'm going to show you a hard copy of this. We have this on the computer. Just for record purposes. Do you recognize this particular Power Point presentation?

FISHER: Yes. These are printouts of a presentation I prepared to explain what Mitochondrial DNA is.

HARRIS: Doctor, would -- the first slide up on the screen, what I want to is to just really go down through the basics. We're talking about DNA. Can you explain for us what DNA is?

FISHER: Okay. Well, DNA is an abbreviation for a chemical term, Deoxyribonucleic Acid. And it's a substance found in most of the cells of your body. And it contains the instructions for what makes you you, what makes you different from your neighbor, and how you function. It's found in a form which has two strands which form a twisted ladder, which is -- portion of which is untwisted and represented on the left-hand side of that. The left hand portion of that slide.

HARRIS: Let me stop you there. We're talking about -- I already forgot the number. Talking about the first slide. People's 220. And on the left of the slide there is something that looks like a ladder. It has letters A and T. And can you explain what that is?

FISHER: Yes. That is a representation of a schematic of what DNA looks like. And it's a two-stranded structure which forms this ladder. And the bases, or these letters, are what we call the building blocks of DNA. There are four of them represented by the letters G, C, A, and T. And this -- the DNA stores all this information that's vital to how you work, how it stores all that information, which is four letters, is by the order of those four bases. So it's the order that's important. If you think of this, if you have a phone number -- for instance, what I have up there, 123-1234. If you would call that particular number, you would get a certain individual. If you would take the same numbers but scramble them so that you had instead 321-4321, you could call that phone number, you would get a different individual. So in a similar manner, that's how DNA uses the order of these bases to store the information.

HARRIS: Now, looking at -- you have up there, where it says the four bases is G, C, A, T. I'm not going to ask you for the names of those particular items. But the G, C, A, T, are they a certain

type of chemical?

FISHER: They are abbreviations for large chemical.

HARRIS: And do these chemicals form in a particular way, or do they join in a particular way?

FISHER: Yes, they do.

HARRIS: That's what you are describing up there as the A, T, G, C?

FISHER: They pair. The two strands of the ladder pair, so that an A always binds to a T. And a G always binds to a C. So you will know you have this. Every time you see an A on one rung, one half of the rungs, you will see a T on the other half and similar with G's and C's.

HARRIS: Going to the next slide where it says at the top, Sources of DNA. Can you explain that for us?

FISHER: Yes. Inside is present two different sources of DNA in your cells. If you think of your cells as an egg, where the egg yolk is what we call the nucleus. And that's where Nuclear DNA. If you heard of DNA before, that's probably the kind you have heard of. And Mitochondrial DNA is found out in the egg white portion of the cell. First let me talk briefly about Nuclear DNA. I want to further explain the differences between Mitochondrial DNA and Nuclear DNA. So Nuclear DNA you have two copies per cell. You get -- because it's inherited from both parties, you are going get a copy from each parent, from your mother and from your father. Because of this unique combination, Nuclear DNA is unique to an individual, with the exception of identical twins. Now, Nuclear DNA is the information -- majority of the information is what you look like. That all comes from Nuclear DNA. Mitochondrial DNA is found in the egg white portion of the cell, in those blue -- large, blue kidney-shaped structures. And what the purpose of Mitochondria is is to form or produce energy for your cells and for your body to survive. And so the information that's stored in Mitochondrial DNA is some of the instructions on how to build the energy-producing machinery. Now within those blue structures are some white circles. And that is what -- the Mitochondrial DNA is represented by those white circles. As you can see, there are several of the larger blue structures, and several white circles within each blue structures. On average, you will have hundreds of thousands of Mitochondrial DNA per cell, where you only have two copies of Nuclear DNA per cell. That's one big difference between Nuclear DNA and Mitochondrial DNA. The other big difference is how it's inherited. Mitochondrial DNA only comes from your mother. So all maternally-related individuals would be expected to have the same Mitochondrial DNA. Because of this, Mitochondrial DNA cannot be used to point to an individual to the exclusion of all others, as Nuclear DNA can be used.

HARRIS: When you are talking about pointing to the exclusion of all others, is it because you have -- just back up and see if I'm understanding this. With Nuclear, you are talking about the two copies, so you have two sets of information. That gives you a lot more points to look at for comparison purposes?

FISHER: It's just the way the DNA is inherited. It is the complexion you get from your mother and your father. It's going to be unique for an individual, except for identical twins.

HARRIS: Mitochondrial, because it doesn't have that second set of information from the father, it's less unique, so to speak, using the term that you have up on the slide?

FISHER: It's less discriminating, because you cannot get -- you cannot discriminate between maternally-related individuals using Mitochondrial DN

HARRIS: Does Mitochondrial DNA have an advantage, or Nuclear DNA, though, in terms of forensic applications?

FISHER: In some situations it does. If the kinds of evidence you have has a limited amount of DNA in it. For instance, if you are working with a hair shaft, as we were in this case, or if you

had degraded remains from bones, those types of evidence do not contain enough Nuclear DNA to get a Nuclear DNA out of this. Because of this difference in copy number, two copies of Nuclear DNA versus thousands of copies of Mitochondrial DNA, there is -- you can get Mitochondrial DNA from these types of evidence. Another reason why it's useful in forensics is, if you don't have access to the actual individual themselves, because of the maternal inheritance of Mitochondrial DNA, you can use a maternal relative to use as a known to compare to the evidence.

HARRIS: You have been talking about the maternal inheritance. We have a slide up there now. If you can explain what you mean by that.

FISHER: Okay. This is just made to describe, again, as Mr. Harris said, about what maternal inheritance is. It's a family tree. And if you start up at the top, we have two individuals, and we're talking about Mitochondrial DNA here. And so to give reference colors are a way of describing that type of Mitochondrial DNA. So a man and woman have children. And they have a son and two daughters. If you follow this, all the solid lines, and you see all three of those children have the blue type of Mitochondrial DNA. When the daughters get married and have children, you can see, if you follow their lines, their children also have the blue type of Mitochondrial DNA. However, when the son has children, his children will inherit his wife's type of Mitochondrial DNA, the yellow and gray type of Mitochondrial DNA. So everyone in this diagram that is in blue is maternally-related and would be expected to have the same type of Mitochondrial DNA sequence.

HARRIS: So when we use that term the maternal inheritance, that's what we're talking about?

FISHER: Yes.

HARRIS: Now, the next slide up there is has a little "mtDNA". Is "mt", is that the universal symbol for Mitochondrial DNA?

FISHER: It's the abbreviation for Mitochondrial DN

HARRIS: If you can explain this, where it's talking about Mitochondrial DNA analysis.

FISHER: This is basically what we do in the laboratory. We do a number of steps which end up giving us the order or the sequence of those individuals: G, C, A, and T. And wecompare those sequences from different items of evidence. Now, I have, therefore, two types of evidence we get. Those with questioned origin, those usually associate -- have a Q number assigned to them in the laboratory. Those are, for instance, a hair. We don't know where it came from or who it belongs to. And those are questioned items. These items are processed in the laboratory completely before we even start processing the known items, or K items, which are, for instance, a blood sample or a saliva sample that you get from a particular individual so you know the source of that particular sample. So when we compare the sequences, I have two cases here, the one on the left, case one, you can see that those two sequences from the questioned item and the known item are clearly different. If those two sequences are different, we can exclude the source. The known item would be excluded as a source of the questioned item. In case number --

HARRIS: Just stop you there and ask a question. You are talking about how a Mitochondrial exam is not as discriminatory, as your term that you used for an exclusion, though. Does it work to exclude individuals for all purposes?

FISHER: Yes. It's very, highly exclusionary technique.

HARRIS: Didn't mean to interrupt. Go on to the next exam.

FISHER: The case number two on the right, when the sequences we get from the questioned sample and the known sample are the same, what I can say there is that I cannot exclude the source of the known sample as being the source of the questioned sample.

JUDGE: Doctor would it be easier if you stood up at the board with a pointer and show where they differ, and so forth, for the jury's benefit? Would it be easier to explain it that way, rather than from a distance?

