F/CR/17/90

IN THE COURT OF QUEEN'S BENCH OF NEW BRUNSWICK

TRIAL DIVISION

JUDICIAL DISTRICT OF MONCTON

B E T W E E N: HER MAJESTY, THE QUEEN

- and -

ALLAN JOSEPH LEGERE

BEFORE: The Honourable Mr. Justice David M. Dickson

AT: Burton Courthouse, Burton, N. B.

ON: May 1, 1991

- TRANSCRIPT OF EVIDENCE AND PROCEEDINGS -

EVIDENCE OF DR. JOHN WAYE

VOLUME IV

Court Reporter:

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JUDICIAL DISTRICT OF FREDERICTON

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A TRIAL HELD BEFORE THE HONOURABLE MR. JUSTICE DAVID M. DICKSON, JUDGE OF THE COURT OF QUEEN'S BENCH OF NEW BRUNSWICK, AT THE BURTON COURTHOUSE, BURTON' NEW BRUNSWICK ON THE 1ST AND 2ND DAYS OF MAY, A.D. 1991.

APPEARANCES:

Anthony Allman, Esq., Graham Sleeth, Esq.and John Walsh, Esq., Solicitors for the Attorney General of New Brunswick

Weldon Furlotte, Esq. and Michael Ryan, Esq., Solicitors for the Accused, Allan Joseph Legere

THE COURT: This is a continuation of the trial The Queen v. Allan Joseph Legere and the same accused is present for the record and the same counsel are present as were present earlier.

And we are resolved into a voir dire, of course. And we are entering on the second phase of the voir dire that pertaining as I believe to the admissibility of evidence relating to DNA typing. Mr. Walsh you were addressing this on behalf of the crown or did Mr. Sleeth, did you have something to say?

MR. SLEETH: Yes, my lord, before Mr. Walsh begins his presentation I would ask permission of the Court to be excused commencing tomorrow, I am required in other matters before the Supreme Court of Canada -- for the Supreme Court of Canada, I would appreciate it if I could be excused starting tomorrow from this voir dire.

THE COURT: Yes, this is for a few days and only, of course, during the voir dire.

MR. SLEETH: Only during the voir dire, oh, absolutely.

THE COURT: You and Mr. Ryan representing the defence counsel spoke with me earlier in chambers about this and I see no reason why you shouldn't be excused.

MR. SLEETH: Thank you very much, my lord.

THE COURT: And Mr. Walsh you were going to speak I gather to the other -- I have had the benefit

of course of the preliminary address at the commencement of the voir dire session by Mr. Allman in which he gave -- outlined the crown's case generally. You may wish to perhaps make some preliminary remarks in addition dealing with the DNA aspect if you like. I gather that the body substances and so on which were the subject matter of the first phase of the voir dire would play a rather integral part in the second part. I suppose we have to assume for the purpose of your argument that those would be admitted.

MR. WALSH: That's correct. My lord, with respect to this phase of the voir dire, it's the crown's intention to call five witnesses. My first will be Dr. John Waye. He will be the only witness that I will be asking the court's permission to stand aside. The reason being that Dr. Waye's presentation will generally as a general outline will involve somewhat of a biology lesson, the basics before we get into the actual technique in the other related matters. Then Dr. Waye is also going to be asked to provide opinions with respect to the evidence in this case. And as a result it will be necessary to recall him after Dr. John Bowen, my second witness testifies. Dr. Bowen will be -- is the scientist who actually performed and conducted the test pertaining to the case of

Allan Joseph Legere. After Dr. Bowen, I will be calling Dr. Kenneth Kidd with respect to evidence pertaining to the R.C.M.P. application of DNA typing, with respect to population genetics and also with respect to the evidence in this particular case. Following Dr. Kidd I will be calling Dr. George Carmody who also will be providing -- he will be providing evidence with respect to the population genetic issues generally pertaining to the R.C.M.P. system and other general evidence. At this point I expect I will be recalling Dr. Waye and then he would be in a position then to comment, to give an opinion on Dr. Bowen's evidence. And then my final witness, I expect, will be Dr. Ronald Fourney, who testified last week in a much limtied role in the voir dire last week. As it pertains to the voir dire last week, when we get to the case specific evidence pertaining to this matter, my lord, I expect the evidence will be that there are in fact, for our purposes, the inclusion purposes there are two gels. The first gel has twenty two lanes on it and the known standard that the crown will be eliciting evidence with respect to a comparison to will be the scalp and pubic hair taken in 1986, identified last week as 56-A and 69-A.

THE COURT: 56-A and 59-A.

MR. WALSH: And 69-A , those were the R.C.M.P. identification numbers that they referred to in

their testimony. The other evidence will be with respect to the second gel. And in the second gel were run bodily substances being, the blood on the toilet paper was marked R.C.M.P. identification number 335. And the second substance run on that gel will be, I believe it's the pubic hair taken from -- purportedly to be taken from Mr. Legere in 1989 at the time of his arrest. Those two substances were run on the second gel as standards. And I expect you will hear evidence with respect to a comparison between that gel and the first gel.

You will also but from the crown's point of view in a much more limited role you will hear evidence with respect to a third gel, the results that were compared with respect to -- involving the matter with Father Smith. The first gel and the second gel pertain to the Flam and the Daughney matters. In fact substances from the Flam and the Daughney's found at the Flam and Daughney scenes were actually run on this first gel.

You will also --

THE COURT: We're going to have to assume, I gather, for the purpose of the voir dire that the crown will seek to prove or will be able to prove the source of these circumstances that were compared with.

MR. WALSH: Yes, my lord, back in -- remember back on February 4th when we met here, I sought

an order from you allowing me to proceed without proving the continuity of the sources of all these different substances, because that related to the factual basis not the legal basis. And it would extend this voir dire quite a bit if the order had not been granted.

In any event, yes, obviously the crown -- it would be the crown's obligation to prove up the continuity associated with any substance that the Court -- for any of the forensic samples that we rely on, yes, I accept that.

THE COURT: Would it serve to clarify the matter if you indicated at this time what substances you will be using in the comparison?

MR. WALSH: If the Court would indulge me, when Dr. Waye -- Dr. Waye will be --

THE COURT: This isn't evidence.

MR. WALSH: No, I understand. Dr. Waye is -- his testimony on his initial direct testimony he will not be dealing with the case of specific evidence pertaining to The Queen v. Legere. He will be dealing with, as I say, the biology, the technique and the general applications associated with the technique. And I will be recalling him. When Dr. Bowen begins to testify later this week, he will, in addition to other evidence, be giving the results and what he actually did in the testing. What I am doing at the present time, being typed is a list of the substances and the lanes in which these substances are purported to be found to guide

both the defence and the Court on the voir dire. And at that time if the Court would indulge me at the opening of Dr. Bowen's testimony, I could provide the Court with a statement for the purposes of the voir dire only as to what substances go in what lanes in what gels.

THE COURT: That's fair enough.

Now, the other thing is, you're going to be using, I gather, screens and things, where are they going to fit into the things here?

MR. WALSH: When Dr. -- for today's testimony and for how long ever Dr. Waye is on in this particular matter, Dr. Waye will be essentially in the biology and the technique. At some parts of that he will be using a slide projection of to teach or to actually demonstrate, demonstrative evidence to clarify his evidence. When he refers to the slide projection I have same of the items that he will be referring to on the slide projection are also contained on charts. As you appreciate after the slide is over some of these charts may be beneficial, they're duplicates from the slide, some of them, not all of them. But some that may be beneficial throughout the whole hearing to keep referring back without turning the machine on and trying to find it.

But to facilitate the Court and the clerk's handling of exhibits, what I have suggested to the clerk and hopefully it will work

when Dr. Waye refers to a slide or a chart I have a duplicate, an 8 1/2 x 11, I believe that's the size, a manageable form, a duplicate. What I thought perhaps, my lord, when he refers to the slide I could have the duplicate, 8 1/2 x 11 marked as the exhibit or marked on the voir dire and that way the only matter that the clerk would have to handle would be these 8 1/2 x 11 duplicates of what the chart of the slide or of the chart. And they're all duplicates, it would just make it easier to handle.

THE COURT: What we see on the screen, is this paper drawing or sketch?

MR. WALSH: Yes, whatever you see on the screen or on these charts will be contained in these 8 1/2 x 11 duplicates. But they just make it easier to handle and if the Court wishes to refer to them in its preparation, it won't be necessary to actually to try to get a slide projector set up or get the charts handled and brought around. It's a suggestion to the Court, my lord.

THE COURT: The defence have no objection to that?

MR. FURLOTTE: I have no objections.

THE COURT: Thank you.

What you're saying then, there's no necessity for the actual slides to be marked in evidence.

MR. WALSH: That's what we would hope, on this particular matter. We are hoping to prevent any

unnecessary handling of items that really do not help what we are attempting to do here, help the law finder..

THE COURT: Fine. You'll appreciate, of course, that it's difficult for a written or a typed record to show all of the movements and actions that take place in using screen projections and so on. So make sure when a witness is referring to something on a diagram that it's illustrated in some way or described in some way so that the written transcript will be meaningful.

MR. WALSH: That's why I had hoped by introducing these actual 8 1/2 x 11 it will support the evidence, in looking a transcript you will be able to refer to it as well, as much as the doctors actually can they will be attempting to put in words what they are showing on the screen, yes, my lord. There are some limitations obviously but they will do their best to do that.

The other thing, my lord, as how the crown intends to proceed is throughout Dr. Waye's testimony and Dr. Bowen's particularly but particularly Dr. Waye, I will be asking and Dr. Waye will be referring to or I will be asking him to refer to certain publications and at that time when he does refer to them, I will be asked that they be marked on the voir dire. Some of them, I have taken the liberty of binding each separate publication so they will be easy

to handle. And I would prefer to do it as we go along, as opposed to attempt to enter any stack of documents without connecting any relevance to them. At the outset, I know Mr. Furlotte and I have discussed this, one of the documents, reference documents that both crown and defence and the Court, because of the document was referred to a case in the States, one of the documents was, GENETIC WITNESS FORENSIC USES OF DNA TESTS, it's Congress of the United States Office of Technology Assessment which the Court is aware of. Mr. Furlotte and I have agreed it would be preferable to have this particular document, I have another copy here, to have this document marked as the first exhibit or the first item on the voir dire with consent, if that's agreeable to the Court.

THE COURT: Why not mark that now as VD-24. Our exhibit numbering or lettering has no medical significance.

MR. WALSH: Whenever the Court is ready, the crown is prepared to call its evidence.

MR. RYAN: Prior to the crown calling a first witness, if I may, a matter of housekeeping from Friday afternoon, a number of cases were cited in defence counsel's submission with respect to the first voir dire, and the Court requested copies of those cases and I have copies for the Court of the Attorney General of Canada and Korponey, Regina and Manninen, Clarkson v. The Queen, and Regina and Bridges, et al.

Well, my lord, I'll pass these to the clerk for the Court and counsel for the crown also copies.

THE COURT: Thank you very much, Mr. Ryan.

MR. FURLOTTE: My lord, I also have a preliminary motion for exclusion of crown witnesses while each other are testifying.

THE COURT: A motion for what, Mr. Furlotte?

MR. FURLOTTE: For the exclusion of the crown's witnesses until they have testified.

THE COURT: What is the attitude of the --

MR. FURLOTTE: My lord, I have -- just in support of that, copies of annotation Ewaschuk on Procedure which I'm referring to.

THE COURT: I suppose before we get into discussing the motion, what is the attitude of the crown?

MR. WALSH: We take serious objections to Mr. Furlotte's motion. I would ask the opportunity to address the Court on that.

THE COURT: Well, we'll hear -- I just wanted to ask, if you were going to say, well, we have no objection, that would be the end of the matter and the Court would probaby grant the motion automatically. Mr. Furlotte, let's hear your argument in support of your motion.

MR. FURLOTTE: Well, my lord, in Ewaschuk on Criminal --

THE COURT: In what is it, what's that word, you're using?

MR. FURLOTTE: Ewaschuk, that's E-W-A-S-C-H-U-K, Criminal Pleadings and Practice in Canada Second Edition, that's at page 16-7, Paragraph 16, Column 2080 on the law on exclusion of witnesses. It states, A judge may on application or on his own motion order the exclusion of all or some of the prospective witnesses except the parties. When evidence is about to be taken in a proceeding. A judge has a discretion to grant or deny a motion to exclude witnesses, but the governing principle is that the order should be the most conducive to the investigation of the truth, with the result that an order excluding witnesses is in practice rarely refused.

Some of the case law listed below is in relation to the discretion of a trial judge to do so, but generally the practice is to grant the motion. There were circumstances where after a judge had ordered witnesses excluded and it was found out that those witnesses remained in court, it was found that the judges could not -- in some cases said the judge could prohibit them from testifying but in most cases, the judge would allow them to testify but it said, where they remain in court, in disregard of orders the witnesses must nonetheless be received, although the weight of the evidence may be affected by the witness having had the privilege of hearing prior testimony.

My lord, since this is a case where the evidence is based on opinion evidence and that opinion evidence is generally based on hearsay evidence, the criteria which they base their opinion is related to experiments and opinions of other professionals in the field. I would submit that in such a proceeding as this, if I am to ask questions on cross examination for opinions which maybe these witnesses have never stopped to formulate or even considered in the past that their personal opinion may well be affected by the witness who gave an opinion on the matter just prior to him.

In one of the cases mentioned, R. v. Hutchinson which was the New Brunswick Supreme Court of Appeal, 1975, the Court of Appeal found that the discretion was in the trial judge and he didn't abuse that discretion. In that particular case, that was in -- I didn't photocopy the whole case for you but it showed in ground 5, on page 427, it showed ground 5 of appeal was that:

> «5. That the learned trial judge erred in refusing to exclude Raymond Stein and Cy Stein from the Court as each was giving evidence.»

And their reasons for denying that, the Court stated on page 432, under ground 5, it says:

«The matter of excluding witnesses from the Court is a matter of practice in the discretion of the trial judge. It is generally done on application of counsel for either the Crown or the accused, but if no valid reason is given for exclusion of a witness the trial Judge has a discretion to refuse to make such an order. I concur with the reasoning of the trial Judge that there was no good reason for excluding Mr. Stein or his son Raymond from the court-room while the other was testifying. The evidence of each was directed to different events and did not overlap or confirm that of the other except as to the fact of Raymond Stein proceeding down the road and entering the father's car after the latter dropped the ransom money in the ditch, and the defendants were in no way prejudiced by the decision refusing to exclude either witness.»

The evidence that's going to be produced in this Court is --

THE COURT: Of course, the evidence in that case and I happened to have been the trial Judge as counsel are probably aware. The evidence touched on factual matters didn't it? It wasn't expert opinions, they weren't experts.

MR. FURLOTTE: And they were not overlapping. The factual matter that each witness was going to testify were not overlapping.