FISHER: That's all I was going to say about this slide.

JUDGE: Okay.

HARRIS: I think she is saying she doesn't want to go stand over there. I'll move to the next slide. Now, the next slide, we have a number of figures up there. It says compare sequence to database sequence. If you can explain what that means.

FISHER: Okay. In that case number two, where the two sequences were the same, we need to be able the give some weight to what that means, that the two sequences are the same. Basically how large is the pool of individuals that cover that same sequence. So what we do is, we compare the sequence. We get in a case to a database of sequences. And the database -- the database is broken down to a number of separate smaller databases that are separated by ethnicity or racial groups, as statistically appropriate. But within each of the databases there are sequences that are common, and sequences that are rare. So, for instance, we'll see up in the left-hand side, there is those green people. Has lot of the green people. That represents a sequence that you see a lot, you expect to see a lots of individuals having. And the sequences -- like there is a purpose person in the front row. That's a sequence only seen one time in the database. That would give an indication, that would be a rare sequence. So by comparing the sequence we get in a case to this population database, gives us an idea of whether the sequence that we found is common or if it's rare.

HARRIS: I don't know if the Court wants to take the break at this point in time.

<break>

HARRIS: Dr. Fisher, you were just giving us the overview of mitochondrial DNA, the PowerPoint presentation, and talking about -- database was the last line. I want to get into how it works in the -- in the actual setting, and what you did in this particular case. And I want to back up to the beginning. At some point in time were you made aware that the Modesto Police Department wanted to do a mitochondrial DNA examination on a particular hair?

FISHER: Yes, I was.

HARRIS: And were you the person that was assigned to do that examination?

FISHER: Yes, I was.

HARRIS: Were you advised that an agent Terry Scott was going to be bringing the evidence from California back to your laboratory?

FISHER: Yes.

HARRIS: Just back up for a second. Where is it that your laboratory is located at?

FISHER: It's located in Quantico, Virginia, which is kind of a suburb of Washington, DC.

HARRIS: And at some point in time did Agent Scott show up at your laboratory?

FISHER: Yes, he did.

HARRIS: And did you meet with Agent Scott?

FISHER: Yes, he did.

HARRIS: And did Agent Scott provide you with anything at that time?

FISHER: Yes, he did.

HARRIS: I want to show you a series of photographs and ask you to look through these real quick and see if you recognize them.

FISHER: These are photographs of the items that Terry Scott delivered to me.

HARRIS: And did you have these photographs taken?

FISHER: I took them myself.

HARRIS: All right.

JUDGE: Do you want those -- have those been marked?

HARRIS: They've been marked.

JUDGE: All right. That's --

HARRIS: Starting with 190 A, is this the outside envelope that you received from agent Terry Scott?

FISHER: Yes, it is.

HARRIS: Now, there's a white sticker in the middle with a number. Is that the identifying case number for the FBI?

FISHER: Yes, it is. Those numbers are -- first oh three comes from this came in 2003. Oh six, in June, second oh six is June 6th, and it was the third case received on that day. The symbols M E are my laboratory symbols.

HARRIS: Showing you 190 B, is this the back side of the same envelope?

FISHER: Yes.

HARRIS: 190 --

JUDGE: Just for the record, there was a stipulation as to the chain of evidence and those items are in evidence.

HARRIS: Yes.

HARRIS: 190 C?

FISHER: Yes, this is one of the -- another -- inside that larger envelope was this envelope.

HARRIS: Now, this one is marked at the top, it says "transport envelope" and has item 144 A. We see here the -- that identifying case information that you were just describing for us?

FISHER: Yes. Followed by my initials, and also a Q 1, which is how this item was designated.

HARRIS: And you were the one that designated the items?

FISHER: Yes, I was.

HARRIS: Showing you 190 B, is this the second transport envelope that was in that bigger bag that Agent Scott brought?

FISHER: Yes, it is.

HARRIS: And, again, this has that same information, your initials there?

FISHER: Yes.

HARRIS: Looking at 219 A, does this appear to be the back of that particular envelope?

FISHER: I believe so.

HARRIS: Now, the bigger envelopes were opened. Did you have photographs taken of the smaller ones as well?

FISHER: Yes, I did.

HARRIS: Showing you 219 B.

FISHER: This is then from inside that -- the first of the two envelopes, inside the original envelope. This came from inside that one. The one labeled Q 1, this smaller envelope was inside that. So it's also labeled Q 1.

HARRIS: And, again, that's your identifying information and your initials up there?

FISHER: Yes, it is.

HARRIS: Okay. And it also has in its description a term we've already heard about, hair from pliers in item 144 A?

FISHER: Yes.

HARRIS: And then you also see the initials of Rod Oswalt, who has already testified. These R O's that are written?

GERAGOS: Are you asking if she recognizes Rod Oswalt's signature?

JUDGE: Well, this is already in evidence. There was a stipulation.

GERAGOS: I know, everything has been stipulated to.

HARRIS: Looking at 219 C, just to go through this quickly. Does this appear to be the back of that envelope?

FISHER: Yes, it does.

HARRIS: 219 D, is this the second transport envelope that we were talking about?

FISHER: Yes, it is.

HARRIS: And, again, has the identifying information and initials?

FISHER: Yes.

HARRIS: 219 E, does this appear to be the back of that envelope?

FISHER: Yes, it does.

HARRIS: 219 F, does this appear to be one of the smaller envelopes that was taken out of the inside of that transport envelope?

FISHER: Of the second transport envelope, yes.

HARRIS: And did you identify this one as Q 2, with your identifying information and initials?

FISHER: Yes.

HARRIS: 219 G, does that appear to be the back of that envelope?

FISHER: Yes, it does.

HARRIS: And 219 H, a second photograph that was taken of that envelope, just slightly different?

FISHER: Yes.

HARRIS: 219 I, does this appear to be one of the envelopes taken out of that transport envelope?

FISHER: Out of the second transport envelope. This one was designated K 1 and K 2, and contains hair samples.

HARRIS: And has your identifying information, your initials, and the K 1 and K 2 designations?

FISHER: Yes.

HARRIS: Does 219 J appear to be back of that envelope?

FISHER: Yes, it does.

HARRIS: 219 K, does it appear to be one of the smaller envelopes taken out of that transport envelope?

FISHER: Yes, this is out of the second transport envelope.

HARRIS: And, again, it has the identifying information of the case, the K 3 number and your initials?

FISHER: Yes.

HARRIS: 219 L appear to be the back of that envelope?

FISHER: Yes.

HARRIS: 219 M?

FISHER: Yes.

HARRIS: Appear to be one of the smaller envelopes from the larger transport envelope?

FISHER: Yes, it does.

HARRIS: Again has your identifying information and the K number you assigned to it?

FISHER: Yes.

HARRIS: And this is the cheek swab from Sharon Rocha as identified at the top, and you assigned that the number or the designation of K 4?

FISHER: Yes, I did.

HARRIS: 219 N does that appear to be the back of that envelope?

FISHER: Yes.

HARRIS: 219 O, a tibia cutting, and again has your designation and initials there?

FISHER: Yes.

HARRIS: That was identified as K 5?

FISHER: Yes.

HARRIS: And then last, 219 P, does that appear to be the back of that envelope?

FISHER: Yes, it does.

HARRIS: Now, we were talking about these particular items, going through these pictures so that we're aware of what it was that you were looking at. Did you receive a hair from Kim Reubush?

FISHER: Yes, I did.

HARRIS: And how was it designated?

FISHER: It was designated Q 1 point 1.

HARRIS: So you received this vial from Ms. Reubush, that's a Q 1 sample. Do you do some mitochondrial DNA testing on that particular item?

FISHER: Yes, we do.

HARRIS: I want to go through the process of how that works. You get this hair that's in this vial. What is it that you do?

FISHER: You take a portion of that hair, roughly -- the hair actually came in two sections. Miss Reubush knows that we use about two centimeters of that hair, so she cut off roughly two centimeters for us. And so we use -- and put the remainder of the hair in another vial. So we took

the section, that roughly two centimeter section, washed it to remove any debris that might be on the surface, any kind of -- anything that we -- if anybody might have handled it or anything like that, we want to get all traces of that off of there. So we wash it thoroughly. Then it goes into an extraction step where we try --

HARRIS: Let me stop you there for a second.

FISHER: Okay.

HARRIS: Because I get this picture in my mind when you're saying you're washing this one hair. You didn't stick it in the sink and rub it around?

FISHER: No, we don't.

HARRIS: How is it that you go through and clean this hair for forensic examination?

FISHER: The hair gets put into a fresh vial that has a detergent solution in it, and it gets sonicated, or hit by sound waves, much the same way jewelers clean rings. So that it kind of knocks -- physically knocks off any kind of surface debris that would be on there. And, again, in a detergent solution. And then that is followed by a number of rinses. Again, not in a sink, but in -- transferred in a vial.

HARRIS: So you now have this clean hair. What do you do with that?

FISHER: That hair then gets transferred to a small glass grinder, which gets some liquid put into it, and gets actually ground up, physically destroyed, so that you can no longer see the hair.

HARRIS: Why is it that you take this hair and go through this grinding process?

FISHER: That's how you get the DNA out of it.

HARRIS: Is that sometimes referred to as starting the extraction process?

FISHER: That's the beginning of the extraction process, yes. And that's followed up then by cleaning that up, separating the DNA away from all the other parts of the hair.

HARRIS: How do you go about doing that?

FISHER: By cleaning -- cleaning it up?

HARRIS: After you get it cleaned, you were talking about how you start this extraction to separate the DNA from the rest of the hair.

FISHER: We use some chemicals that separate the DNA from the other portions of the hair, and then we concentrate the fluid that we have. We concentrate that. So it's concentrated.

HARRIS: Just for comparison, we've heard before about nuclear DNA. In fact, we had a criminalist from the Department of Justice explain to us how nuclear DNA was done. This process of the cleaning the hair and obtaining the DNA, this extraction portion, is that pretty much the same for nuclear and mitochondrial DNA?

FISHER: Nuclear DNA typically does not do a hair shaft, so they would not be doing the grinding process, but the same fluid that we put the hair into, the dissolved hair into, it would be very similar if not exactly the same. And the clean-up process we do would also be the same.

HARRIS: Now, you said that there's -- they wouldn't be doing a hair shaft. Why is it that there would be that distinction from the nuclear to mitochondrial?

FISHER: Well, because there's not enough DNA in a hair shaft for you to be able to get a nuclear DNA type. You would need some attached tissue or a forcibly removed root, something that was -- still had nuclear material there. A hair shaft or just plain shed hair will not have enough nuclear material to get that.

HARRIS: So if -- if the police find a hair that doesn't have this root attached to it, they then have to go by the way of mitochondrial DNA?

FISHER: Yes.

HARRIS: So you're telling us that you're separating the hair portions of the DNA, going through the grinding, adding these chemicals. What's the next step that you do?

FISHER: After that we then amplify, or we make many copies of the target mitochondrial DNA where we're going to be sequencing.

HARRIS: When you say amplify?

FISHER: Amplify. We're -- some people liken it to a molecular Xeroxing, that if you think of two strands of DNA as two sheets of paper, if you put those two sheets of paper through a photocopier, after one time you end up with a total of four sheets. If you put those four sheets in, you end up with eight sheets, and so on. And we do that for 36 rounds of copying to give you several million copies of the original starting material.

HARRIS: Now, this amplification process, is that consistent with what is done in nuclear DNA?

FISHER: Yes, but they're looking at different portions of the DNA than what we're looking at. The technique itself is very -- is the same.

HARRIS: What is that technique?

FISHER: It's called Polymerase Chain Reaction. Which is also abbreviated PCR.

HARRIS: And PCR, is this something that's very standard and accepted in the scientific community?

FISHER: It's very commonplace and very accepted.

HARRIS: Now, you had mentioned earlier, kind of going back to your background and education, that there are other applications of DNA work outside the forensic field. Does PCR have this accepted use in other applications outside of forensics?

FISHER: PCR is used almost wherever DNA is being processed, whether it be for medical fields -- in fact, I even heard that high schools are using PCR in their high school science laboratories. In medical diagnostics, most of the kits that you're seeing are now based on PCR.

HARRIS: So that's just as you referred to it, that Xerox processing and making extra copies?

FISHER: Yes.

HARRIS: And you were saying you did it a certain number of times. Why is that?

FISHER: Because you need to do it a certain number of times so that you have enough material to work with in the end.

HARRIS: And you can't just do it with one or two?

FISHER: No, that won't give you enough. From studies, we've shown that we need to do 38 cycles -- excuse me, 36 cycles.

HARRIS: So in this particular case, we have the hair, it gets the cleaning, goes through this PCR step. Do you end up with your 36 copies of this hair, Q 1 point 1?

FISHER: Well, not 36 copies. Hundreds of millions of copies, after the 36 cycles of -- of the hair, K 1 point 1.

HARRIS: Again, so I'm clear about this, when you're talking about the cycling process, it doesn't just make another copy; it kind of -- it doubles and it's geometric as it goes through this process?

FISHER: Yes. Theoretically, every time you double your starting material.

HARRIS: So ultimately, after you run these 36 cycles, and you end up with the amount that you need, are you able to start doing your analysis?

FISHER: After we have done -- done the PCR, then we need to do some more steps in the laboratory, which actually help determine the order of those bases, the individual G's, C's, A's and T's. That's the next step.

HARRIS: Can you explain that to us, what is this next step that you're doing?

FISHER: The next step is the sequencing. And how that works, it's similar to PCR except you're not doubling every time. You're simply making a partial copy, because when you're putting in the building blocks of the DNA and trying to make that -- that long chain, you're only -- every now and then they throw in a -- it's called a terminator, something that cannot continue the chain. It stops. And there's a -- fluorescent tag on that, and when you do that enough times, you end up with a series of fragments that differ by a single base in length. Each -- and the end of each of those has this fluorescent tag. So then when you run it through another instrument, which separates the bases, it reads the bases coming through -- through the column, through the instrument, and can read which fluorescent tag is at the end of that, and each fluorescent tag is associated with one of those letters G, C, A, T, and that gives us the ultimate sequence of that fragment.

HARRIS: So you take this, the DNA bundle that you ultimately produce after the 36 cycles, and you apply this machine process, and which sounds like a fluorescent chemical process, and as it goes through this machine, it's straightened out, so to speak, so that it's viable?

FISHER: By virtue of having the fluorescent tag on it, the instrument can see -- see that. So, yes, it is viable, if that's what you're asking.

HARRIS: Well, this viable process, is this something that you walk up and you look at with the naked eye? Or is this part -- part of the machine?

FISHER: It's part of the machine. It's captured in a data file as a series of peaks and valleys of different colors.

HARRIS: And this -- this machine, what machine is that?

FISHER: That's the Applied Biosystems 3100 Genetic Analyzer.

HARRIS: And is this machine fairly common and used in the scientific industry?

FISHER: Either this machine or some of its predecessors, yes.

HARRIS: So as you go through this process, you run it through the machine, and you get this sequencing, did you ultimately, after all the testing of the questioned, the K 1 point 1, do you obtain some type of sequence that shows you where all of these hairs have been?

FISHER: Yes, I do.

HARRIS: And once you've got that done, is that where you just stop? Or where -- what do you keep doing?

FISHER: I compile the sequence from all these fragments, and as far as the questioned sample, that is the sequence of the questioned sample. There is a shorthand notation that we use. When we're looking at mitochondrial DNA, I know in that slide there's just a short section, but we're actually looking at over 600 bases, and instead of actually writing out all 600 of those bases to compare them to something else, what is done throughout -- anybody who's doing mitochondrial DNA analysis does this, we compare it to a reference sequence. And it just happens to be the first fully sequenced mitochondrial DNA, and this is the same reference that everybody in the world will use.