This case is strictly a matter of opinion and the opinions and issues are definitely overlapping for each of the witnesses, and I expect that I will be proposing questions to these witnesses that have never been proposed in court before, at least not that I was able to come across. So in a good deal I would have to say that they're going to be asked questions that they're not expecting. I am going to be asking them to form an opinion on them. And I would submit, my lord, that if they are able to hear the opinion and the reasons given for the opinion given by a former witness then that -- they're going to be influenced by those opinions given and I would submit that if we are looking for what is considered to be the most conducive to the investigation of the truth, then, we are looking for honest opinions here, opinions that are not influenced by one of their colleagues who they happen to be working with and who they would not want to contradict and make their colleague look bad. So we are seeking the truth here, my lord, and the only thing that I want to get out is the truthful opinions and the most conducive way to do that under these circumstances is that the witnesses be excluded, because I feel strongly that if they are not excluded it will be to the prejudice of the accused. In all

sense of fair play, I would ask that these witnesses be excluded.

THE COURT: Thank you very much.

Mr. Walsh, what do you have to say?

MR. WALSH: My lord, I certainly take no exception to the matter of law as set out in Ewaschuk, and I think that is certainly a understandable aspect of the law and every one at least from the Crown's point of view, we certainly are attempting to elicit the truth. Not only do we want the true opinions but we want accurate opinions and we want opinions based on all available information.

What Mr. Furlotte seems to do in relation to his argument is blur the lines as to what witness -- what the witness is and what his testimony is about. He says on the one hand, which is correct, is that opinion evidence by its very nature draws on sources of information of all kinds. It draws on sources of informations, discussions with other people in the field, one of the sources of information that it will draw on is other people testifying in the same case, because they take that information into consideration in assessing their opinions, in giving an accurate opinion.

In fact it's the Crown's intention to ask some of the witnesses to comment on some of the opinions that preceded them. If that was not the case, I'll give you an example, my lord,

just to give you an example, if Dr. Waye was to testify as to the RFLP system and what it is and how it's applied to the R.C.M.P. When Dr. Bowen goes to testify, not knowing, what, if any, comments Dr. Waye made with respect to that system, it would be absolutely necessary for Dr.Bowen to repeat the whole thing. The same with Dr. Kidd, it was my intention and we have a daily transcription being prepared or as close to a daily transcription as possible, it was certainly the Crown's intention to have the transcription of evidence that preceded to be given to the doctors so that they can take all sources of information in to give their opinions on, because they will be asked to, for example, give opinions on Dr. Bowen's opinions or on Dr. Waye's opinions and Dr. Carmody will give the same thing. I asked these gentlemen who have probably and without jumping the case and I don't wish to testify, probably the most experience in this country. They've never been asked -- never been asked to be excluded that I am aware of from a courtroom. And to use scientists in this particular case is, I would suggest, highly irregular and the arguments of Mr. Furlotte have no application to this. The very reason that you would want them here is part of the basis for their actual testimony. Then, as I say, if they were in fact excluded, then I can suggest that we've changed the

time frame from this voir dire to a substantially longer one.

The other thing Mr. Furlotte mentions is he would like to give -- put questions to these experts, so that they can formulate their opinion. Now, if last week was any indication Mr. Furlotte has a tendency to put the answers of one witness as a question to another witness. I think it would form a nightmare, if we are into a situation where Mr. Furlotte is trying to accurately relate the answers from one witness and try to put it in the form of a question to another one. It certainly would do nothing in terms of actually the truth seeking.

We are dealing with scientists, they are influenced, certainly, if that is the word, I don't wish to use the word influence but they take opinions of other people in the field into consideration. If Mr. Furlotte is suggesting that because one opinion may not coincide with theirs and as a result they would tailor that, that's a problem with any witness, and I mean that's something that we always deal with.

We are not dealing here with evidence that may be unnecessarily unduly influenced by that of another. Because ironically, that's part of the very basis for their testimony, that is the opinions of people who precede them.

Thank you, my lord.

THE COURT: May I ask this of you, Mr. Walsh, to what extent has the evidence to be given by your witnesses been condensed or has been reflected in reports or information made available to opposing counsel at the present time?

MR. WALSH: That's a good point, my lord. One of the reasons, one of the things that I had noticed and it was reflected in Mr. Allman's letter that was filed in relation to Mr. Furlotte's request for an adjournment. One of the things I have noticed about the case law, particularly, the American case law is that they have had these scorched-earth type cases, in which the technology is cross border, and they had these scorched-earth type cases in which judges in giving their -- in formulating their opinion on judgment have actually in great detail elicited all the countervailing opinions or majority of the countervailing opinions. If Mr. Furlotte is going to be asking questions that have never been asked in a courtroom before, well, so be it, but that certainly is opinions that have been disseminated and circulated and I expect read by the experts and read by counsel. There is nothing to be gained I can see by blurring the lines between someone who may be giving testimony and may be by their position or what they saw would be unduly influenced by someone else. But we are dealing

dealing with scientists, then I would go so far as to say as a scientist of the caliber that I expect will be called by the crown, to exclude them from listening to other fellow scientists, I don't see how that in any way would prejudice Mr. Legere. In fact it would make the seeking of the truth that much more difficult.

THE COURT: Have you anything to say, Mr. Furlotte, in reply? May I ask you this, too, are you -- can you cite any cases where opinion evidence is being recorded as or being accepted in a court as a voir dire of this nature where the witnesses have been excluded. Hutchinson is a case you've cited. Hutchinson, of course, was a thing where the defence counsel didn't want the boy to hear what his father said about certain physical events or happenings which actually took place or perhaps it was vice versa, I can't recall now.

But what about opinion evidence? Surely all of the -- any opinions which these witnesses would be giving must have been given before in some American case which are fully reported at great length. Surely those witnesses must be aware of those cases.

MR. FURLOTTE: No, I stated, my lord, I believe I have questions for these expert witnesses which have never been put to expert witnesses before, at least not that I've been able to uncover.

In this particular case, I'm not trying to say that these expert witnesses and I'm not trying to destroy their credibility to say that they'd come here and lie, just to protect the preceding witness's testimony. But it's a question of being bias. And it's as the publicity that Mr. Legere got, it's going to be difficult to find twelve unbiased jurors out there. Well, let's make sure that the opinions given by these witnesses are not biased by something they just heard their colleague who they worked with and who they've done articles with and done lab experiences with together and wrote articles together. These colleagues are not just scientists out there in the field, they are closely related scientists in their work and they're mostly all members of the R.C.M.P., at least had been at one time, they've worked on experiments together. It's just--

THE COURT: I suppose their opinons will reflect to some extent a certain about of collaboration and agreement or otherwise the Crown wouldn't be calling them as their witness.

MR. FURLOTTE: Definitely, as they work together they collaborate together and that's to be expected and there's not much I can do about that. But let's try to stop it there and begin anew.

THE COURT: You have indicated that you are going to call an expert on this phase of the voir dire.

MR. FURLOTTE: Yes, I am.

THE COURT: He's not present at the present time, I gather.

MR. FURLOTTE: He's not present at the present time, I think, my lord --

THE COURT: Would you feel that the Court should exclude him from being present when the Crown experts were testifying, so that he wouldn't be lucid or biased or whatever?

MR. FURLOTTE: I would have no objections to that. I think in order to get honest opinions that --

THE COURT: Surely though, that would not operate very much in the interest of justice to say that your expert should be put out of the courtroom while the others testify.

MR. FURLOTTE: Well, my lord, in the interest of justice and fair play here, I think the Court has to realize that an accused person usually does not have the resources of the Crown in bringing to the court witnesses. And most of the --

THE COURT: That's not what we're --

MR. FURLOTTE: No, but most of the time the defence has to rely solely on the ability of good cross examination in order to present their case. And since, I think it's probably obvious that I cannot afford or Mr. Legere cannot afford to get five or ten expert witnesses here to come and refute the evidence given by the Crown and their expert witnesses. I have to rely on good

cross examination to present Mr. Legere's case, the best way I can. And by these witnesses and the substance of the testimony given, it would take away from my ability to cross examine properly and in my attempts to seek true opinions and maybe a variety of opinions.

It surely would not hurt the Crown's case. The Crown is suggesting that what he does is take copies of the transcripts and let his witnesses read it all over and that's copies not only of the direct evidence but the issues on cross examination. So they can have lots of time to contemplate the answers which would not contradict their prior testimony or the testimony of their colleagues. That's -- I think that's a little too clandestine approach and it's -- like I say, it's not a question of my saying that the Crown's witnesses are not credible witnesses, but I think they would be unduly influenced by listening to the opinions given by the people who immediately precede them. And rather than my being able to elicit their own opinion, I may be eliciting somebody else's. I don't want a pack -- I don't want a bunch of pack horses in this case, one just following behind the other and saying, yeah, yeah, yeah, yeah, yeah, yeah. I want them to have a free rein to go out on their own.

THE COURT: Thank you very much, Mr. Furlotte.

Mr. Walsh, I'm not sure that I got a clear answer as to the question that I raised

in the information that you've given to defence counsel, were the opinions or the basic opinions that you are going to solicit from your various witnesses contained?

MR. WALSH: Yes, my lord, both in the articles that I actually gave notice that I intended either to rely on here or they may be referred to, in as well the cases, the case book that I've provided in terms of all the cases. These opinions are all generally relied on. We are dealing with the integrity of these individual scientists. As the Court has pointed out, Scientists have the obligation to listen to fellow scientists. Their integrity certainly is something that can be challenged but to actually exclude these people from the courtroom while the other testifies, they don't -- they haven't been able to tell one where it happened in Canada and I'd be very surprised in listening and reading these other cases, whether it's ever happened in the United States at least in these DNA hearings, where I see Crown, in that case State evidence actually being, one is giving an opinion on the other's evidence. It's not, I would suggest, to exclude the witnesses would gain nothing. It kind of surprised me, he did mention last week that he may do this but it was kind of a surprise to me that he actually went ahead with it because it's contrary to the whole purpose behind having

opinion evidence. And it certainly is going to change the nature of the actual voir dire as how we call it and the length and period of time that's involved in actually doing it.

And it -- again, my lord, one final point as I pointed out, that it may be necessary and I'm not saying it is, I know that the right to rebuttal is a limited right in Canada. I had reserved that right at some point to try and convince the Court, should it be necessary, but that would effectively prohibit such an order would as an ancillary -- or as an incident of such an order would actually put me in a very difficult position should I want that.

We are dealing with a concept here and a technique and a technology that's necessary to get everyone's opinions.

THE COURT: Thank you. Did you have anything to add, Mr. Furlotte, in reply, anything else?

MR. FURLOTTE: No, my lord, but it's just back to the basics of the Crown and i.e., versus Mr. Legere and these people are all or had been at one time members of the R.C.M.P. and it's just conducive to fair play for you to allow the exclusion of witnesses.

THE COURT: Well, I'm not going into my reasons immediately I will give them a brief summary of reasons at some later stage of the voir dire today. But the application is refused. I don't feel that it's a proper place to exclude witnesses.

The Hutchinson case was one that pertained only to factual situations. I think it would be most impractical to put expert witnesses out of the courtroom when others were testifying in issues like the ones with which we are concerned here.

But I will have something a little more to say about it for the record at some later stage today.

Now, Mr. Walsh, your first witness.

MR. WALSH: My lord, I'm prepared to call my first witness, Dr. John Waye.

DR. JOHN WAYE, called as a witness, duly sworn, testified as follows:

DIRECT EXAMINATION BY MR. WALSH:

Q. Would you give the Court your name, please?

A. John Stewart Waye.

Q. And what is your present occupation?

A. Assistant Professor at McMaster University in Hamilton, Ontario.

Q. And your previous occupation or your previous position, I should say?

A. As a civilian member of the R.C.M.P. Central Forensic Laboratory.

Q. At this time, doctor, I am going to ask you to look at this particular document and tell me whether or not you recognize it?

A. Yes, it's my curriculum vitae.

MR. WALSH: My lord, if I may have this marked on the voir dire?

THE COURT: VD-25.

Q. I hand you VD-25, Dr. Waye -- my lord, with your permission, I would seek permission to lead him through the C.V.

THE COURT: All right.

Q. Your C.V. shows Dr. Waye that you obtained a Bachelor of Science--

THE COURT: Do you have another -- you don't have a copy that I could follow along on.

Q. Dr. Waye will know it --

THE COURT: You may know it yourself, all right.

Q. Dr. Waye, your C.V. shows that you obtained a Bachelor of Science in Microbiology from the Department of Microbiology from the University of Guelph in Guelph, Ontario, is that correct?

A. That's correct, yes.

Q. You received a Masters of Science degree in biology at McMaster University, is that correct?

A. Yes.

Q. You've also received a Ph.D. in Medical Biophysics from the Department of Medical Genetics at the University of Toronto in Toronto, Ontario?

A. Yes.

Q. And you are a Post-doctoral Fellow in Medical Biophysics at the Department of Medical Genetics in the University of Toronto in Ontario?

A. Yes.

Q. You have won a number of -- you have a number of scholarships and awards to your credit as shown in the C.V.?

A. That's correct.

Q. You had two dissertations, those dissertations do they relate to DNA?

A. Yes, they do.

Q. Between March, '88, and January, 1990, you were a molecular genetic specialist in the Molecular Genetics Section of the Central Forensic Laboratory of the Royal Canadian Mounted Police in Ottawa, Ontario?

A. Yes.

Q. Would you explain, doctor, what your duties were and how you came to that position?

A. My duties involved with other scientists setting up DNA analysis program at the R.C.M.P.

Q. And you remained in that position until January, 1990?

A. Yes.

Q. And during the period of time that you were with the R.C.M.P., you were also an adjunct professor at the Department of Microbiology and Immunology at the University of Ottawa?

A. Yes.

Q. And I take it that you taught courses in those particular fields at that time?

A. No, I left Ottawa before my teaching responsibilities became a reality.

Q. I also note that between April, 1989, and January, 1990, you were an associate member of the Children's Hospital of Eastern Ontario Research Institute in Ottawa, Ontario?

A. Yes.

Q. What type of work would you have done there, doctor?

A. Again, I left Ottawa before I formally began my own research at the institute, I worked with another Dr. Korneluk(phonetic) and collaborated on some of his research projects.

Q. And between July, 1990, and the present as you pointed out you are an assistant professor in the Department of Pathology at McMaster University and Assistant Director of the Provincial Hemoglobinopathy DNA Diagnostic Laboratory at the Chedoke-McMaster Hospital in Hamilton, Ontario?

A. Yes.

Q. You have -- you are also a consultant, I see to The Ministry of the Solicitor General of the Centre of Forensic Sciences in Toronto, Ontario?

A. Yes.

Q. And you are also a consultant to the Royal Canadian Mounted Police at their Central Forensic Laboratory in Ottawa?

A. Yes.

Q. And that consulting deals with DNA and DNA typing?

A. Yes.

Q. I see, doctor, from your C.V., that you are a Journal Referee for Journals, such as the Proceedings of the National Academy of Scientists in the United States, a journal by the name of Genomics and Chromosoma?

A. Yes.

Q. What is a journal referee and what do you do?

A. When an article is submitted for publication, the editor or the associate editor of the journal will identify people who work in that field, experts in that field and send the article to them to critique the article, to review the article and to recommend whether it be published, revised or rejected for publication.

Q. And those articles deal with DNA or DNA typing?

A. Yes.

Q. What general field of science would you consider yourself to belong in, doctor?

A. Molecular genetics.

Q. I see, and would you describe what, very briefly, what DNA is and what application it would have to the field of molecular genetics?

A. DNA is a substance that controls all our genetic diversity and encodes all the information that makes us a human. So in fields as far reaching as -- from medicine to applied fields, such as, various biology fields, environmental studies, evolutionary studies, you analyze DNA as part of all these disciplines.

Q. What is, very briefly, what is DNA typing and what application would it have to the field of genetics?

A. DNA typing is just the analysis of DNA, some various techniques.

Q. Are there particular types of typing? Is there particular --

A. Yes, there's various ways you can analyze them. There's many different ways you can analyze.

Q. Could you name just a few, please?

A. I can analyze it at a gross level by RFLP restriction fragment length polymorphism.

Q. And that technique is used by who?

A. That's used throughout biology.

Q. And what other types are they?

A. You can sequence the DNA molecule itself, actually determine its precise code, that's the finest level of analysis is the nucleotide sequence analysis and again, that's used throughout biology.

Q. What other scientific fields, you've pointed out that you are in molecular genetics. You've also indicated that the DNA and DNA typing as applied to other scientific fields outside molecular genetics?

A. Yes.

Q. And they are biology, what kind, biology, would biochemistry fit in that particular category?

A. Yes.

Q. Does it have application to, you pointed out medical diagnostics?

A. That's the application I'm most familiar with, yes, throughout medicine it's used.

Q. I see in your C.V., doctor, that you have under the heading, first of all, you are teaching courses at the University at the present time?

A. Yes.

Q. One of your topics is genetic disorders?

A. Yes.

Q. Does that relate to DNA?

A. Yes.

Q. Another topic is molecular diagnosis of thalassemia?

A. Thalassemia.

Q. Fine, does that relate to DNA?

A. Yes.

Q. Another topic is DNA fingerprinting in forensic medicine, that's to be taught in the spring of '91?

A. Yes.

Q. And you are also to teach the human genome, does that relate to DNA?

A. Yes.

Q. Under the headings of Publications: Peer Reviewed Journal Articles, would you first of all, tell us, doctor, what a Peer Reviewed Journal Article is?

A. This is an article that you submit to a journal whose policy it is to have it reviewed by other experts in the field prior to publication. They will rule on it, whether it's acceptable, whether it should be revised or whether it should be rejected.

Q. Would that be looked at by more than one scientist in the field?

A. Generally two to three reviewers will review for the journal.

Q. And I see by your C.V. that you have, I believe, it's thirty Peer Reviewed Journals or Peer Reviewed Journal articles?

A. Yes.

Q. Do you have any other ones that are not peer reviewed that are not listed in this particular C.V.?

A. Yes, there's a number that are being peer reviewed at the present time.

Q. Do any of these articles deal with DNA?

A. All of them.

Q. Do any of these articles deal with human DNA?

A. With the exception of one article early in my career, an article on moose and deer DNA, all of them deal with human DNA.

Q. And you also have set out here in your C.V., you have under Publications: Short Reports and Letters (Peer Review Journals), what are you referring to there?

A. These are either commentaries or reports that received limited peer review. They're very short reports, they're generally rapid reports where you want to communicate either an idea or a small piece of data, very short, precise reports that can be communicated to the scientific community in a rapid fashion.

Q. But they are in fact peer reviewed as you've described?

A. Generally less extensively by the editor himself usually.

Q. You have in this particular instance, you've noted four, do they deal with DNA?

A. Yes.

Q. Do they deal with human DNA?

A. Yes.

Q. You also under the heading, Publications: Book Chapters and Symposium Proceedings, you have a number of journals and chapters there, would you explain, please, what a symposium, what you refer to as a symposium proceeding, a publication in a symposium proceeding, what would that relate to?

A. Some of the symposia that you attend the organizers will publish the talks that were given in the form of a book. And you are asked to give a talk and you are later asked to submit a manuscript that coincides roughly with the talk that you gave at that meeting.

Q. And you have a number of those, do they relate to DNA?

A. Yes.

Q. Human DNA?

A. There's one talk that again deals with DNA for identifying various species of deer and the deer family.

Q. That particular aspect, you were asked to do that in a forensic aspect?

A. Initially it was for a forensic application for poaching cases and the likes.

Q. Under Publications: Abstracts(Peer Review Journal) would you explain to the judge, please, what an abstract is?

A. The scientific meanings where you present papers or you present your work in a poster format. You're generally asked to write a short synopsis of what that paper or poster dealt with and those are published in the journal.

Q. And this particular C.V. shows that you have seventeen of these that have actually been published?

A. Yes.

Q. And do they relate to DNA?

A. Yes.

Q. And what percentage would relate to human DNA?

A. I believe all of them.

Q. I would just like to go back, there was a part in relation to book chapters, you have a recent chapter, you have submitted a recent chapter, you note here, DNA Identification. Forensic Evidence in Criminal Cases, are you in fact a contributor to that book?

A. Yes.

Q. Doctor, you have participated from your C.V. in a number of working groups, in particular, you've noted the Technical Working Group on DNA Analysis Methods, I think the short name is TWGDAM of the FBI Academy at Quantico, Virginia, would you explain what that group involved and what was the purpose behind it and who would have been attending that grouping?

A. That was a working group that was formed I believe sometime in 1988 and it involved

scientists from various federal and state labs in North America who were initiating and trying to implement DNA analysis for forensic case work. And it was decided that since we all had the same goals and we share a common border that we'd meet regularly and try to develop a technique, the techniques as a unit, as a group and that way speed up the entire implementation process. And we agreed that we'd meet roughly quarterlies, four times a year.

Q. And were you a participant when that began?

A. Yes.

Q. You also have a list under a Working Group on Statistical Standards for DNA Analysis, FBI Academy, Quantico, Virginia, would you explain what that working group involved and what was the purpose behind it and who would be involved in it?

A. That was a specific subcommittee that came out of the TWGDAM group, it also involved scientists that weren't participants in the TWGDAM group, people from private companies, people from academia who had interests in the statistics of DNA typing. And that was put together again to address some of the concerns that had been raised concerning statistics, and again, to deal with the problem in a cohesive manner.

Q. Under your C.V. you noted under Participation in Training Courses and Workshops, you have here, doctor, listed, invited lecturer, DNA Typing

Workshop, Canadian Society for Forensic Sciences, Toronto, Ontario, invited lecturer, is that correct?

A. Yes.

Q. Invited Lecturer, DNA Typing Workshop, Wisconsin Department of Justice, Madison, Wisconsin?

A. Yes.

Q. Invited Lecturer, DNA Typing Training Course, Royal Canadian Mounted Police, Molecular Genetic Section, Ottawa, Ontario?

A. Yes.

Q. Invited Lecturer, DNA Typing Training Course , Centre for Forensic Sciences, Toronto, Ontario?

A. Yes.

Q. And you are an Invited Lecturer at the Ontario Crown Attorney Training Course in London, Ontario?

A. Yes.

Q. Under Presentations at Meetings: Invited, what do you mean by that, doctor?

A. There's two ways you can present material at a meeting. You can be invited by the person who's chairing the meeting to give a specific talk or you can volunteer to give a talk and submit your work to them and they judge whether you should give a talk or whether you should give your work in some other format or whether you should be excluded from the meeting.

Q. Under that particular Presentations at Meetings you were invited to give a presentation at the

The International Symposium on the Forensic Aspects of DNA Analysis at the FBI Academy at Quantico, Virginia?

A. Yes.

Q. You were invited to give a presentation to The International Symposium on Human Identification: Data Acquisition and Statistical Analysis for DNA Typing Laboratories, Promega Corporation in Madison, Wisconsin?

A. Yes.

Q. You were invited to give a talk at the McMaster Pathology Symposium - Evolving Concepts and Pathology?

A. Yes.

Q. Did that relate to DNA?

A. Yes.

Q. Under Presentations at Meetings: Contributed (Papers), what do you mean by that, doctor?

A. Those are meetings where I gave a talk.

Q. And would you have submitted a Paper at that particular meeting?

A. An abstract.

Q. In those particular meetings, from this you've attended -- you've contributed to the Annual Meeting of the Amercian Society of Human Genetics in Philadelphia, Pennsylvania?

A. Yes.

Q. Did that deal with DNA?

A. Yes.

Q. At the Annual Meeting of The American Society of Human Genetics, San Diego, California?

A. Yes.

Q. Did that deal with DNA?

A. Yes.

Q. At the Annual Meeting of the International Society for Forensic Haemogenetics at Liege, Belgium?

A. Yes.

Q. Did that deal with DNA?

A. Yes.

Q. You had an Annual Meeting of the Canadian Society for Forensic Sciences in Toronto, you contributed to that?

A. Yes.

Q. Did that deal with DNA?

A. Yes, it did.

Q. Doctor, under your C.V. Presentations at Meetings: Contributed (Posters), would you explain to the judge, please, what a poster is?

A. Generally at meetings there's a limited number of time slots to give a talk and there's generally more people who would like to give a talk than there is space alloted. So they select people who are going to give talks and the remainder whose work they want presented, they present in a poster format and that is, you summarize your work on an 8 x 4 poster board and there's a large room where people can walk around and go from poster to poster and talk with the authors and discuss the work with them.

Q. And you've done this at the Annual Meeting of the American Society of Human Genetics in Toronto?

A. Yes.

Q. And that dealt with DNA?

A. Yes, it did.

Q. At the Annual Meeting of the American Society of Human Genetics at Salt Lake City, Utah?

A. Yes.

Q. I've been saying, DNA, can you tell me whether or not you are dealing with DNA generally or human DNA in particular?

A. All the talks and presentations that you've talked about thusfar dealt with human DNA.

Q. You've contributed posters at meetings of the Human Gene Mapping 9 in Paris, France?

A. Yes.

Q. And that dealt with DNA?

A. Human DNA, yes.

Q. Human DNA. You have contributed a poster in Nature: Exploring the Human Genome, Boston, Massachusettes?

A. Yes.

Q. And did that deal with human DNA?

A. Yes, it did.

Q. You presented a poster, at the FBI DNA Typing Symposium in Quantico, Virginia, did that deal with DNA, human DNA?

A. Yes.

Q. You presented a poster at the Internatial Congress of Genetics in Toronto, did that deal with human DNA?

A. Yes.

Q. You presented a poster at the Annual Meeting of the Canadian Society of Forensic Scientists in Ottawa, did that deal with human DNA?

A. Yes.

Q. And you have presented a poster at the American Society of Hematology in Boston, Massachusettes?

A. Yes.

Q. Did that deal with human DNA?

A. Yes.

Q. Doctor, could you name other individuals working exclusively with DNA typing with whom you have worked or collaborated, could you name a few for the Court, please?

A. My mentor, Dr. Huntington Willard, he's presently a faculty member at Stanford University in California, where I received -- he was my supervisor during my Ph.D. and post-doctoral training.

Q. Does he have a field in human DNA?

A. Yes, he/does basically all of the human DNA, he works globally with the entire DNA molecules that are in each cell.

Q. Does he have a reputation, a good reputation in the scientific community in that field?

A. Yes.

Q. Did you work with him --

THE COURT: His name was what?

WITNESS: Huntington Willard.

Q. Have you worked with or collaborated with anyone else in this particular field, in DNA typing?

A. Oh, many scientists.

Q. In different aspects, forensic, medical research?

A. Forensically, the closest collaborators are my colleagues at the R.C.M.P. and the F.B.I. Center for Forensic Sciences. Medically, faculty members at McMaster and other universities both in Canada and United States and abroad who work on the same diseases which I'm currently doing research and clinical work on.

Q. How is your role at the R.C.M.P. lab connected or involved with DNA typing? What kind of typing were you involved with there, do you have a particular type of typing that you are involved with?

A. The principal technique that we were using is called RFLP or restriction fragment length polymorphism, that's the acronym that's used.

Q. Do you have experience with any other types of techniques?

A. PCR, another acronym for polymerase chain reactions, another way to analyze DNA, also nucleotide sequencing. There's many different ways you can analyze DNA.

Q. And I believe you had said earlier that that type or those different type of typings, apart from the forensic aspect are also used in medical and research?

A. Yes.

Q. How many DNA typing tests, in particular, RFPL tests would you have conducted in your forensic work?

A. Hundreds.

Q. On how many samples would you have actually -- do you have any idea of approximation of how many samples you would have actually run in an RFLP test?

A. Thousands, I can't say exactly how many but it would be thousands.

Q. What types of samples, have you experienced in actually using the RFLP test on?

A. We use the procedure on a wide range of samples in an attempt to see how it would perform with forensic samples. So virtually any type of biological fluid or tissue that you can think of, urine, blood, skin, hair, saliva.

Q. Semen as well?

A. Yes, certainly semen.

Q. Where else in Canada are DNA typing tests being performed for forensic use?

A. I believe there's a private lab in Western Canada that's done DNA typing. But the principle uses of DNA typing for forensic uses are the Center for Forensic Sciences in Toronto, the Ottawa Lab of the R.C.M.P. and a lab in Montreal.

Q. And the lab in Montreal is for what police force?

A. Quebec Police Force.

Q. Outside Canada, where is the DNA typing being forensically performed, particularly the RFLP technique?

A. Actually, I'm not aware of too many places

where it's not being performed. Virtually every country is either using it now or developing the technique for forensic uses.

Q. Do you have any experience dealing with scientists from other countries that are actually using RFLP technique for forensics?

A. Yes, at these meetings whether they're held in the United States or abroad, you meet scientists from all over the world who attend these meetings and they're all either at some stage of implementation or they have already implemented DNA for forensic casework.

Q. England, for example, I know England, is it being used in England, the RFLP technique?

A. Yes, there's several labs in England that are using it.

Q. For example?

A. The Metropolitan Lab and the Home Office Lab.

Q. Do you know any of those scientists, have you had any discussions or exchanged any opinions with respect to any of those scientists?

A. Yes, I've met those individuals.

Q. And Europe, is it used in Europe to your knowledge?

A. Yes, throughout Europe.

Q. Apart from essentially police lab or forensic, I should say, more forensic casework, where in Canada is DNA typing being conducted?

A. Virtually any university, for that matter any hospital that has a research component to their hospital.

Q. Would that include the RFLP technique?

A. Yes.

Q. How is your present position at the Children's Hospital connected or involved with DNA typing, particularly RFLP?

A. We analyze DNA to diagnose a series of genetic disorders. Genetic diseases are caused by flaws in a person's DNA. So you can analyze the DNA to diagnose a person's illness, you can also analyze the DNA to predict whether a child is going to inherit that disease.