HARRIS: Does that have a particular name that it's referred to?

FISHER: It has a number of names. It's been called the Anderson Sequence or the Cambridge Reference Sequence. It was done in Cambridge, England, at Cambridge University, and published. The first author on that is Anderson, so that's why it's referred to by both of those names.

HARRIS: And when you're -- when you're talking about this referencing, Cambridge Reference Standard, this is a sequence of mitochondria that's almost those 600 base pairs that you're talking about?

FISHER: Well, the entire 16,569 bases were sequenced, but we're only interested in about 600 of those, that we're actually doing in forensic mitochondrial DNA testing.

HARRIS: So you take the 600 of the standard from the Cambridge Reference, 600 base pairs that you're interested in looking at?

FISHER: Right. And I compare them and see where they differ. Where they differ, I make a notation of that particular site and what the change has been.

HARRIS: Now, this area that you're looking at on the Cambridge Reference Sequence, does that have some particular terminology that you use? Or is it just identified by numbers?

FISHER: The -- well, the two areas -- actually two areas that we look at, and they're referred to as Hypervariable Region 1 and Hypervariable Region 2. Or HV1 and HV2. They also have numbers associated with them, so yes to both of those questions.

HARRIS: Okay. So when you're making your comparison, you're using the HV1, HV2 from the Cambridge Reference, and you're comparing what your sequence shows to see if there's any distinctions or differences from that reference?

FISHER: Right. It's -- as I mentioned before, it's a shorthand representation of all the work that we've done on it.

HARRIS: When you've done this or you've made this comparison and you find what distinctions or differences there are, do you stop there? Or do you then have to go on to the known samples as well?

FISHER: Once we have the sequence, the entire sequence for the questioned samples, that's when we start the known samples.

HARRIS: In this particular case did you have known samples?

FISHER: Yes, we had two known samples that we used.

HARRIS: One of which was a cheek swab from Sharon Rocha?

FISHER: Yes. That was I believe designated K 4.

HARRIS: And so it was identified by Modesto PD as SR2, and then that was given your K 4 number?

FISHER: I don't have that in front of me, but I know it was designated K 4. I'm not sure what the Modesto designation was.

HARRIS: We're just trying to make sure we're talking about the same thing. Your K 4, though, was a cheek sample?

FISHER: Yes, it is.

HARRIS: Is that a cheek swab so that it's DNA material, kind of on a --

FISHER: Cotton, almost like a Q-Tip, but sterile.

HARRIS: When you go -- do you go through the same process with this Q-Tip?

FISHER: You don't -- you don't grind it up, but as far as the solutions and the processes, yes, it goes through the same -- same processes.

HARRIS: And were you able to obtain mitochondrial DNA from that particular known sample?

FISHER: Yes.

HARRIS: Did you go through the same process of running it through a sequence?

FISHER: Yes.

HARRIS: And you then do that shorthand view of what you're talking about, the differences between the Cambridge Reference and what you see?

FISHER: Yes.

HARRIS: Do you do -- besides the known, that K 4, and the Q 1, did you do any other mitochondrial samples?

FISHER: Yes, I did a blood sample from Scott Peterson, which I believe was designated K 3.

HARRIS: And, again, if you were to look at that envelope, it would have MPD's designation of 18 A, but it was your number of K 3?

FISHER: If that -- I only remember my designation.

HARRIS: So you take a -- you take this blood sample. Do you go through the same process with that?

FISHER: Yes. Not as the hair, a blood sample doesn't get ground up. It gets similarly incubated and cleaned up and goes through the PCR and sequencing. And you get the sequence in the end.

HARRIS: So, again, just to speed that process up, you compare it to the Cambridge Reference and you come up with your shorthand notations of the distinctions?

FISHER: Yes.

HARRIS: And are those the two knowns and the one unknown that you performed mitochondrial DNA testing on?

FISHER: In this case, yes. <noon recess>

HARRIS: Thank you.

HARRIS: Before -- doctor, before we took the lunch break, we were going through the process of sequencing three particular samples, Q1, K3 and K4. I want to go back and talk about something you were saying earlier. In the earlier testimony you were telling us that you cleaned those hairs, or cleaned the hair from Q1.1. Is there a reason why you clean the hair?

FISHER: We don't want to introduce what we are typing to be that of the hair, not of the something that might be stuck to the hair. And also because Mitochondrial DNA is different from Nuclear DNA. We can't handle mixtures. If there are sequences from -- or source from two individuals in a sample, we can't tell which base belongs to which individual. So a mixture is uninterpretable for Mitochondrial DNA. Where Nuclear DNA, they can interpret mixtures. So that's one of the reasons we try and avoid any kind of contamination on the hair.

HARRIS: And when you are doing a forensic examination of Mitochondrial DNA, do you -- are the tests designed to try and deal with any potential contamination issues?

FISHER: Yes, they are. Actually contamination is a big concern for Mitochondrial DNA testing. We go to great lengths to try and avoid introducing any extra DNA into the sample. We run a number of controls alongside the sample. We also run a positive control that we know the -- sample we know the sequence of. And we must get the correct sequence for that positive control, or we can't use we can't use the sample, the sequence we get from the sample.

HARRIS: Let me just ask you about that. You are saying using a control and a positive control. What do those terms mean?

FISHER: Let me back up. We start -- when we start grinding the hair, on that step, before we -- even before we start grinding the hair, we start what's called a reagent blank. It's a control for any other DNA that might inadvertently get introduced into the sample. So that we want to make sure that the sequence that we're getting is from the sample itself, and not something that's in some of the chemicals that we're adding to it. So we have something called a reagent blank, which gets started before we actually grind the hair. We put it into the same the grinder that we use to grind the hair. We put some fluid in it, simulating grinding, then put that aside to process throughout the entire procedure with the sample. Also, when we start that PCR step, amplification step, we start another -- something called a negative control. In essence, they are both negative controls where we don't -- we hope to not find any DNA in there. That starts what we term our negative control. Starts at the amplification step again. It's carried throughout the procedure. The positive control is also started at the amplification step. So we're -- when we run a sample, we're not only running the sample, we are rung two negative type controls and one positive type control. And all of those have to meet, work appropriately for us to be able to trust the sequence that we get from the sample.

HARRIS: Now, in this particular case Q1.1, K3 and K4, did you follow the same protocol that you use in all of your Mitochondrial DNA applications?

FISHER: Yes, we did.

HARRIS: So you got the two -- three actual controls, two negatives and one positive control?

FISHER: For each sample, yes.

HARRIS: So when you get the sample that you are going to sequence ultimately, you can tell if there is a problem with it if there is any contamination by these controls that you use?

FISHER: Yes.

HARRIS: Did you find any problems with these three samples that we're talking about?

FISHER: None at all. There was no evidence of contamination in any sample.

HARRIS: Since we're talking with things that might be of concern from the forensic point of view, when it comes to Mitochondrial DNA, besides contamination, are there any other concerns?

FISHER: Not really a concern, but an additional complexity is something called heteroplasmy. It's where you can have the sequence -- obviously everybody doesn't have the same Mitochondrial DNA sequence. Different maternal sequences will have different sequences. At some point they must change. And it's believed that the state of change kind of goes between a medium stage where it has -- it would change at a single position. And you cover two bases at one, at that same position. This is termed heteroplasmy. And these things -- two different Mitochondrial DNA sequences can either differ by actual sequence, or a point where you see two bases at a particular spot you could see, or what we see in our printouts, or the different -- not printouts, but the readout from the instrument would be two different colors representing two different bases at a particular point. That would be the point heteroplasmy, also called length heteroplasmy, which, in some instances, is fairly common, and it only occurs at certain sites. And we have procedures to deal with that.

HARRIS: You are saying you have procedures to deal with that. Does that mean, in the scientific community, these issues are something that you are aware of, and science takes into account when you do these examinations?

FISHER: Yes.

HARRIS: And in the examination of these three particular items Q.1 and K3 and K4, did you have any of these potential problems?

FISHER: There was length heteroplasmy, but everything -- the items that were the same had the same variance, so they were not different.

HARRIS: So in your expert opinion, it's not that particular --

GERAGOS: Objection. Leading.

JUDGE: Well, you can lead an expert witness. Overruled.

GERAGOS: Argumentative.

JUDGE: Overruled.

HARRIS: In your expert opinion, was that an issue in your analysis in this case?

FISHER: Not at all.

HARRIS: You told us you got there and the process sequenced this particular -- the Q1.1, K3, K4, do you make ultimate comparisons of these particular items?

FISHER: Yes, I do.

HARRIS: And after you make these comparisons, do you also run them through the this database that you are telling us about?

FISHER: If there is a match between a questioned item and a known item, yes, that particular sequence gets run throughthe database. If there was not a match, we would not run it through a database.

HARRIS: Let's go through -- if I could have marked next in order a chart, which is --

JUDGE: 222.

GERAGOS: What is 221?

JUDGE: 221 is Ebay records produced by Mr. Myers.

GERAGOS: Thank you.

JUDGE: You are welcome. Mr. Geragos seen this?

HARRIS: Yes.

GERAGOS: Yes.

JUDGE: What are we going to call that?

HARRIS: This would a blowup of -- it's a chart blowup, one page of the doctor's report.

JUDGE: Okay.

GERAGOS: Or DNA chart.

HARRIS: I'm going to put this uphere, doctor. Now, you indicated that you do these comparisons, and you see if there is a match before you go to the database step. What I want to do is go through this and start with Q1.1, the questioned sample. Did you compare that to the defendant's Mitochondrial DNA?

GERAGOS: Can I ask, is there a way that we can use the small --

JUDGE: Are you going to use this? Going to have to testify from this?

HARRIS: We are going to get to this.

JUDGE: Can I ask you to use the pointer so the jury knows what you are referring to on that diagram?

GERAGOS: I was just going to suggest that we use the smaller sheet and blow it up on the screen.

JUDGE: Well, yeah, that's another way of doing it. He is doing it. Go ahead, Mr. Harris.

HARRIS: We hadn't quite got to that point yet. I'll just leave you standing there for a second. You were telling us that you do a comparison. If there is an inclusion, you run it against the database. I want to talk about running the unknowns to the Q1.1, running that against the defendant's known. I believe that was K3.

FISHER: Yes. First thing I do, I had gotten the sequence from Q1.1, first, completely, then started processing K3 and K4. And at the end of that, I have a list of the -- shorthand list of the differences from that standard reference sequence that everybody uses for the shorthand notation, so I simply have everything in a table like this. And I compare these differences, and see if I have the same sequence. And you can see that -- we'll just deal, first column -- everybody can see this is first column, the sequence of the Q1.1 here from the pliers. You can.

HARRIS: Tell up what, since you are going to the small stuff, I'm going to put that up on the screen at this point in time.

JUDGE: Doctor, we'll ask you do keep your voice up so we can hear you. There you go.

HARRIS: Don't look into the light.

FISHER: So first compare this Q1.1 sequence. I got hair from the pliers and the K3 sample from Scott. And you can see that these two sequences are different. They do both have this 16189 C. But K3 also has 16147 T. Q1.1 does not. The same thing with K3, has 16147 T, 16183 C and 16270 T, just in this HVI rung, and Q1.1 does not.

HARRIS: Let me interrupt for a minute. What's that mean when you see a difference like that?

FISHER: Well, two sequences are different by -- different by one or more bases. The contributor of K3 can be excluded as coming from the same source.

HARRIS: So based on what you are talking about in the HVI, Scott Peterson's known sample of K3 would exclude him as being the possible source of the hair in the pliers?

FISHER: That's correct.

HARRIS: Further explanation.

FISHER: Okay. Continuing down through HVII, the difference that -- K3 has 73 G, Q1.1 does not. Also K3 has 150 T, and Q1.1 doesn't. They both have 263 G, and both have 315.1 C. Q1.1 has two sections of 309.1 and 2, K3 does not. The difference is visible, is clearly different. And thus Scott Peterson is excluded as being the source of the Q1.1 hair from the pliers.

HARRIS: Now, you also did a comparison of -- I would move it out a little bit but -- so you are not leaning against that, but I can't move it any more. You did a comparison of the known sample, the cheek swab from Sharon Rocha and compared that to the sample of the hair from the pliers; is that correct?

FISHER: That's correct.

HARRIS: If you can, explain for us your results.

FISHER: You can see they both -- Q1.1, this far column hereand K4, both have 16189 C at HVI, and 263 G, both have 309.1, both have 309.2 C. Furthermore, these are not -- asterisk is here. Means that there was a length heteroplasmy. It's like the different length variance. And you can see that they are the same. They both have -- so there is a number of different lengths of this in this particular area, C's on top of each other. Like, for instance, there is -- this sample, there is an 8 and 9 and a 10, three different length variant, with 9 being a major length variant. 9 is what you plainly see. This one you have got 8, 9, 10, and a little bit of 11. And, again, 9 is the main

length variance. So this is not difference in the length. Apparently length variant is not really a difference. And so these two sequences, Q1.1 and K4 are the same then. Therefore I would not be able to exclude Sharon Rocha or any maternal relatives as being source of Q1.1 hair from the pliers.

HARRIS: You can go ahead and resume your seat. I just want to go back through and ask some questions about that. So you are saying that the Q1.1, the K4, that you are finding nothing that excludes K4 as being the source of Q1.1.

FISHER: Correct. They both have the same Mitochondrial DNA sequence. Thus, by this test, I cannot exclude them as coming from the same source or same maternal lineage.

HARRIS: When you are talking about that lineage, what we are referring to is that maternal lineage that you described for us earlier today?

FISHER: Yes.

HARRIS: So in this particular case, if Laci Peterson is the biological daughter of Sharon Rocha, would she have that same maternal lineage, Mitochondrial DNA, that we're talking about?

FISHER: Yes, she would.

HARRIS: So Laci Peterson's maternal or Mitochondrial DNA would be the same as K4, or substantially similar to K4 up there?

FISHER: That's what I would expect, yes.

HARRIS: Now, when you have this inclusion at this point in time, so you have Q1.1 and K4 being an inclusion, not an exclusion, like the defendant's blood sample, is that when you now run it through the database?

FISHER: We then enter that sequence in to a search type program, which searches a database 5071 individuals and sees how many times that particular sequence is seen in that database, and gives you a result.

HARRIS: We can go just go back there a little bit. This database, how -- you have a database. Is that maintained by the FBI?

FISHER: It's maintained by the FBI, but we are not the sole contributors to the database. A number of other laboratories submit population samples, and submit the results to us, and we maintain the database. Anyone in -- at least in the United States, potentially the world doing Mitochondrial DNA would be using this database.

HARRIS: Is this database available to other scientists for them to use for research?

FISHER: It is. This not quite all 5071, but there are -- the database has been published in a journal, Forensic Science Communications, which is available on the web. And it's -- the database is downloadable. But there are about 200 samples that are missing because we did not get permission from the individuals who contributed those samples to publish their -- to have their samples in a publication. So that's why there is about 200 samples missing from the web version.

HARRIS: So when you run this through the database, you are sequencing through the database, you are comparing it to the -- what's the total number?

FISHER: 5071.

HARRIS: On the 5071, statistically is that a big enough sample for you to get results from?

FISHER: Yes, it is.

HARRIS: And when you look at these, and you make these comparisons, how are you trying to report this out? You were telling us earlier, so you have some idea what the numbers really

mean?

FISHER: We apply some basic statistical formula to get -- see how many times we see it in the database. And that gives us a point estimate. But since we don't have everybody sampled in the country, or the world sampled, we put a confidence limit, or confidence interval around it, much like when you hear about a presidential poll, they call a number much individuals and say what's the presidential approval ratings. And they will say 50 percent plus or minus three percent. That means the it could be as high as 53 percent, or as low as 47 percent, to account for any differences, in fact that their sampling was not asking everybody in the country. So we put -- we do something similar, but we only give you the upper bound, because we want to make this as common as possible. So instead of, you know, we would just report the 53 percent, not the 50 percent, or put 47.