Q. And that's the same technique that you use in forensic?

A. Some of the techniques are virtually identical.

Q. How many DNA typing tests would you have conducted in clinical setting, either RFLP or PCR?

A. Again hundreds.

Q. How many DNA typing tests would you have conducted in the research center?

A. Many hundreds

Q. The peer review papers and the posters and the abstracts that you referred to in your curriculum vitae, are any of these dealing-- involving the actual RFLP procedure?

A. I would say the vast majority of them have used that data that went into the papers or part of the data, the vast majority of them.

Q. The papers that you've written are abstracts that you've presented?

A. Correct.

Q. What is population genetics and what application does that have to what we are dealing with DNA typing or in particular RFLP?

A. Population genetics is -- rather than studying the DNA of an individual person or within, say, a family related individual, you look at DNA at a population level, that is if you wanted to know how often a disease occurred you would look at it and say, this disease occurs in this percentage of individuals in this population or this racial group and this percentage of individuals in this racial group. It's a study of genes and gene frequencies in various human populations.

Q. You say, human populations, is there population genetics associated with any other life forms other than humans?

A. Yes, classically population genetics has its beginning with fruit flies, insects and plants, those types of studies. Virtually any field of biology will have a population genetics field with it.

Q. Do people specialize in particular areas of population genetics in your experience, for example, a particular form of animal or humans as one field?

A. Correct, yes.

Q. There is that type of specialty. Is there any specialties developed by those dealing, for example, in human population, any sub specialties associated with that, any -- look, for example, at any particular aspect of human population genetics?

A. Yes, there's people that look at population genetics of again, diseases. There's people who look at population genetics with a view to how different human populations have evolved over history. There's various sub specialities depending on the purpose that you want to do the population genetic study for.

Q. Okay, I'm going to give you a phrase, doctor, and ask you if you could explain it or give any meaning to it? What would the phrase, human population genetics as it pertains to forensic DNA polymorphisms mean or identify?

A. Polymorphism just means a genetic difference, a recognizable difference in a population. As it pertains, DNA polymorphisms pertains to forensics and population genetics, is that you would like to predict, if you have several different forms of a DNA molecule that you'd like to predict how often that occurs on a population level. If I have this recognizable form, have a test for in the lab, you'd like to be able to use population genetics to predict how often you'd see that in a population level.

Q. Do you have any experience in this particular aspect of human population genetics as it pertains to forensic DNA polymorphisms?

A. Yes, that was part of my job at the R.C.M.P.

Q. What would that necessarily entail, what kind of things would you have to do in relation to that?

A. Well, once you've developed a test to detect variability within different individuals, you

simply build what we call a data base, that is you analyze many hundreds of individuals in the population and you ask the simple question, how often do each of these various forms that I could detect with my test, how often do they occur in a population.

Q. I take it then from what you're saying, that population genetics, statistical work and things of that particular nature are important in that field?

A. Yes.

Q. What about empirical studies of other populations, is that taken into consideration in that field?

A. Yes, it's all based on empirical studies, you ask it a simple question, how often will this occur in this population center.

Q. And in forensic work what are you attempting to do with human populatin genetics as it pertains to forensic DNA polymorphisms?

A. I simply determine whether if I can detect Forms A, B and C in a population I want to determine Form A is very common, moderately common or extremely rare and the same thing with Form B, C or how many forms you could detect in the lab, you just want to determine whether they're common or rare and the degree of whether they're common or rare.

Q. Are any of the publications, papers or abstracts that you've written or presented in relation, are any of those in relation to human population genetics as it pertains to forensic DNA polymorphisms?

A. Some of the papers involve population genetics, yes.

Q. And you've actually written those?

A. Yes.

Q. In the forensic field?

A. Yes.

Q. Are they related to as it pertains to the genetic aspect of RFPL typing?

A. Yes.

Q. Doctor, I am going to refer back again to your C.V., I see under court testimony that you have given expert testimony in courts in Canada?

A. Yes.

Q. As it relates to DNA typing?

A. Yes.

Q. For forensic purposes?

A. Yes.

Q. I see one case here is the Crown vs. Paul Joseph McNally, voir dire April, 1989, Jury Trial in April, 1989, in Ottawa, Ontario, what if any significance did that case have for either yourself or your work in relation to the R.C.M.P.?

A. That was the first case at the R.C.M.P. lab and for that matter any testing lab in Canada had used the RFLP procedure and taken it through the court system.

Q. I see another case here, the Crown vs. Stephen Brill, a murder preliminary hearing in August, 1989, in Calgary, Alberta, what, if any

significance and did that proceed past the preliminary hearing?

A. That, again, that was the second case that myself and the lab conducted and took to the court stage. And that didn't proceed past the preliminary, he changed his plea.

Q. Doctor, you had mentioned the Centre for Forensic Science, where would they fit in in relation to actually having casework brought before the courts?

A. They're just now bringing their first cases to the court system.

Q. I take it then from what you're saying that this McNally case and the Brill case were the first two to be presented in Canada?

A. I believe so, yes.

Q. I also note here, doctor, the Crown v. Claude Bourguignon, a murder, preliminary hearing voir dire, February, 1991, what significance did this particular case in relation to the R.C.M.P. or to the work you do?

A. That was a case I did just before I left the R.C.M.P. and I believe it was the first murder case that we did that went through the court system and actually the first case that went-- the first jury trial that went from beginning to end, and the jury ruled on DNA?

Q. And did you give evidence in relation to DNA typing?

A. Yes.

Q. As applied and used by the R.C.M.P. lab?

A. Yes.

Q. And this particular trial has just concluded?

A. Yes.

Q. You gave evidence in front of the jury and at the voir dire?

A. And the preliminary hearing, yes.

Q. Doctor, in addition to this court testimony, have you ever had any occasion to, you say, that you were a consultant to the Centre for Forensic Science and to the R.C.M.P. lab or at least you are presently a consultant to the R.C.M.P. lab, have you ever consulted to anyone else in relation to any other cases dealing with DNA typing, forensic DNA typing in this country or any other country?

A. Yes, I have.

Q. Would you explain, please, what those would be?

A. On several incidences I have been contacted by defence counsel and others, other crowns concerning their cases.

Q. All right, in relation to defence counsel, have you ever given any consultation to defence counsel in any case in Canada?

A. Yes.

Q. What case would that be?

A. That was a case recently done, a court case was in Woodstock.

Q. And you consulted, you gave advice to the defence in that case?

A. Yes, defence counsel approached me for

information. I talked to him over the telephone and --

Q. Do you have any problem talking to defence counsel in these issues?

A. No.

Q. Just as an aside, in that particular case that you were consulting the defence counsel or he consulted you, who was the forensic expert for the R.C.M.P. that was presenting that evidence?

A. Dr. John Bowen.

Q. He's the gentleman sitting in court to testify following you?

A. Yes.

Q. Doctor, have you ever consulted in any other cases, for example, the United States?

A. I have.

Q. All right, could you give me some of the cases and who you would have consulted or have consulted with?

A. There was a case in San Diego and the name of the case escapes me but the public defenders office there contacted me and it was about a technical matter, not about the actual data in the case but they wanted me to testify about a technical matter in the FBI's DNA typing procedure.

Q. And had you agreed to do so?

A. Yes.

Q. And what happened to that particular matter?

A. The case that I had in Calgary was coming to trial and it was moved to the same time they were

having that Frye hearing in California, so I had to attend my case. I had to decline at the last minute.

Q. But, again, doctor, do you have any problem consulting or giving opinions to defence lawyers when they do inquire from you on these cases?

A. No.

Q. Have you had an opportunity to be -- to act as consultant in other cases in the United States, for example?

A. In the last year I have been contacted by several defence attornies, there was a case in Toledo.

Q. What was the name of that?

A. Yee.

Q. That's Y-E-E?

A. Yes.

Q. And who did -- who consulted with you in that particular case?

A. Initially Barry Sheck, I believe he was counsel for the defence in that case or a consultant for the defence. And after I talked with him about various matter, he asked permission for his or one of his defence experts to contact me and again to discuss a technical matter, in fact the same technical matter that I was going to testify on in California and I discussed that with his expert.

Q. Who was that expert?

A. Dr. Paul Hagerman.

MR. WALSH: At this time, my lord, I am going to motion the Court and I would ask that Dr. Waye be declared an expert in the field of molecular genetics, DNA technology testing procedures generally and clinical and forensic DNA typing in particular.

THE COURT: What was -- the last was what?

MR. WALSH: An expert in the field of molecular genetics, DNA technology and testing procedures generally and clinical and forensic DNA typing in particular. I also would ask that Dr. Kidd or excuse me, Dr. Waye be declared an expert in human population genetics as it pertains to forensic DNA polymorphisms.

THE COURT: Do you have any questions you want to ask about -- ask this witness, Mr. Furlotte?

MR. FURLOTTE: One moment, my lord.

Could I have a short recess, my lord?

THE COURT: Yes, surely, I meant to say earlier when I ruled against your motion, Mr. Furlotte for the exclusion of the witnesses, I meant to say and I omitted it at that time, that if there's any -- if you want time to consider any matter before you embark on a cross examination either at the conclusion of a witness's testimony or at a stage like this, don't hesitate to ask for it and within reason it will be granted.

Let's take our morning break at this time anyway, ten minutes, fifteen. You are not to discuss this matter with anyone Dr. Waye until your testimony is completed.

COURT RECESSES AT 11:15 A.M.

COURT RESUMES AT 11:30 A.M.

SAME APPEARANCES

ACCUSED PRESENT

THE COURT: Now, all are present again and you were going to -- did you have questions you want to ask this witness, Mr. Furlotte?

MR. FURLOTTE: Yes, a few on his expertise.

THE COURT: Okay, fine.

CROSS EXAMINATION BY MR. FURLOTTE:

Q. Dr. Waye, I believe you said that you are most familiar with the medical diagnostics of DNA analysis, is that correct?

A. That's the application that I use currently and one that I'm most familiar with, yes.

Q. The one you are most familiar with. And as far as the aspect of DNA and forensic applications, how many years did you work in that?

A. Since 1988 I've been working on that, actually worked in -- worked with forensics longer than clinical diagnostics. Other that forensics clinical applications are what I'm mostly familiar with.

Q. Maybe describe the difference between DNA analysis and clinical diagnostics and that used for forensics?

A. Different purposes, different questions, the techniques are essentially the same, they're different applications to the same technology.

Q. Would one be more difficult than another to --

A. They both have their moments, they're difficult aspects associated with them. I wouldn't say one is more difficult than the other.

Q. Nor to analyze, I'm not talking about just the technique now, I'm talking about whether you are going to declare a match or something say in forensics or in -- if you are just checking for a parentage?

A. It's no more complicated to declare a match looking for a parentage than it is forensically, it involves the same process.

Q. It involves the same process?

A. The same judgments.

Q. Your match window would be the same size or does a match window come into play in parentage?

A. I don't do parentage testing.

Q. Well, you must be familiar with it though?

A. Yes.

Q. Is a match window involved in parentage testing?

A. It depends on which lab you're making reference to, there's various paternity testing labs in the world and they all have their own rules for determining whether the sample comes from the correct father or someone else. They have their own policies, their own match criteria, their own rules for making judgments.

Q. You say, you've been consulted and you've been at workshops with scientists from England and all over Europe?

A. Yes.

Q. And they use the RFPL analysis for their forenics?

A. Yes.

Q. And is it the same system that's used as here or do they have a different method?

A. Conceptually it's the same, they are subtle differences, some of the differences aren't so subtle. There are differences, yes, but conceptually it is still the RFLP technique, with some modifications between labs.

Q. I understand they use the multilocus probe?

A. There is one particular lab that started out using the multilocus probe and there are several other labs that again started out using multi-locus approaches, yes.

Q. Are some of them using the single locus?

A. Yes.

Q. As I understand, you stated you have written some papers on basically on population genetic studies?

A. Population genetics has been involved in the papers.

Q. Been involved?

A. Yes, usually the papers will encompass a lot of different issues, technical issues, implementation issues, practical issues and population genetics will be involved in there as well.

Q. Do you consider yourself an expert in population genetics?

As. As it pertains to particular uses, population genetics as it applies to disease loci, I'm quite

familiar with that area, as it pertains to forensics, I'm familiar with that area as well.

Q. Is that just to know how to use the figures or for the multiplication purposes?

A. I understand the theories and I understand how to apply those theories for those purposes.

Q. Would you put yourself in the same category, say, as Dr. Eric Landers or Richard LeWanton or Eric Kidd?

A. No.

Q. No. So you wouldn't be an expert in comparison to them?

A. That is principally their career research topic, they spent their careers studying population genetics and that's principally what they do for a living. I wouldn't put myself in that same category, no.

Q. So basically you were just a -- say, a user of their theories?

A. Not their theories.

Q. Their works?

A. Not necessarily, their works either, this isn't a very old science, I don't think Eric Lander or any of the other people you've mentioned would claim to be the founders of any of these theories. Again, they've investigated and they've used them for their purposes of investigating various populations.

Q. Why would you say that you are an expert in forensic DNA typing?

A. Why would I claim expertise in that field?

Q. Yes.

A. I've worked in that field, I've developed techniques to apply DNA analysis to forensics, I've done research in that area, I'm familiar with, I believe, most aspects of the technique.

Q. So just basically because you work in the field, that's the reason why you should be declared an expert in the field or is there more to it than that?

A. I'm not really sure how one makes the judgment of whether someone is an expert or not. I've never been in a position where I've had to declare someone else an expert. So I've never really reviewed how I would go about doing that.

Q. DNA typing in forensic is basically to identify individuals, is that correct?

A. You're generally asking the question, could this sample and this sample have come from the same individual.

Q. And to draw some kind of statistical probability on it?

A. Yes, if your conclusion is that these two samples could have come from the same individual, you would have to put some sort of likelihood to that conclusion.

Q. In molecular biology and population genetics in those fields, is it generally accepted that there is a field of forensic DNA typing, that there are experts in that field?

A. I'm not sure where there's an actual listing of what is a field and what is a discipline. These things are changing constantly and with the emergence of DNA technology, there are all sorts of fields that are present today that weren't present five years ago, and I'm sure if you went to one scientist, they'd say forensic, what? If you go to another scientist who's read it, they would certainly recognize it as a field. There's international symposium, there's meetings, there's certainly -- peer review articles, et cetera. It has all the ingredients of a discipline but I'm sure there's people that wouldn't call it a discipline.

Q. Well, let me put it another way, would you agree that for a person to be an expert in a field and to give opinions that basically that opinion should be reliable?

A. Yes.

Q. Would the field of forensic DNA, is that generally considered reliable amongst scientists who deal with --

A. Who deal with DNA technology?

Q. -- population genetics and molecular biology?

A. In my opinion, yes.

Q. In your opinion? Your opinion that it is generally accepted?

A. Yes.

Q. How did you form that opinion?

A. Again, based on the opinions of people that I respect in fields of human genetics, population genetics. If they accept it, I take that as a good indication of general acceptance. You'd really have to scientifically poll everyone, have a vote.

Q. That hasn't been done?

A. We generally don't vote on such frivolous issues.

Q. Would you admit that the opponents' list is growing continuously to the reliability of forensic DNA analysis?

A. I'm not aware of it increasing, there's always been people in -- that have opposing views as to the reliability of DNA typing. Those people have been there before the technique was even described. Those people were there when the same techniques were used to analyze proteins.

Q. I understand studies that you've done for -- in forensics, DNA typing, you've prepared and with other colleagues you've done articles, experiments in articles and had them published?

A. Yes.

Q. And would you call for a peer review?

A. Yes.

Q. Just what does that entail, a peer review?

A. As I mentioned earlier you submit the paper to an editor or an associate editor of the journal, they have a list of people that they know to be experts or they people that they feel would have a reliable expertise in that field who could

read the article, critique it and decide whether to publish it in its original form, in a revised form or to outwardly reject it or suggest that it go to another journal that may be more appropriate.

Q. They don't do your -- they don't retest any of your experiments?

A. No, I'm sure that -- I know myself as a peer reviewer and looking at papers that are very close to home in my own areas of research, that it has often prompted me to go to the lab and look at another matter, not necessarily try to replicate what they've done, it gets the wheels in motions for doing further experiments. I'm sure that happens with various peer reviewers.

Q. In other words, if, what they proclaim sounds feasible then you would pass it for publication?

A. There's generally a lot of work that goes into peer reviewing. Obviously the author is much more familiar with the work than the peer reviewer, because he did the work or did it with a collaborator. So you generally have to go to the library, become engrossed in the literature in that area, find out if in fact what they're proposing is consistent with the literature and if it's scientifically reasonable and if their experiments support their conclusions. At the end you'll either say yes, no, or they should do the following to substantiate these conclusions.

Q. What happens when they publish?

A. When it is published?

Q. Yes, at the end of the peer review process or --

A. No, people subscribe to journals they read the journals, if they're in disagreement with the article as it's published after peer review most journals have sections in there, letters to the editor where people are quite free to express those dissenting views in the journal or add to the paper further points about that paper. The author generally is given the courtesy of reading their comments prior to them being published and to offer rebuttal or some sort of statement about that person's criticism. That's again a form of peer review that the whole scientific audience can peer or debate about a paper after it's been published.

Q. Was there any dissenting views to any of your published articles?

A. Not enough in that form, not that I'm aware of really.

Q. Any other forms?

A. Generally a lot of this work is presented at meetings and at the end of a presentation, there will be microphones set up and people will ask questions, make inquiries, express dissenting opinions if they have them. And that certainly has happened when I've given talks. You have people both pro and con express views about what you've just said.

Q. Any other forms?

A. People write you letters, that's probably the

most courteous form, if they have an inquiry about a paper, they generally express to you over the telephone or in writing rather than going to the scientific community at large and criticizing your work. I certainly had the views of other scientists conveyed to me both in writing and on the telephone about my work, not always dissenting.

Q. And what about in court, any dissenting views in court?

A. In court there's generally evidence for and against. I will say something and a defence will have an expert who will take the stand and he will not -- he generally doesn't echo my statements or he wouldn't be for the defence.

Q. But there were defence -- experts called by the defence who were critical of your articles that you had published, some of them?

A. I've never sat through a defence expert's testimony about my work.

Q. Have you read case law where they criticized your work, say, decisions from judges where the judge revealed that expert witnesses come to court and criticized your work?

A. The transcripts, et cetera on the case I have are fairly fresh and I haven't been given copies of transcripts of the judge's decisions or summaries or the defence expert's comments. I have talked with defence experts. The last time I did I met privately without lawyers present

and went over all my data with their defence experts prior to the voir dire.

Q. Would you say that your expertise and your knowledge on forensic DNA typing is a -- it's an ongoing educational thing?

A. Science is not static, you never reach a point where you've learned everything in an area because it changes fairly fast and it's always a learning process.

Q. And you keep an open mind?

A. Certainly.

Q. And in the field where you were setting up the laboratory for the R.C.M.P., I understand you started in 1988, March, 1988?

A. Yes.

Q. And you -- I would assume you were curious as to how this evidence was standing up in court?

A. At that time there was very little court testimony to fall back on, it was very untried in the court systems in '88.

Q. Would it be safe to say that the R.C.M.P. attempted to formulate their technique and I suppose, their -- improve their expertise by considering court cases and taking into consideration the criticisms of the methods used by the FBI and Lifecode, and other private corporations?

A. The private corporations were the first people to actually implement this type of technology and take it through the court system, and yes,

it would be fair to say that we were all quite anxious to see how they fare in court in 1988 when the first cases were going through. At the same time there really wasn't anything that you could look at, say, with the FBI or State labs because they were at the same stages of implementation as us. They were as curious about the private corporations and how they'd, do in court as we were, because they were developing the technology and developing the system at the same time.

Q. So it was still under development at that time?

A. We were putting together things and we were making some strategic decisions about how the systems would be put together, the nuts and bolts of the system.

Q. And it's safe to say that it is still under development and room for improvement?

A. I think if somebody suggested a way we could improve the efficiency or the sensitivity or the accuracy of the technique that that certainly would be looked in to. There's an active research and development wing of all of these labs, constantly looking at ways that you can improve the technology. Nothing remains static.

Q. Would it be safe to say that the R.C.M.P. lab in Ottawa today as a year ago keeps informed of case law on the admission of DNA evidence in order to maybe improve itself?

A. Improve the process technically.

Q. Improve the process and to answer the criticisms against the --

A. I think they use the -- like all the scientific labs, I think they use the scientific forum at a symposia et cetera, they rely on that a little more heavily to develop and to initiate new scientific endeavours. They don't use the court as a system to make scientific judgments. They certainly -- issues brought up in court, they go to great lengths to get transcripts and rulings, et cetera from all over the world. And there's quite a net work of people involved in this who do exchange interesting cases on a very regular basis.

Q. But the court is a form of peer view, is it not, in actual practice?

A. I think scientists would disagree with that.

Q. Most scientists would disagree with that?

A. That the court is an appropriate peer review for scientific method or a scientific application.

Q. Doesn't peer review also entail any forum by which you can obtain critiques of your experts?

A. Could you repeat that?

Q. Wouldn't the courts also be a forum where scientists would be able to obtain critiques of their expertise and their theories?

A. Yes, I think it's a nice place to start when you have a large case where a large number of people testify, generally the judge's ruling on

it will be quite extensive and will summarize the views of all the various scientists. So it's a nice place to start. The next place you would probably go if you actually wanted to take all those views into consideration is the telephone and actually phone some of these people and then conduct in a proper scientific manner, talk to the person who has a dissenting view, talk to him about what his concerns are, ask how you might address them, scientist to scientist rather than actually going to his full transcript and reading through all the --

Q. Do you bother to read expert reports that are submitted to the court in different trials?

A. When they come across my desk, I don't have time to be phoning around, prosecutors around the country to ask if there's a new expert report or whatever. But when an interesting expert report comes along from a case either in Canada or United States, it generally comes by my desk and I will read them.

Q. You will read them. So you will admit that some of these experts called by the defence do have interesting reports?

A. They're good reading some of them, yes.

Q. Some of them have valid criticisms?

A. Some valids points are made.

Q. Now, the decision of the R.C.M.P. and I suppose yourself to use monomorphic probes in running your gels --

MR. WALSH: My lord, if I may object at this point in time, I'm wondering where we're going with this cross examination. What we are simply trying to do at this point in time is to determine whether or not he should be declared for the purposes of giving opinions. Mr. Furlotte appears to be getting into the actual substantive evidence itself.

MR. FURLOTTE: No, I have no intentions of getting into the substantive evidence.

Q. I just want to ask this witness whether -- if the decision to use monomorphic probes was gained through the benefit of court action?

A. No.

Q. That was your own idea?

A. That was an initiative that came out of our working group TWGDAM.

Q. Working group TWGDAM.

A. Yes.

Q. And many of the members of that working group were hit with those criticisms in court --

A. No, this was prior to the --

Q. -- in previous cases?

A. -- word band shifting ever coming out of Eric Landers mouth or any of the other court cases where issues of monomorphic monitors were raised in the public.

Q. Can we turn again about your -- the Crown wishing to have you declared as an expert witness in human population genetics in forensic DNA analysis? Again, I would like to know

how you use other people's expertise, such as, Dr. Kidd or Dr. Landers to apply it to the test results, I guess?

A. What specifically do you want?

Q. I would like to know what you base your expertise on to have yourself declared an expert in human population genetics, as applying it to DNA analysis?

A. Is the question whether I'd consider those people an expert or how I'd base that decision or --

Q. No, it's not if you consider them an expert, you've already stated that you don't consider yourself to be in the same field as these men, Drs. Landers, Lewanton and Kidd.

A. Certainly not to the same degree, that's their principal job. That's what they base their research on, that's what they they base their careers on which are more extensive than myself.

Q. You don't do your own research?

A. I do my own research, yes.

Q. You do your own research in human population?

A. In population genetics?

Q. Yes, population genetics?

A. It's part of my work, yes. It certainly isn't the main focus of my life as it is with those individuals that you've mentioned.

Q. Were you into human population genetics before you were hired by the R.C.M.P. in 1988?

A. Again, population genetics is part and parcel of working with DNA. If you work with DNA in

human populations, you have to have more than a passing knowledge of population genetics. And yes, I did, I work with gene frequencies, polymorphisms and how they are in populations. In fact I collaborated with some of those individuals you've mentioned when I was a student.

Q. So what you're saying if you're an expert in one you're an expert in both?

A. No, I'm saying that you have to have a knowledge or an expertise in population genetics to study polymorphisms in humans. It doesn't have to be your career focus for you to have to recognize and use the principles of population genetics.

Q. So you would be an expert enough to recognize a -- say, a sub group within a general population?

A. I know what a sub group is, yes.

Q. You know what it is?

A. Yes.

Q. And if you were going out and doing studies in population genetics, if you come across a sub group you would be able to recognize that there was a sub group and it was substantially different from the general population?

A. Yes, I know how to define a sub group and I'd know how to design experts to ask the question whether it had any significance.

Q. How would you distinguish a sub group from the general population?

A. Well, the general population is as you define you place the boundaries, if you want to talk

about the general population in New Brunswick, well, you know where the boundaries of that Province are, that would be every one who lives in New Brunswick. If you wanted to talk about sub populations in New Brunswick, you'd start with a little logic, you wouldn't pick people that aren't represented, you wouldn't talk about a sub population of Tebetans, in New Brunswick, you'd talk about components of the population that are --

Q. I guess I didn't explain myself properly, I'll try again.

A. Okay.

Q. You want to be declared an expert in human population in genetics in relation to forensic DNA analysis?

MR. WALSH: No, as it pertains to forensic DNA polymorphisms.

Q. Forensic DNA polymorphisms, would you explain what that means, please?

A. Polymorphism is just a genetic --

Q. Explain what an expert is in human population genetics and forensic DNA polymorphisms?

A. I can explain what the discipline is, I think the Court has to decide, it's outside of my working knowledge of the courts to define what an expert is in anything.

Q. Just define what --

A. I can define what population genetics is.

Q. I'm not sure what he means by this, so you tell me what he means by this?

A. I'll define what he described.

Q. Yes.

A. Population genetics as it applies to forensic RFLP polymorphisms, first you define what a polymorphism is, it's a genetic difference. And the population genetics of it is how that difference is represented through the population period.

Q. Would that also include your ability to identify a sub group within the general population, DNA polymorphisms, through DNA polymorphisms?

A. That's part of population genetics.

Q. So there would have to be a difference?

A. No, there would not have to be a difference.

Q. If it was going to have any meaning there would have to be a difference?

A. Correct.

Q. As you say if the general population was all the same there'd be no study, no need for a study?

A. Correct.

Q. How much of a difference would be necessary for it to make a difference in the identification of DNA polymorphisms?

A. How much of a difference?

Q. Yes.

A. In what?

Q. In the identification?

MR. WALSH: My lord, again, I am going to object again, he's back into -- he's into substantive evidence, I don't know how he's getting -- relating it to whether or not this man is to be declared an expert. He's asking him substantive questions on evidence that I hope to elicit.

THE COURT: What were the particular fields, Mr. Walsh. Just to interrupt you for a minute, Mr. Furlotte. Molecular genetics, an expert in molecular --

MR. WALSH: Molecular genetics.

THE COURT: Molecular genetics.

MR. WALSH: DNA technology and testing procedures generally.

THE COURT: Yes.

MR. WALSH: Clinical and forensic DNA typing in particular, and human population genetics as it pertains to forensic DNA polymorphisms.

THE COURT: Yes. Do you really, Mr. Furlotte, think this witness isn't qualified as an expert. That doesn't mean we've got to accept everything he says, you know. We may have another expert in these fields who gives completely opposite views.

MR. FURLOTTE: It's just the last one that I'm concerned with at this point in time, my lord.

THE COURT: Well, isn't he -- the only objection I think I could take from what I've heard to date to the Crown's description is adding this as it pertains to forensic DNA polymorphisms.

I'd be quite prepared, I think on what I've heard, to declare him an expert simply in human population genetics generally and without trying to identify this too closely.

Well, you go ahead and ask other questions if you feel that you're going to break this down. I mean you appreciate that there may be other -- what he says in evidence isn't necessarily going to be accepted by the Court as the gospel.

MR. FURLOTTE: I also appreciate it's very difficult for Dr. Waye and myself to communicate on the same level, because I'm just not in his field. I am going to do my best, I hope he does the same.

THE COURT: All I know is he knows an awful lot more about it than you do or I do.

MR. FURLOTTE: That's for sure, he wouldn't have to know much to know more than I do.

THE COURT: But surely, hasn't he on the basis of what he has said here, his qualifications, the papers he's produced and prepared, surely, he knows enough to qualify -- he's been quite frank about it, he says, I'm not the best expert in the world on human population genetics. There are other people who are more expert than I am. But if he's declared an expert, I can hardly say he's an expert subject to there being better experts. This may be reflected in a view where to call, for instance, one of those better

experts, I would probably have to say well, I reject -- and they gave opposing views, I would have to say, well, I accept their opinions in preference to Dr. Waye's. But you either qualify somebody as an expert or not as an expert, there are no degrees in the thing. I've listened to a lot of experts in civil cases, criminal cases, too where I have concluded don't know what the devil they're talking about, with all difference to Dr. Waye, I haven't formed that opinion just yet here in this case. But you know, the mere fact you declare somebody an expert doesn't mean what he says is gospel.