HARRIS: Now, would that -- with that somewhat background and explanation of statistics of what you do, I want to walk you through the process of what you do here. Did you run this sequence the sequence that you find in Q1.1 and K4, run that through the database?

FISHER: Yes, I did.

HARRIS: Did you find any hits in the database?

FISHER: Yes, I did.

HARRIS: Can you explain to us that? What did you find?

FISHER: I found that there were some hits in the database.

HARRIS: Okay.

FISHER: For a particular Caucasian portion of it, the database is broken into different racial and ethnic categories. In the Caucasian portion of the database, there were ten individuals who had the same sequence as that in Q1.1 and K4.

HARRIS: So that's basically 10 out of however many are in the Caucasian database?

FISHER: There are 1814 Caucasians in the Caucasian section of the database.

HARRIS: Do you apply that confidence level that you were talking about to those raw numbers of the 10 out of the 1814, I believe it is?

FISHER: Yes. That gives us, with the upper bound frequencies, then is 0.89 percent. And what that means is that I would expect to find this particular sequence in no more than 0.89 percent of the Caucasian population, unrelated Caucasian population.

HARRIS: And to put that at different way, kind of a one out of something number?

FISHER: About one out of a hundred twelve.

HARRIS: So approximately one out of a hundred twelve people would have that same type of maternal characteristics that you see in Q1.1 and K4?

FISHER: Approximately one out of 112 Caucasians would be expected to have that same sequence that we see in Q1.1 and K4.

HARRIS: Statistical application to the database, is this, again, something that's generally accepted in the scientific community, and used on a regular basis?

FISHER: Yes.

HARRIS: So your opinion as to the defendant being excluded and Q1.1 being included in the known sample of K4, and your results from the database, is that something that's generally accepted in the scientific community?

GERAGOS: Her opinion -- there is an objection. I don't know if her opinion is accepted in the scientific community.

HARRIS: I'll rephrase it.

JUDGE: All right.

HARRIS: Your opinion of what you have been testifying to, the information that you provided --

GERAGOS: Objection by the paramedics.

JUDGE: Okay

HARRIS: The information that you have been testifying to about what your results were, that how you obtain this data, the process that you used and the statistics that you have just told us about, is that generally accepted IN the scientific community?

FISHER: Yes, it is.

HARRIS: The information, getting into the opinion, the opinion that the defendant is excluded; is that your opinion?

FISHER: Yes, it is.

HARRIS: And that Q1.1 is included in the known sample of K4?

FISHER: It cannot be -- yes. I prefer the term cannot exclude; but included often means the same thing.

HARRIS: Is there a difference scientifically?

FISHER: A subtle difference, but --

HARRIS: Well, then we'll use your term. It cannot exclude. Cannot exclude. People have no other questions.

Cross Examination by Mark Geragos

GERAGOS: Good afternoon, Doctor Fisher.

FISHER: Good afternoon.

GERAGOS: How are you? Specifically the hair from the pliers which you label Q1.1, that's the --

JUDGE: Do you want the pointer, Mr. Geragos? Do you want the pointer?

GERAGOS: No. I'll grab it in a second. I'm going to ask some other questions first. The hair from the pliers, you labeled that Q1.1. You get just a segment, clip off a piece, correct?

FISHER: That's correct.

GERAGOS: Okay. That came from the woman who testified before you?

FISHER: Miss Ruebush.

GERAGOS: So she give gives you that. And then -- and then specifically, is that the first item that you actually get in order to do a comparison with?

FISHER: It's -- in this particular case, yes, this is -- the questioned item is always processed before any of the known items. And that was followed through in this case.

GERAGOS: Would you have ever opened that up -- you know, they showed you some of these pictures of the envelopes. Do you remember these here? Hair from the pliers?

FISHER: Yes.

GERAGOS: Should come in an envelope like that, a property envelope. You are familiar with those?

FISHER: Yes.

GERAGOS: You see those -- I assume the FBI -- the FBI's involvement is that you are one of the few labs that does this Mitochondrial testing in the United States?

FISHER: Yes.

GERAGOS: That's accredited, and most of the law enforcement agencies across the country send their samples to you, if they have got a need for Mitochondrial testing?

FISHER: That's true.

GERAGOS: You would never open that up to take the hair out yourself, would you?

FISHER: No, I would not do that.

GERAGOS: And you would never open up that envelope to take the hair out, even if you were in the Trace Evidence Section, yourself, correct?

FISHER: No, I would not do that. That's not my area of expertise.

GERAGOS: Okay. And, specifically -- and I have asked you this before. We talked about this at a previous hearing. You would not specifically -- the rooms, the environment that the FBI uses, they are not sterile rooms. They are clean rooms, when see somebody doing computer chip technology. But you have a protocol, and you have a mechanism by which you operate under; isn't that correct?

FISHER: We do have rooms at the FBI that are very clean, and we have areas inside our own laboratory that are that clean. But I do not open hair evidence before it goes to Trace Evidence.

GERAGOS: Okay. And your understanding of the trace -- the trace rooms are where they do open up these envelopes, correct?

FISHER: That's correct.

GERAGOS: And they are more similar to those type of rooms, those sterile clean rooms, right?

FISHER: Yes.

GERAGOS: And the reason for that -- the reason why you open up the packages in those kinds of environments is specifically why?

FISHER: You don't want to either lose anything from that package, or introduce anything into that.

GERAGOS: And when you say introducing in, you wouldn't want to open up in a room in a non-sterile or not clean room, because what would happen is another hair could get introduced into the sample, correct?

FISHER: Theoretically, yes.

GERAGOS: That's not uncommon. One of the reasons that the FBI set it up this way, correct?

FISHER: Yes.

GERAGOS: And you could also -- I mean while you could have a hair introduced, you could have a hair lost, correct?

FISHER: That's correct.

GERAGOS: And it's a fair statement, I assume, that it would not be an appropriate protocol at the FBI lab where you work, but it's not generally accepted to open an envelope that contains a hair which is a known sample, correct, necessarily subject it to possible contamination, correct?

FISHER: You asked several things in there. But I think the answer is yes. But do you want to go through each one ever those?

GERAGOS: You are not going to open up this envelope in a property room, so to speak, in order to do an

examination of this hair, correct?

FISHER: No, that's correct.

GERAGOS: Okay. And the reason you would not open it up in a property room is precisely because there are contaminants. As we sit here today, if I walked around this courtroom, I could probably pick up hairs off

of various people, because hairs transfer, correct?

FISHER: I'm not a qualified hair examiner. But I am aware that hairs can transfer, yes.

GERAGOS: And so one of the reasons that you don't open up these kinds of packages and have hair samples in them, in places like property rooms is precisely because they are not a clean environment, correct?

FISHER: That's why we have our protocols in place, yes.

GERAGOS: Okay. And when you keep saying -- I use the term protocols. You are using the term protocols. Basically that's the scientific equivalent for, this is how we proceed, so that we have got some basis upon which we can say, look, I'm comfortable that what I'm dealing with is a good sample, correct? That it hasn't been contaminated? We have got some kind of controls; is that right?

FISHER: Well, there is no controls that are added at this point. But if the environment is controlled, if that's what you are asking --

GERAGOS: That's what I'm asking. You have got a controlled environment so that you know what you are dealing with, right?

FISHER: Yes.

GERAGOS: Okay. Now, one of the reasons that you go through, as Mr. Harris led you through washing the hair, is because you want to make sure that you don't have contaminants, right?

FISHER: That's true.

GERAGOS: And one of the big problems, one of the big differences between Mitochondrial DNA and Nuclear DNA, at least in the testing, is that contamination is a big problem with Mitochondrial DNA, or it's a significant

problem?

FISHER: It's a concern. I wouldn't say it's a problem. It's a concern. There is two different kinds of contamination. You are talking about here contamination of the hair itself, which we could never end up being a mixture. If it was, say, contaminated with some kind of body fluid, you would get two sequences basically on top of each other. You would not be able to interpret that. But there is also contamination during our processing, which is something we can do something about.