But if you were sitting here as a judge, wouldn't you on the basis of what you've heard already, say, look, this man for the purpose of the trial and for the purpose of deciding whether he should give opinions in these particular fields has qualified himself as an expert in some degree or other.

MR. FURLOTTE: I don't think I should just have to take a bare statement either from the Crown Prosecutor or from the witness that they are an expert in a certain field.

THE COURT: Oh, no, you don't. But a Court has to look at what a person has done in the way of publications, in the way of university training, in the work of -- employment, in the field of employment, in the field of recognition of some masterly ability and by his peers, and the

question whether he's been called as an expert in other court cases. That's not absolute, of course, a person -- merely because a person testifies as an expert in one court case doesn't make him an expert in all of them. But --

MR. FURLOTTE: It's just, my lord, before we get started, I would like to understand as to how broad this term expands in his expertise.

THE COURT: Well, if you would like to --

MR. FURLOTTE: I can see a technician --

THE COURT: May I ask this question of the witness, Mr. Furlotte.

EXAMINATION BY THE COURT:

Q. Were the fields -- you were qualified as an expert, I gather, before you testified?

A. Yes.

Q. Can you recall how your expertise was described there when you were qualified?

A. My recollection of it is actually at the time was quite a shock in what they asked to qualify me as and what was granted. I think the Crown was --

Q. You didn't know that you were as big an expert --

A. No, actually it was a different --

Q. -- as broad an expert as you were?

A. The Crown at some point and she admitted this to me afterwards, lost track of where she was on my C.V. and asked to have me qualified as an expert in microbiology which is the first degree I received in 1981. And it was -- the judge looked surprised but granted it and nobody asked any further questions, so that was what I was qualified in there.

Q. Wait until I see what Dr. Waye said -- or not Dr. Waye, Mr. Justice Flanagan, wasn't it. What did he say about you in his judgment in the case up there? Well, I can't find it here right at the moment.

MR. WALSH: Well, I believe, my lord, if I may be of assistance, I think it was Mr. Justice Flanagan and I stand to be corrected, declared Dr. Waye in the field of -- I believe, DNA typing, if I may have a moment. Three professional experts have been presented to the Court and sought to be qualified as experts on the question of DNA and the testing techniques and the production of results. He refers to the three expert witnesses. 'I have no hesitation', he says, 'in accepting each of them as qualified experts to give evidence in this case'.

Q. If you were going to -- you know what opinion presumably, you are going to be asked for in this trial or you have an idea, at least by the Crown?

A. Yes.

Q. How would you describe your expertise as embracing those opinions, in the least number of words?

A. As the Crown did, I'd put the qualifier on about population genetics as it applies to forensic analysis.

Q. Forensic DNA polymorphism?

A. Simply because if we start talking about work and

say, fruit flies or wild animals, the population genetics of animal species or all these different areas, I'd quickly have to acknowledge that I'm not an expert. And I don't even have a passing interest in the literature.

Q. Yes, although the --

A. So I would limit the scope of the expertise.

Q. -- yes, although the word, human did precede the word, population genetics, that would eliminate fruit flies, wouldn't it?

A. Yes, and again there's enormous literature with human genetics itself and it's a literature that, although I'm familiar with the concepts of human genetics and how you apply it to these matters, it's not a literature that I've spent my career either contributing to or reading on a daily basis.

Q. But the other expressions here, molecular genetics that sort of an all embracing expertise description, I suppose?

A. That's a very broad expertise that a lot of different people would fall into.

Q. And then your DNA technology and testing procedures, that was the other one --

MR. WALSH: That's correct, my lord.

Q. -- in general, that is descriptive, I would say of your expertise?

A. Yes, that would be a -- molecular genetics would be a theoretical expertise, a knowledge of the theory and the latter would be a practical knowledge of an area.

Q. And then you get down into the more particular field of clinical and forensic testing and DNA typing?

A. That would be an applied expertise.

Q. That would be your applied expertise.

A. Yes.

THE COURT: Well, any other questions you want to ask, Mr. Furlotte, you go ahead.

MR. FURLOTTE: He is revoking the request to be considered an expert on human population genetics as it pertains to forensic DNA polymorphisms.

THE COURT: Well, I don't look upon that as revoked, unless you are.

MR. WALSH: My lord, I spent a long time ensuring that the qualifications I asked this man to be declared in was properly done or at least in my opinion, I wish to stand by the motion that I have now before the Court, with which I understand Dr. Waye agrees.

MR. FURLOTTE: I just have a few more basic questions on that last one, my lord. I'll try it at a different angle, rather than coming from the front, I'll come from behind.

CROSS EXAMINATION CONTINUED BY MR. FURLOTTE:

Q. Just a brief description, what is DNA polymorphisms?

A. A genetic -- a detectable genetic difference, and in this case it would be --

Q. Technical genetic difference?

A. A detectable genetic difference.

Q. A detectable --

A. In this case, since you prefaced it with DNA, it would be a genetic difference that you detect by analyzing DNA as opposed to a protein polymorphism.

Q. Now, as you apply that to the human population, what are you attempting to do?

A. You're attempting to ask questions about the frequencies with which these detectable differences occur on a population level.

Q. Now, I understand that there are differences within different ethnic groups?

A. There can be, yes.

Q. Can be and these would be identified as different say, sub populations?

A. If they were contained within what you're calling a general population, then, yes, you'd preface that with sub, you'd call it a sub population. It's an identifiable sub group within the broader population.

Q. Now, what does it take to identify an identifiable sub group within a general population?

A. Analyze them.

Q. What kind of difference would be necessary to set them aside?

A. You have to give me some specifics about the population sizes, the proportions of the various sub groups, the number of genetic forms in the population, the frequencies themselves. I can't

tell you what level unless you give me the parameters to put that question into. It's not a question you can answer with five percent.

Q. It's not a question you can answer with a percentage?

A. If you gave me all the particulars that I asked for, I could certainly -- and you gave me an example, if you gave me a proper question, with all the particulars, I could sit down and I could go through and I could tell you whether -- whether there are significant differences in these populations.

Q. Okay, if -- let's say in the general population, say, for one probe, your statistics added up that, well, there'd be one chance in, say, one chance in two hundred of this individual matching this profile for identifiable sub group, how much would the statistics have to change for that one probe? Would it one in one hundred, one in one fifty or one in two fifty?

A. You'd have to, again, for the probe, you'd have to define, you'd have to define what the geno type was, you'd have to define what exactly what forms were detected, the number of different forms represented in the general population. You'd have to define what the sub populations are that I'd want to look at. You have to give me something to analyze. You've given me an end number and saying, is there a problem with this end number and I don't think anyone can answer that question, not with the particulars.

Q. If you -- I'll try and put it another way. If you were trying to identify between, say, Caucasians and Indians or Caucasians and Blacks, and you had a statistical difference for a certain probe within the Caucasians at a certain one of your bins, and in, say, bin number seven and statistical probability of say that matching somebody else within bin seven on a certain probe was one in fifty?

A. Correct.

Q. Okay, say for the Caucasian data base, and of course, we don't know if we should form another data base for Indians or Blacks unless there is a statistical difference, would that be correct?

A. You would apriori form a different data base from the beginning because those are identifiably distinct populations from the beginning. There's not many people that would take black populations white populations, mix them together and say, they're freely interbreeding. That's a statement that you start off with as a very basic premise, that I don't think too many people would argue with.

Q. Yes, but if you don't know if they're white or black?

A. You said they were white or black.

Q. No, I mean we know if they're white or black they're probably going to be statistically different, because they don't mate at random.

A. Correct.

Q. Right, and I'm taking, if you don't know if they're white or black and you identified a group of people here and a group of people over there and --

A. And you know nothing about them.

Q. -- to find a statistical difference between these two groups in different locations, say one end of the country to the other, how much of a statistical difference would there have to be to say, that they don't fit within the general population, say, for bin seven in any probe, if the number was one in fifty?

A. What was the number?

Q. If the number was one in fifty?

A. If the number was one in fifty, give you an exact difference.

Q. Yes.

A. If the number you came up with the other was one in fifty one or one in forty nine, that certainly wouldn't be a statistically different --

Q. It wouldn't be a statistically difference, no.

A. If you wanted to define what we use in science as confident intervals and confident intervals are just statistical formulas that you can, with ninety nine percent surety, I can tell that these two numbers are statistically the same and intuitively, fifty and fifty one are statistically the same, depending on how many individuals you sampled, those are very similar numbers. I'd go to a statistician and I'd ask

him if it was say, one in forty one versus one in fifty, I'd go to him and ask him, is that statistically different, he'd perform the necessary tests and give me an answer. It's another level of expertise.

Q. So what I'm saying, you don't have that level of expertise to decide that yourself?

A. I could go through -- I could certainly go through those calculations myself, we have statisticians who again do all those analyses for us and do much more complex analyses on various things for us. As a scientist if there's an intense specialty, which statistics is, you bow to their expertise and you generally go to them with your raw data and ask if they can form an opinion and analyze it for you.

Q. So you could not do that yourself?

A. I do that myself. As a good scientist, I think it would be good scientific method to take it to somebody who does it for a career. In the program we have statisticians that we do that precisely with.

Q. We don't have time for you to go to another scientist or a statistician to get the figures, but you could do it yourself, what would you consider to be a statistical or significant difference?

A. Again you have to define how I derived that initial frequence, the one in fifty. Did I look at fifty people, did I look at five thousand people to derive that number?

Q. Okay, let's say you looked at -- you give me the example, you're the expert.

MR. WALSH: My lord, again, I'm going to object at the risk of what I did last week, being told to shut up by Mr. Furlotte. I am going to object and I am going to object strenuously. At this point in time this Court has given him all kinds of opportunities to direct his questions to the issue presently before it. He's way off in a tangent, he's way off into the substantive evidence itself.

THE COURT: We seem to be getting into a lot of matters here, Mr. Furlotte, that might very well be left --

MR. FURLOTTE: All I'm asking the Court --

THE COURT: -- be better left until later.

MR. FURLOTTE: All I'm asking the Court to do is to allow me to have this witness give me an example of his expertise and that's all I'm asking.

THE COURT: Well, have you read the C.V. yet?

MR. FURLOTTE: Pardon.

THE COURT: Have you read the C.V. that's been provided?

MR. FURLOTTE: I don't see anything in his C.V. which would allow him to declare himself an expert in this field that -- population genetics.

THE COURT: Well, is this the last question you want to ask, that you want?

MR. FURLOTTE: That's all I want him to give me an example of his expertise.

THE COURT: An example, in other words, what can he do in the field of -- what are we talking about here, the last -- the human population genetics.

MR. FURLOTTE: Human population genetics.

THE COURT: Can you tell us, Dr. Waye, what you're capable of doing as an expert in that field that Mr. Furlotte and I can't do.

MR. FURLOTTE: I would like him to answer that specific question of an example, I mean it's the most simplest one that could be asked that I'd understand.

WITNESS: Okay, we're stuck at an impass here and I'll provide the example then.

If you had a number, one in fifty, let's say you based that on a sample size of 5,000. You've analyzed 5,000 people. You found a number of people that have that bin, bin seven, I believe your example was, that's just a fragment size, something you can identify in a population. And the number of people out of those 5,000 that you've identified it in is -- comes out one in fifty people have that pattern. You've analyzed an enormous number of people, you've seen the events a lot of times, statistically you can have a lot of faith that one in fifty is an accurate number, it's not one in twenty five and it's not one in seventy five.

I'd have to go to a statistical table and see for a sample size of 5,000 if I saw this many events that gave me a one in fifty frequency, they'll be able to give you a 99.9 percent confidence interval and that will say, you know, if I did this thing again and again and again, I can have that level of surety that I won't have a number that say, deviates from one in forty eight to one in fifty two. Those are just numbers that I'm pulling out of the top of my hat, but it would be a very tight level.
So your actual data says one in fifty, you know statistically that it's probably somewhere between one in forty eight and one in fifty two, it's not. a wide spread because you've analyzed a lot of people.

Now, if you've analyzed another population, somebody from another city or whatever, another 5,000 people and your point estimate was one in twenty six. Well, that doesn't fall within your first range and that statistican and yourself will tell you that, yes, you have a significant difference. That the boundaries that you've set on one in twenty one would be, say, if I can use those two unit intervals, it would be one in twenty four to one in twenty seven something like that, which doesn't overlap with one in forty eight and one in fifty two, and you'd say those differences are significant.
Is there anything else?

Q. So if it doesn't overlap it would be significant?

A. There's not even in the same ballpark.

Q. That's one in twenty six or one in fifty not even in the same ballpark?

A. Right. You've analyzed --

Q. One in forty would not overlap, it would have to come with about one in forty eight.

A. Again, you have to know those exact numbers to know that, whether those differences would be significantly different. Those are basic statistic tests that I can do given the proper tables, so that I can take a large amount of data and give to a statistican.

Q. Okay, that's fair, as I understand it now, it's something like your public opinion poll it's within plus or minus two percent, depending on how many they poll?

A. Correct, if you polled a million people you'd have a very accurate poll, if you poll a thousand people you have to -- you'd have to put fairly specific qualifiers with it.

THE COURT: Now, is that your one question?

MR. FURLOTTE: That's it. That wasn't so hard, was it?

THE COURT: It wasn't hard but it was lengthy. Are you opposing or agreeing with this witness being declared an expert in those fields?

MR. FURLOTTE: Oh, I'd never agree with anything, my lord.

You're going to have to rule on this one.

THE COURT: Are you -- well, I don't think I'm required to hear Mr. Walsh again on the matter.

I declare the witness an expert in those fields, the fields of molecular genetics, DNA technology and testing procedures in general, clinical and forensic testing in DNA typing in particular and human population genetics as pertains to forensic DNA polymorphim. All of which had been left to me I think I would have described as an expert in the field of molecular genetics, Mr. Walsh.

MR. WALSH: Yes, my lord.

THE COURT: Now, we're --

MR. WALSH: Unfortunately, my lord, I wasn't left with that choice, considering the other case law in the field. They have a tendency in the other fields as you are aware in case law, in this particular DNA aspect to be very specific or to be generally more specific in a particular field of science and that's the reason.

THE COURT: Yes, I may take an overly liberal view of that perhaps, a little generous.

Were you going to embark now on your --

MR. WALSH: No, in fact I was going to suggest, my lord, that perhaps this would be an opportune time for a lunch break and then we can actually start in the substantive aspects after lunch.

THE COURT: So we'll adjourn now, two o'clock or do you want to start earlier?

MR. WALSH: I would like to start at one thirty, my lord, we have a lot of ground to hoe here and if one thirty is convenient?

THE COURT: I would rather like to -- we could get started at one thirty, Mr. Furlotte?

MR. FURLOTTE: We'll have a quick lunch.

THE COURT: Yes. So we'll adjourn until one thirty and Dr. Waye, you're still on the witness stand.

COURT RECESSES FOR LUNCH AT 12:30

COURT RESUMES AT 1:30

DR. JOHN WAYE, still under oath, continued to testify as follows:

DIRECT EXAMINATION CONTINUED BY MR. WALSH:

Q. Dr. Waye, I am going to go into an area, I'm trying to delve into the theory underlying DNA typing. Could you describe to the Court, please, the term cell chromosome and explain how DNA would be connected to those descriptions?

A. Your body is composed of cells, your skin, your blood, all the tissues in your body are composed of cells, little tiny compartments and there's literally trilliums of them that make up your body. Within each of those cells there's a compartment, a subcompartment called a nucleus and it's just a smaller compartment within the cell. And in that nucleus is the DNA molecules, and each cell has the same DNA molecules and

those molecules are packaged into units that are called chromosomes. So those are the terms we deal with, the cell being the little blocks of tissue that make up your body. The nucleus being a component within the cell, and the chromosome as being the actual bodies that contain the DNA.

Q. What types of cell would DNA be found?

A. Virtually any cell that has a nucleus which would include every cell in the body, excluding mature red blood cells. So you can find it in semen, skin, hair follicles, bone marrow, dental pulp, epithelial cells.

Q. Epithelial cells, what do you mean, for the uninitiated, what is an epithelial cell?

A. It's essentially a skin cell that would be a good generic description of an epithelial cell.

Q. And you say, outside of red blood cells, what about in blood, what parts of the blood would contain DNA?

A. Oh, there's cells in blood, white blood cells leukocytes, leukocytes contain nucleui and they also contain DNA as well.

Q. Does DNA vary from cell to cell in one particular body, for example, would the DNA in my blood differ from the DNA in the root hair in my scalp?

A. No. The idea behind this is the central premise, is that upon conception the fertilized egg contains the DNA inherited from the father from the single sperm and from the mother from the

single egg. And that cell continues to divide and every cell in your body is essentially a product of divisions, replications of the DNA in those original -- in that original union.

Q. Do you -- is there anything that could alter an individual's DNA, a person's DNA?

A. Mutations.

Q. Would you explain what you mean by a mutation?

A. Something that people can relate to, say, a cancer. If you have a change in any particular cell in your body, say, in your lung, all the cells, if that change changes, if that mutation in the DNA causes a program change or changes how that cells grows, you can have a tumor develop from that single cell. So all the cells within the tumor are altered and you have a cancer and that's how cancers are formed.

Q. Would that account for every cell -- would that then affect every cell in the body?

A. That would only affect the cells that are derived from the cell that have the mutation, so it would affect the lung tumor, it wouldn't affect, the change in the DNA wouldn't affect the DNA in your toe.

Q. What about age, for example, the DNA that I have when I'm two months, would it be the same as the DNA that I have at thirty years old or forty years old or fifty years old, sixty, would it change as a result of age, for example?

A. Only the mutations that you acquire as a -- during the process of aging, it doesn't change.

Q. Doctor, I understand that you have a couple of slides related to -- at least chromosomes, to the areas in the chromosomes and I believe you also have a slide dealing with -- as it relates to the different chromosomes and substances in which DNA is found, is that correct?

A. Yes.

MR. WALSH: At this time, my lord, I am going to ask to have marked --

Q. I show to the doctor, first, doctor, I'll show you this first item here, does that purport to be an accurate replica of your first slide?

A. Yes.

MR. WALSH: If I could have this marked for identification on the voir dire.

THE COURT: That's VD-26.

Q. And this item here, is this an accurate depiction of your second slide?

A. Yes.

MR. WALSH: The next item, my lord.

The second item would be marked V-27 the second slide you'll be showing.

Q. Perhaps at this time, would you like the lights dimmed, doctor?

A. Yes.

MR. WALSH: If we could have one bank of lights turned off.

Q. I'll ask you just to explain the first slide, that's VD-26.

A. Okay, to reiterate some of the points that I made just a moment ago, the human body is composed of

trillions of cells from head to toe. This is the cell shown here, it's just a compartment, it contains proteins and other materials. And within that cell there's a subcompartment, it's call the nucleus, within the nucleus you have all the DNA molecules and they're arranged in these they appear as little X's here, that's a chromosome and each cell has forty six of these.

This just shows the various different types of cells, an example of the different types of cells that you can -- that contain a nucleus and by definition then contain DNA, hair roots, blood, the white blood cells contained in the blood, semen, bone marrow, organ material, such as, spleen, tissues such as muscle and again, bone marrow, dental pulp, all sorts of tissues, virtually anything that contains nucleus cells and that would include fluids such as saliva, urine, you could even have some cells from human feces, materials such as that.

Q. This would be V-27.

A. The second slide shows the organization of DNA in a given cell. And all the cells in your body with the exception of sperm and in the female, the eggs would have this number of chromosomes, they contain forty six chromosomes and they're numbered according to their size and their length, numbers one to twenty two, males and females all have two copies of chromosome one, two copies of chromosome two and so on through chromosome twenty two.

Q. Where does each copy come from?

A. One copy you inherit from your mother and one copy you inherit from your father. In males they're sex chromosomes are a Y chromosome inherited from your father and an X chromosome inherited from your mother. A female inherits two X chromosomes, one from the father and one from the mother. That's essentially what you find in all cells. I noted the exception of sperm in the ovum. Those cells only contain the twenty three chromosomes, in the male they'll one chromosome one and one chromosome two and one chromosome three through to chromosome twenty two in either the X or the Y. And in the female you'll contain one of chromosome one, one of chromosome two, one of chromosome three through to chromosome twenty two and an X chromosome because they have two X chromosomes.

Q. Dr. Waye, you've indicated that the DNA is located within the chromosomes?

A. Yes, what these chromosomes are is long, long DNA molecules and they're drawn like cigar shaped units here. What you actually have is a DNA molecule wound up very tight over and over and over again, it forms this wide body. But it actually is just one long chain of the chemical DNA.

Q. And does that extend through the -- all of the chromosomes, one long chain extending through chromosome one through to twenty two?

A. No, you have one continuous chain from the end of chromosome one down to this end and there'll be another chain for the other chromosome one and another independent chain for chromsome two, each chromosome representing a continuous chain of DNA.

Now, in humans this is the way DNA is organized. In other animals the number of chromosomes and their shape and the amount of DNA they contain is different. But in humans this is the pattern that all humans share. Most of this DNA is the same in all humans. My DNA, my chromosome one is essentially organized identically on both of the chromosomes and it's going to be the same as every one in this room as well, the bulk of the DNA. There are however regions on the DNA molecule which we know are very different in different individuals. We call that polymorphic regions of DNA. And in these regions we know that it's very likely to have two different individuals that DNA will be different between both of their chromosomes, one from their father and one from their mother. And that in turn will be different from an unrelated individual or even in a related individual. And it's these regions, the regions that we know that there's a high probability of them being different in different individuals that we choose to analyze for forensic DNA tests, because they have the capability of distinguishing between individuals.

THE COURT: Doctor, there's no reason why you can't sit down if you'd prefer to do that. Would you prefer to bring that chair over and sit down there.

WITNESS: Actually, I prefer to stand.

THE COURT: You're okay.

MR. FURLOTTE: Are the lights down okay for the court reporter?

THE COURT: Pardon me.

MR. FURLOTTE: I'm just thinking about the court reporter with no lights, if there's a problem with her, maybe you could check?

THE COURT: What can we do to help your situation? Is there any single light that can be put on here in order to --

MR. FURLOTTE: Maybe we could get her a table lamp.

MR. WALSH: We could try -- we were working on the light system to ensure that we give the best resolution and at the same time try to enable people to work in here. Is the court stenographer having a problem with the lighting conditions?

THE COURT: Well, it's pretty difficult, I would think, I'm trying to make a few notes here myself, I'm not sure what I've got down.

Did someone go out to check?

MR. WALSH: Yes, he went to see if he could get a table lamp, my lord.

THE COURT: Oh, a table lamp, yes. Let's just hold on a minute to see what he can find.

Is there a table lamp in one of those offices out there? Bring it right up, if you wouldn't mind, perhaps it could go right on the desk.

Q. Continue, doctor, please.

A. To reiterate, there are regions although the bulk of the DNA is similar, estimates are made that are 99 percent identical between different individuals. There are regions that are very hypervariable and can be used to distinguish different individuals. Forensically we selected several of these regions to focus our analysis on, we don't really want to be analyzing DNA that we know is going to be the same in different individuals, it's not informative. So we selected a number of these regions that are highlighted by the boxes here, which have been previously characterized, they've identified -- scientists have identified which chromosomes they're on, which region of the chromosome they're on and how variable they are. So we know a lot about these pieces of DNA, there's one on chromosome one, chromosome two, chromosome four, chromosome ten, chromosome sixteen, chromosome seventeen. I have highlighted a couple of other areas here as opposed to being in variable regions, this regional chromosome seven is what we call polymorphic region, we call it a monomorphic region, that's a region that the DNA is the same in different individuals and later on in the process it will become

evident that this is a good control that we use. We analyze a piece of DNA which we know should be the same in different individuals, that gives us a control, an expected result.

And there's another region down here in the Y chromosome, which because males have a Y chromosome and females don't, you get a positive result in analyzing this area, you know that the DNA came from a male and not a female.

So by analyzing these regions you can discriminate between different individuals and you can call the sex of the donor of the DNA. Those are the regions of the chromosomes that we choose to analyze forensically.

The numbers associated with these regions are catalogue numbers that are given out by the gene mapping library, which is a world wide organization that takes pieces of DNA and assigns them to regions on chromosomes. The number D just means designation, one identifies the chromosome, S says that this occurs only on one chromosome in one spot and the 7 is just a catalogue number that indicates that that was the seventh piece of DNA that was entered into the gene library for chromosome one. It's a catalogue number that scientists can refer to and go to the gene mapping catalogue and find out information about that region.

Q. Doctor, I'm going to ask you, perhaps if you could, if it's appropriate at this time to perhaps define certain terms to the Court and

perhaps in using this slide or the one previous. We have used the term polymorphism, what could you tell the Court or could you define that again, please, for us using this particular slide?

A. A polymorphism using this slide you'd be looking at regions such as D1S7 and that just means that we can recognize differences between the DNA on different chromosome number one. So it's not the same on all chromosomes number ones and not the same between different indivudals. There are differences or polymorphisms that we can recognize at this region of DNA.

Q. What does the term locus or site mean in relation to this field?

A. Locus when you talk genetically basically means location and you talk locus D1S7 and that just means this region of the chromosome.

Q. Site is an interchangeable term with locus?

A. Site or locus when you speaking of chromosomes, yes.

Q. We've talked about polymorphisms, what does the term highly polymorphisms mean or highly poly -- yes, highly polymorphisms?

A. If something was, just, polymorphic, you may have two different forms that the DNA could be in, you could either, to use an alphabet term an A or a B, so this chromosome could be an A or a B, this chromosome could be an A or a B, you only have two choices. There's not much variation, that's polymorphic but not very polymorphic.

Hyper -- if something is hypervariable or very polymorphic or highly polymorphic, those terms are reserved for regions of the DNA, where they'd be more variation in say, Form A and Form B, perhaps you'd use the entire alphabet, a person could be a Form A or Form B or Form F or Form G on one chromosome and any of the twenty six letters on the other chromosome. So you have an awful lot of combination, you could be an AF, you could be a BF, you go through the entire alphabet and all the combinations to find out which combination a person is at that locus for that chromosome.

Q. On your slide, you referred to these areas D1S7, D2S44, D4S139, are these sites or locus, are they considered to be highly polymorphic?

A. Yes, as is D10S28, D16S85, D17S79.

Q. Doctor, perhaps just for clarification if it's a help, could you provide that analogy, if you could, for example, between a highly polymorphic area as you pointed on this particular slide and for example the ABO blood type system, how -- what is the difference there?

A. It depends on your blood grouping, you have a limited number of possibilities, you could be an A, an AB, a B or an O, there's only so many combinations that you can come up. And with the ABO system, that's actually the different blood groups are coded for by DNA that's present on chromosome 9. So if we wanted to deal with blood grouping in a DNA sense, those various blood

groups are coded for by the DNA molecule, and there's a locus or slot on chromosome 9 that contains the information that determines, for example, that I am an A type, that's my blood type. That information is contained on my two chromosomes 9's. There's not very many choices there, as I said, for the different blood groups, so that's not a very polymorphic system.

Q. But with DNA are these particular loci or locus that you've got shown there, instead of the combinations ABO, how would that relate by analogy?

A. Well, if we went over to the next locus, locus 10, you're using the same analogy out of a limited number of blood types here, you may have literally hundreds of different combinations that you can have rather than A, AB, B and O here you may have a hundred different possibilities at this highly polymorphic locus. It's much more discriminating if you were to look at two individuals.

Q. Perhaps at this time, could you tell the Court, please, what you mean by the term gene and the term allele, allele is spelt A-L-L-E-L-E.

A. Broadly speaking a gene is just a unit of DNA, and a gene resides at a location or a locus. And allele is just a different form of a gene. So if we were going to go back to an example I said earlier of somebody either being an A or a B and those were the only two combinations that

you could be, that particular system would be a-- would have what you call a two allele system, you're either an A type or a B type. Those are two possibilities at that particular gene.

Q. Doctor, is there anything else you would like to add with respect to this or would you like to move to the next slide?

A. I think we can move on.

MR. WALSH: My lord, at this time I have two additional slides, I show the first one as headed, «THE DNA MOLECULE», for purposes of the record it will be -- it doesn't say it but DNA Molecule without a probe attached.

Q. Would you look at this document for me and tell me whether or not that would be an accurate depiction of the next slide?

A. Yes, it is.

MR. WALSH: If I could have this marked, my lord.

THE COURT: So that will be VD-28.

Q. And I would ask you to look at this particular depiction, it's call THE DNA MOLECULE, and I would add all the condition with probe attached, is that an accurate depiction of the second slide to follow?

A. Yes, it is.

THE COURT: VD-29, did I say that?

MR. WALSH: My lord, may I continue?

THE COURT: Yes.

Q. Perhaps, I'll lead the question for you, doctor, what is DNA and its composition, perhaps you could refer to the next slide in that regard?

A. Before I leave this slide I would just like to mention that what in effect I am going to be doing going into the next slide is zoning in on exactly what the DNA molecule is. We will effectively be taking a microscope, if you will, zoom in on the chromosome and actually look at what the DNA molecule looks like at a particular -- a very small portion of the chromosome.

Q. This would be VD-28.

A. If you are going to compare back to the entire length of the chromosome, this is an extremely small fragment of that chemical chain. In fact the length of this is somewhere around the thirty units or thirty base pairs, which is the unit that we use in DNA. All the DNA in a cell is three billion base pairs. So this is thirty out of three billion, so it's a very small segment shown only -- to give an idea of how the DNA molecule is organized.