GERAGOS: I'm not talking about the latter, because I would assume during your processing you have certain controls, and that's why you work with the reagents and everything else so that you know what you are dealing with, right?

FISHER: Yes, sir, that's true.

GERAGOS: I'm talking about in terms of a chain of custody for the sample itself, and to have an environment, you want that environment controlled, right?

FISHER: Yes. I'm not sure what that has to do with chain of custody. But in our space we -- we don't --

GERAGOS: Specifically when you get these envelopes, these envelopes have markings on them. You are aware of that?

FISHER: Yes.

GERAGOS: You are aware that the markings are generally placed on there as the chain of custody for what, the evidence?

FISHER: No. The chain of custody is usually a separate piece of paper that documents which items are going where.

GERAGOS: If I told you in this case that that's not how it operates, would that surprise you?

FISHER: It's -- well I know that in our testing in our laboratory, we have a separate piece of paper which was provided upon discovery. That is our chain of custody.

GERAGOS: Okay. How about -- you are not aware of how Modesto PD operates, are you?

FISHER: No, I'm not.

GERAGOS: Well, so you get the sample, you get two millimeters, approximately. What does that translate to in inches?

FISHER: It's two centimeters, which is about one inch.

GERAGOS: Okay. Short of one inch, isn't it? Three quarters of an inch?

FISHER: It's roughly an inch, yes.

GERAGOS: Okay. Now these two centimeters came from one of the two hairs?

FISHER: Yes, that's correct.

GERAGOS: Did you test both hairs?

FISHER: No, I only tested the one.

GERAGOS: And the one you tested, you don't know which one it was, because you were not the one who opened it up, correct?

FISHER: That's correct.

GERAGOS: Okay. And when you tested it, what you basically -- if I can kind of distill this down in my simple brain, basically if it's a Nuclear DNA, when we have both sets of the genetic -- we are able to get percentages for a statistical formula that will be able to see numbers like one in four billion, or one in eight billion, correct?

FISHER: That's correct.

GERAGOS: The reason for that is that you have got both of the genetic lines, both the father's side and the mother's side. And when you have both of those there, you are able to then be -- particular genetic combination you are able to identify with a great deal of precision; is that correct?

FISHER: Not quite. The reason why you are able to come up with such large numbers is because with the most recent technology, they use for Nuclear DNA, they look at 13 different bits of DNA. And they have a frequency for each of the 13 areas. And they are able to multiply them together. Mitochondrial DNA is an -- in essence, just like one of those areas. You can't multiply it with anything else. So that's why you don't get the great numbers.

GERAGOS: The great numbers is because you have got more of the bits of information, you have got more of the bits of information, because you have got both of the lineages; isn't that correct? You don't only have this Mitochondrial DNA, the maternal lineage, correct?

FISHER: You only -- it is inherited as a unit. So no matter what part of the Mitochondrial DNA you type, it would still be the same inheritance.

GERAGOS: So if you had Nuclear DNA, you got this 13 times -- you can just one, two times. The second set times the third set, times the fourth set, out to 13. And you get these astronomical numbers, right?

FISHER: Usually, yes.

GERAGOS: Okay. Usually. I mean you are -- you talk in terms of billions, don't you?

FISHER: I'm not a qualified nuclear examiner. I don't know what --

GERAGOS: What we're talking about here is that out of every 112 Caucasians, you would expect to find -- based on your database of 5,000 people, you would expect to find one person out of 112 who matches the

sequence that you have got right here; is that correct?

FISHER: One Caucasian, yes.

GERAGOS: Okay. And, specifically, if it's an -- if this were a hair from Laci Peterson, specifically a hair that was on the pliers, was Laci's hair, this one here, you are saying that -- basically what you are saying, it can't exclude it from being somebody that's related to Sharon, that's right?

FISHER: That's correct.

GERAGOS: Because Sharon has got these numbers that line up here, with the exception of the -- what you said the C11TC6, which is not over here?

FISHER: Uh-huh.

GERAGOS: So this -- the hair from the pliers shares basically everything but the one marker there, comes from the HVII region, that you can't exclude it, right?

FISHER: That's correct.

GERAGOS: But you can't get do a point -- you cannot say that matches; is that correct?

FISHER: That's correct. Mitochondrial DNA cannot do that.

GERAGOS: It does not match the hairs?

FISHER: On a match of Mitochondrial DNA means the sequences are the same. Does not mean the same thing as a Nuclear DNA match.

GERAGOS: So that's the significant difference, if you will, between Nuclear DNA and Mitochondrial DNA. Nuclear DNA -- I know you are not qualified -- but at least at the basic level, Nuclear DNA, you are able to say, look, if it's one in eight billion, that looks like a match, right?

FISHER: Match is where the markers they get are the same. The statistics, the one in eight billion, has to do with the statistics, not whether it's a match.

GERAGOS: Okay. And you can't do that with Mitochondrial DNA?

FISHER: We cannot get to the eight billion number with the Mitochondrial.

GERAGOS: This database that we have got of 5,000 people that Mr. Harris was talking about, that's -- basically 1800 of those people are Caucasians, right?

FISHER: Correct.

GERAGOS: Okay. And out of those 1800, how many are put in by the FBI?

FISHER: Caucasians?

GERAGOS: Caucasians. If I understand correctly, you have got 5,000, and that's contributed by, what, five or six different sources?

FISHER: Probably around eight.

GERAGOS: But out of those eight sources, the FBI is one, right?

FISHER: Yes.

GERAGOS: So when you do a test, for instance, this test at some point this will be entered into the database, correct?

FISHER: No. This -- the sequence will not be entered into the database.

GERAGOS: Is that because you don't have permission?

FISHER: No. It's because we do not enter casework samples into the database.

GERAGOS: Okay. So other samples that you have, you will enter into the database?

FISHER: Samples that were obtained for population purposes are entered into the database.

GERAGOS: Paternity testing, things like that?

FISHER: That's a lot of -- sometimes that's where the samples come from, yes.

GERAGOS: Most of these database is mostly results that are obtained as a result of a paternity test?

FISHER: No. They are samples that are obtained by paternity testing laboratories, or blood Banks, or sometimes people just donate samples for the population testing. So they are not from somebody else's case work. They are actually for the database.

GERAGOS: Somebody has got to do the case work in order to get a sequence, don't they?

FISHER: It's not -- I'm sorry, it's semantics. We're not -- it's different. It's processed for the database, not for a forensic case.

GERAGOS: I understand that. But somebody still has to do the work to get your sequence, right?

FISHER: That's correct.

GERAGOS: You don't have a sequence to match up against just -- if somebody gets a blood sample, you don't know what your sequence is until you do the work, right?

FISHER: That's correct.

GERAGOS: Once you do the work, you get a sequence that goes into the database?

FISHER: That's correct.

GERAGOS: When you run -- you get a sequence here, like you have got, you have entered that into the database, right?

FISHER: Not this particular sequence. But, yes, this sequence gets entered into the database.

GERAGOS: You will get a result that says one out of 112?

FISHER: Yes.

GERAGOS: Does that mean that if you tested -- you would expect that if you tested anybody who was related to Sharon Rocha, maternally, along her mother's side, that you would expect to see this same sequence?

FISHER: Yes. The one out of 112 would be for unrelated individuals. So --

GERAGOS: So it would be one out of one -- or one out of -- five out of fifty if they are related?

FISHER: If they are all maternally-related individuals, would be expected to have the same DNA sequence. So, yes, all of the maternal relatives would be the same.

GERAGOS: Okay. But there is no way to distinguish whether it's -- as you sit here today, given the current state of the science, we can't distinguish with any kind of specificity what you would call a match for Nuclear DNA purposes.

FISHER: I'm sorry, I don't understand that question.

GERAGOS: You can't -- all you can do -- this is more a test of exclusion; is that correct?

FISHER: That's correct, yes.

GERAGOS: So we can exclude Scott Peterson. We know it's not his hair?

FISHER: That's correct.

GERAGOS: We can't -- we can't say that this is Laci Peterson's hair?

FISHER: No, we cannot.

GERAGOS: Okay. We can't say that it is not Detective Brocchini's hair?

FISHER: If I haven't tested Detective Brocchini, no, I cannot say.

GERAGOS: We don't know if it's Mrs. Peterson who used to own the boat's hair. She used to own the boat, would be inside the boat, we don't know?

FISHER: Well, if she is --

GERAGOS: Related by a maternal lineage to Sharon Rocha, or Sharon Rocha's maternal lineage?

FISHER: Are you talking about Scott's mother?

GERAGOS: No. No. There is -- believe it or not, the boat was previously owned by somebody also by the name of Peterson. So if the woman who is married to the man who used to own the boat was in that boat, if she's in the same maternal lineage, then you would expect to see the same sequence?

FISHER: If she's -- if this other Mrs. Peterson is in the same maternal lineage as Sharon Rocha, then I would expect to see the same sequence.

GERAGOS: Okay. So what we're doing is, we're basically excluding people who aren't -- and then we're left with only this universe of people who are possible; is that correct?

FISHER: That's correct.

GERAGOS: Okay. Would you be able to -- I asked this of the woman who was -- I keep forgetting -- who testified right before you.

FISHER: Mrs. Ruebush.

GERAGOS: Yes. You would be able to -- and she said you are the expert on it -- would be -- you would be able to test a pubic hair for Mitochondrial DNA?

FISHER: Yes.

GERAGOS: Is there any prohibition, that you are aware of, to testing a pubic hair versus a head hair? Does it make any difference whatsoever for extracting and amplifying the DNA and doing the sequences?

FISHER: No.

GERAGOS: And did anybody ever submit to you a sample pubic hair, sample DNA from the duct tape on the remains of the Laci Peterson on the outside? Did anybody ever submit that to you for Mitochondrial DNA

testing?

FISHER: No.

GERAGOS: Okay. If they had submitted that hair to you, that pubic hair that was on the duct tape that was on the outside of the remains, and you tested it, would you expect it was Laci Peterson's hair, that it would match up with the same Q1.1 hair from the pliers and the Sharon Rocha sequence?

FISHER: If the hair came from Laci Peterson, I would expect it to have the same sequence as we see in Q1.1 and K4.

GERAGOS: If it came from somebody who was not a maternal relative, what would you expect?

FISHER: I would not expect it to have the same sequence.

GERAGOS: That would be the one thing that would -- Mitochondrial DNA would be really good at, which is to exclude a sample as not being part of the maternal lineage; is that correct?

FISHER: That's correct.

GERAGOS: That's basically the best thing Mitochondrial DNA does is this exclusion, correct?

FISHER: Yes.

GERAGOS: Is that correct?

FISHER: Yes.

GERAGOS: Were you given any other hairs at all to test?

FISHER: We had a number of different hairs from Scott Peterson, but -- I believe those are the only other hairs we were given that were submitted.

GERAGOS: Were any other, that you are aware of, other than Scott Peterson and Laci Peterson's, what -- I guess we call the known samples. You were given the hairs from the black-blue hairbrush; is that correct?

FISHER: Yes.

GERAGOS: Were you given anything else in terms of hairs that were recovered, either connected to items that were found near her remains?

FISHER: No.

GERAGOS: Were you given any hairs that were recovered, other hairs that were recovered from the boat itself?

FISHER: No.

GERAGOS: Were you given any -- I guess the easier question, rather than just asking you the entire universe, is it fair to say the only comparison that up did was the two centimeters of the hair that was taken from the pliers, and you compared that to the cheek swab sequence from Sharon Roch

FISHER: That is correct.

GERAGOS: And the exclusion of Scott Peterson?

FISHER: Yes.

GERAGOS: I have got nothing else.

Redirect Examination by David Harris

HARRIS: Doctor, going through real brief. On some of things, if I understand what you are saying, Q1.1 and K4, you have a high confidence that those are basically the same maternal

Mitochondrial DNA?

GERAGOS: There is an objection. That misstates the evidence. It also violates the 402.

JUDGE: I don't think so. Overruled.

FISHER: Could you ask the question again, please?

HARRIS: Try it again. Q1.1 and K4 that we have been talking about, you were being asked questions about Sharon Rocha, who is the known source of K4, that's the K4, and comparing that to the Q1.1. Are you confident in your examination with the limitations of the Mitochondrial DNA, that Q1.1 and K4 share that same sequence?

FISHER: I'm confident that the sequences are the same, yes.

HARRIS: Now, in terms of counsel's asking where Mitochondrial DNA might be used for an exclusion rather than an inclusion; if the sequences are different there is an exclusion if it's more than one base pair different, if I understand you.

FISHER: If there is two or more bases difference, it is an exclusion.

HARRIS: And, again, with what you have for Q1.1 and K4, you find that to be an inclusion?

FISHER: An inclusion. Cannot exclude, yes.

HARRIS: Now, when you were being asked about whether we would expect to see certain things if people were related. From what we know of the science of Mitochondrial DNA, if people have that same maternal linkage in connection to each other, the inheritance, would we expect to find that same Mitochondrial DNA sequence?

FISHER: Yes. Maternal relatives are expected to share the same Mitochondrial DNA sequence.

HARRIS: What were you were talking about in terms of the numbers that one out of 112, that is for unrelated individuals?

FISHER: Yes.

HARRIS: What you have seen in your database is that, in the Caucasian group, 10 out of 1814 have that. So there is kind of a rarity, or at least less frequency of that particular sequence?

FISHER: Yes, that's correct.

HARRIS: Now, we're talking about relatives. I think counsel was saying it would be one out of one, or five out of five. Again, that's just the science of Mitochondrial --

FISHER: All maternal relatives should have the same Mitochondrial DNA sequence.

HARRIS: Now, going back to some of the first questions that he was asking you about, the potential issues for contamination. We just want to go through the sequence there. You were saying the FBI has a form or some type of document that you use for your chain of custody.

FISHER: That's correct.

HARRIS: And you don't know what MPD does in terms of their chain of custody?

FISHER: No, I don't.

HARRIS: So what within your department, you have certain protocols and procedures; and, in your opinion, that's what was followed in this particular case?

FISHER: They were followed, yes.

HARRIS: And in terms of what the Modesto Police Department does, you don't have any knowledge or experience with what they did or didn't do in this case?

FISHER: I have no idea what they did.

HARRIS: You don't know what their policies and procedures, or even what their facilities are, do you?

FISHER: No, I don't.

HARRIS: But in terms of your testing, you tested the hair that they sent to you; is that a fair statement?

FISHER: Yes.

HARRIS: And you obtained the results that you testified to based on the actual physical hair that they gave you?

FISHER: That's correct.

HARRIS: From that physical hair, you took all the steps that you told us about, washing the hair, the two negative controls and positive control, to make sure that the sequence that you obtained from that hair came from that hair.

FISHER: That's correct.

HARRIS: And that particular hair has the same sequence as the cheek swab sample from Sharon Rocha?

FISHER: That's correct.

HARRIS: People have no other questions.

Recross Examination by Mark Geragos

GERAGOS: When the Trace Unit -- what do they wear when they go into that room and do the examination?

FISHER: Again, I'm not a qualified Trace Examiner, but I have observed them. And they wear lab coats and gloves. And actually in the room is the area, I believe the air is filtered. Actually should have spoken with Miss Ruebush and Korsberg. They know this much better than I do. There is sticky tape on the floor before you enter the room to remove anything from your shoes. They have protocols as far as changing lab coats and gloves between items that they examine, things like that.

GERAGOS: Why are those things done?

FISHER: To avoid transfer or loss of hairs, or any kind of trace evidence.

GERAGOS: Transfer of hairs, meaning somebody bringing a hair in and falling off of them, so to speak, and contaminating the areas?

FISHER: That's correct.

GERAGOS: I have no further questions.