Q. When you say base pairs, perhaps, doctor, you can just describe the composition of the DNA molecule?

A. Yes, the molecule is actually a long chemical chain and it's composed of two intertwined chemical strands. So this one here and it's wound around the other in what they call a double helix. The composition of these strands, it's a very simple genetic code, all the information in your cells is determined by the

order of four chemicals in the DNA and they're abbreviated TGC and A. And these will be repeated over and over again in various combinations three billion times in each cell, and it's the order of TGCA that determines various things like your eye colour and other heritable features, the simple code and all the permutations of how these basis can be aligned. That's one feature of the DNA, that has a simple code composed to TGC and A and the two strands that are wound around each other. What you also notice is that on the other strand you have complementarity that is A always pairs with T, C always pairs with G and you see G pairs with C, A with T. So if you know the sequence of these letters on one strand, you can deduce the sequence on the other strand, because it's always complementary. So knowing that the sequence of say, populous molecule is TGCA, I can deduce that it's AC GT if I read the other strand. Those are the basic features of all the DNA in your body, for that matter throughout nature, plants, animal, bacteria, yeast, moles.

Q. What is a base pair in relation to that molecule?

A. A base pair is this unit. T paired with A here, that would be a base pair, G paired with C would be the next base pair and so on and so on, and again in each cell there's three billion base pairs of DNA.

Q. Doctor, you had mentioned before that a large part of everyone's DNA is the same, how does that relate to this molecule?

A. Yes, as far as looking at, well, my work, we work with genes that encode essential functions, hemoglobin molecule which transports oxygen in the body. If I looked at the region of DNA that makes the hemoglobin molecule and I read a sequence of chances are almost every base pair in that gene it will be the same, pretty much every one in this room because it codes for an essential functions that all human beings need. Now, if I went to a piece of DNA in the cell that serves no obvious function and whose sequence therefore it really doesn't matter what it is, you see an enormous amount of variation, it may read TGCA in my DNA. It may read TTCA in someone else's DNA. And that would be polymorphism or a difference that we could detect between individuals.

Q. For historical background, doctor, could you tell us when this particular structure was discovered by scientists?

A. In the early 1950's the structure was defined by Watson and Crick.

Q. Did they win any award for that discovery?

A. The Nobel Prize.

Q. Continue. Perhaps, doctor, before we leave that, could you tell us something about what the term variable number of tandem repeats would mean or the term restriction fragment length polymorphism in relation to the DNA molecule?

A. Those are both terms used to describe differences

in the sequence of DNA. Restriction site polymorphism, I'll have to describe what a restriction site is and what a restriction enzyme is. There are enzymes which you can buy, they're commerically available, they're proteins that you -- when you add to DNA they will look at the DNA molecule and each enzyme, we can use an example of an enzyme that recognizes TGCA. Every time that enzyme sees the sequence TGCA in your DNA molecule, it will cut the molecule, break the molecule. Now, if your DNA does not have the sequence TGCA at this position the restriction enzyme will not cut it. If my DNA doeshave TGCA at this position the enzyme will cut it. So the ability of the enzyme to cut at this particular position could differ between different individuals, depending on whether you have TGCA here, if you have TTCA the enzyme wouldn't cut. So that's something we can measure in a lab. Does the enzyme cut here or doesn't it? And that's called restriction fragment length polymorphism or RFLP.

Q. And that's what typing procedure you described later is called after?

A. Yes, that's how it measures genetic variation, we don't actually determine the sequence, indirectly we measure whether the enzyme will cut at that site or not.

Q. And the term VNTR, variable number of tandem repeats?

A. VNTR is again a different type of polymorphism, and it deals, it's a little bit more complex, I'm not sure I can --

Q. If you can't do it in this one, we'll do it, we can wait until later and do it.

A. I'm not sure I can do it with this model.

Q. Okay, fine. You had mentioned, I just wanted to go back to that, you said that there was approximately three billion base pairs contained within a molecule of DNA, is that correct?

A. Contained in each cell.

Q. In each cell, yes.

A. And all the chromosomes combined.

Q. And you had indicated that some portions of your DNA molecule would be the same from person to person?

A. Yes.

Q. Is there any estimation of how many base pairs would be the same or how many base pairs you would expect to be polymorphic or how many base pairs you would expect to be highly polymorphic?

A. A very crude estimate and this is taken from sampling only a very small portion of the DNA and looking at different individuals, the estimate is that about 99 percent of the DNA will be the same and on average one in a hundred base pairs will be different in different individuals, very general numbers, the bulk of the DNA is the same.

Q. Continue, doctor.

A. One other feature before I leave this, is that these chains although they're in the cells they're interwound against each other and A is paired with T and G with C throughout the entire chain, these bonds aren't etched in stone. You can simply heat the molecule, raise the temperature and these bonds that hold the strands together will come apart.

Q. Is there a term for that?

A. It's called denaturing the molecule.

Q. Fine, continue.

A. So your helix goes from being what we call double stranded to single stranded. That's done by simply raising the temperature.

Q. The next slide, I believe, is VD-29.

A. That feature of DNA, the fact that T always pairs with A, C always pairs with G, and the fact that you can break these bonds and denature the molecule is very important in just about every technique we use to analyze DNA. And the reason for that is you have to have in the lab the ability to zone in and look at particular regions on a chromosome, specific DNA sequence on a chromosome, remember this is only a very small part of the chromosome. And if we are interested in looking at, say, sequences here, we have to have a way to identify that region of DNA and not look at the entire three billion base pairs, we just want to look at these thirty base pairs. The way you do it is that you can

denature this molecule, break it apart and then you can synthesize pieces of DNA which have the complementary sequence, the matching sequence to the region that you are interested in. In this case G pairs with C on this piece of DNA and T with A, et cetera. This piece of DNA the term that we use, the jargon that we use in the lab, we call it a probe. It's simply a piece of DNA that has the complementary or the matching sequence to a region of DNA that you are interested in. And we can make these pieces of DNA in the lab and we can tag them with radioactivity, so that when it detects this piece of DNA we can detect where it is. And it's actually a honing device, you can look at all the chromosomes, hone in on one area on the chromosomes, just a tool that we have to do this.

Q. For the record, doctor, for the future record, that you're referring to with your laser pointer, you're referring to an area on the lower right hand corner of that schematic in which shows two lines with the letters AA, CA, I believe it is?

A. AA, CA and that will be a C because it's a G over here.

Q. Fine, that's fine, continue, doctor. Are you finished with that schematic, doctor?

A. I believe so.

Q. Is there a generally accepted theory in the scientific community regarding DNA?

A. Well, the working premise and it's not a theory that is in dispute, I'm aware with anyone it's a universally accepted theory is that the DNA in each of your cells will be the same throughout your body and with the noted exceptions of mutations that you might accumulate throughout your lifetime and that the DNA in all other individuals excluding identical twins will be different.

MR. WALSH: At this time, the doctor has put another schematic on the screen and I have --

Q. I'll show him this document, does this purport to be an accurate depiction of the schematic on the screen?

A. Yes.

MR. WALSH: I would move to have this marked for identification on the voir dire, my lord.

THE COURT: VD-30.

Q. Doctor, if I may, can scientists identify sections of a person's DNA and if so, how can they do it, when did they commence to do so and for what purposes, if that's not too big a question?

A. Yes, you can identify particular regions on the DNA. When did they start doing this?

Q. Yes.

A. In humans, technology became widely used in the 70's and it's continued through until now.

Q. Where did it start -- where did it first start to be used to identify human DNA, sections of a person's DNA?

A. In using these particular techniques again the question was when or where?

Q. Where, in what field?

A. In genetics.

Q. Fine.

A. And the actual widespread use of DNA typings was initially done in medical genetic terms to define areas that contain genes that are involved in various genetic diseases.

Q. Are we talking about the RFLP technique?

A. Yes.

Q. In isolating various diseases, would you explain to the Court, please, how it was used for that purpose, what kinds of diseases it was used to identify or isolate?

A. The initial reports using this technology to analyze people's DNA, it was done to analyze and to make predictions as to whether somebody would have sickle cell disease or not. And that was done in the late 70's, where they could analyze the region of the DNA that contains the gene that's involved in sickle cell anemia and they did the technique to characterize that region of the DNA.

Q. Were there any other discoveries using this particular technique for isolating diseased genes?

A. Well, that was just the beginning, since that this technique has played a role in virtually the identification of virtually all genetic diseases since that time, some examples, muscular dystrophy, cystic fibrosis, Huntington's disease,

an enormous number of diseases have been characterized using this technology.

Q. What about medical diagnostics, what, if any, applications have you had to that particular field and could you give us some examples, if in fact it's used in that field?

A. One good example and it's an example from my current employment is that you can analyze DNA from a fetus. You can draw amniotic fluid or take a biopsy of a fetus, like a human before it's born and analyze it's DNA and make predictions as to whether it's going to inherit a disease that the parents are carriers of. That's in widespread use for a number of diseases right now, if parents are carriers of, say, cystic fibrosis, you can now once the woman is pregnant you can predict on the basis of the fetus's DNA whether it in fact will have cystic fibrosis or it won't, just by analyzing the cystic fibrosis gene.

Q. In your present work, could you give the Court some description as to how you could use the RFLP technique in your present work?

A. Yes, I use that example and I just switch diseases from cystic fibrosis over to hemoglobin disorders. Sickle cell disease we do in our lab, they're all disorders that impair the function of your hemoglobin, the molecule that transports oxygen throughout your body.

Q. Is there any way that you are able to validate whether or not you made the correct call, for example?

A. Oh, certainly, when you make a prediction prenatally, there's two choices that the child is either going to be affected with the disease, and if the parents choose to terminate the pregnancy you will receive tissue from the aborted fetus to confirm your diagnosis that yes, the fetus would have had the disease. If you predict that the fetus is going to be normal, obviously if the child is born and it has the disease you've misdiagnosed the case, the child is born and it's healthy you've made the right prediction.

Q. How many cases would you have actually been in in your present employment in that type of diagnostics?

A. The prenatal diagnosis, we do around thirty a year in our lab.

THE COURT: Is the witness's voice picking up adequately for the machine, you don't need a special microphone or a microphone?

Q. Doctor, in medical diagnostics, is there any effort in medical diagnostics, apart from trying to isolate genes or genetic defects, is there any use of it, for the purpose of differentiating between individuals?

A. Paternity testing is one use that's one application that's in widespread use, if you

want to determine whether an alleged father is actually the biological father of a person, you can analyze the DNA of both parents, the child and ask the question, is this -- could this person be the father of this child? That's done by simply analyzing one of these variable regions.

Q. What about transplantation, what, if any, impact would this particular type of diagnostics have on any aspect of medical transplantation?

A. One of the uses that it has in that type of application is monitoring bone marrow transplants. Some, say, for example, has leukemia, one of the treatments that he can have is a bone marrow transplant, and what they do is they irradiate you and destroy your bone marrow, they take bone marrow from a donor and they put the donor's bone marrow in your body, and then that marrow replaces your marrow that was destroyed and you become healthy again. One of two things can happen, your marrow can regenerate and you will come out of remission and have leukemia again or the donor's marrow will take over your body and you will be healthy. One of the ways that you can predict the clinical course is to actually look at the DNA, is the DNA post transplantatious, is the DNA from the donor or is it from the person who is receiving the transplant? If after the transplant you see the donor's blood cells being replaced by the recipients, then you know this person is going to go into -- is going to relapse and have leukemia. If the donor's DNA

continues through the circulation of the recipient, then you'll know that the marrow transplant was successful.

Q. Doctor, we're in a courtroom today, so obviously it's been applied, from what you've said to date, it's been applied forensically, could you explain when this was -- when the medical diagnostics and the isolating disease genes use or paternity, when the forensic use of that relates to when that was used for the other reasons, for the other purpose?

A. The forensic use of this technology and perhaps the most recent application relative to all these other uses, none of these techniques were invented for forensics, they're simply applied to forenics, and that's a fairly recent event beginning in the mid 1980's.

Q. Would you explain -- perhaps could you explain to the Court how that began this forensic application?

A. It began in England with the observation of Dr. Alec Jeffrey that that particular piece of DNA that he was characterizing in his lab was very different in different individuals and he coined the term DNA fingerprint. It was so different in different individuals that in his experience, he couldn't find unrelated individuals or anything but identical twins that looked the same when he analyzed that piece of DNA. So he coined the phrase DNA fingerprint.

And the forensic lab in that country quickly collaborated with him and applied that to forensic case work.

Q. Did he publish his results, his findings and its application to forensics?

A. Yes.

Q. I am going to show you at this time, doctor, a couple of articles, please, could you look at this one, please, it's entitled, «INDIVIDUAL - SPECIFIC «FINGERPRINTS» OF HUMAN DNA», do you recognize that article and if you do, who wrote it?

A. Yes, this was written by Alec Jeffrey, the scientist I just described and two people that worked in his lab, that was published in the Journal Nature.

Q. And was this at the same time of his discovery for forensic use?

A. I believe that this is the characterization that preceded the forensic use. But it's a -- they were very close, there was a series of issues of that Journal.

MR. WALSH: If I could have this marked on the voir dire?

THE COURT: What was the date of that?

MR. WALSH: I have it at the top here.

WITNESS: Sometime in 1985.

MR. WALSH: It's July 4th, I believe, 1985, my lord.

THE COURT: VD-31.

MR. WALSH: In Volume 316 of the Nature Journal.

Q. I'll show you this particular publication here, would you look at it for me and tell me whether you can identify that?

A. Yes, this was an article again published in The Journal of Nature somewhat later in that year, December, 1985, it's entitled, «FORENSIC APPLICATION OF DNA «FINGERPRINTS» », authored by Peter Gill, Alec Jeffrey and David Ware(phonetic) are forensic scientists, Alec Jeffrey again is the person who discovered this piece of DNA and published it in the preceding article. But this described the forensic application of that technique.

THE COURT: VD-32.

Q. Would this be considered the first publications, dealing with the -- is the first publication dealing with the forensic aspect?

A. Yes, it's considered so.

Q. Doctor, as a result of these discoveries by Jeffrey and his colleagues and these publications, how did this develop from there, what happened, what did the scientific community start to do?

A. The forensic scientific community, virtually all labs began planning to investigate this type of technology for their own use.

Q. And who would be the first to actually start using it in the courts and in what countries?

A. It was first used shortly after this in Britain, again, by that lab that published the last paper.

Q. Are there any new scientific principles involved in the DNA typing test called RFLP between medical diagnostics and the forensic use?

A. No.

Q. Does there presently exist a standard method used and accepted in the scientific community generally and in the forensic scientific community, particularly, for typing an individual's DNA?

A. Yes, all these technologies are borrowed from the scientific community although there's various ways of doing it, they're all scientifically accepted.

Q. And at the present time where would this particular technique, the RFLP technique be used, what kind of labs, could you describe them for us, please or name some fo the labs that it would be used in?

A. Forensically?

Q. Yes.

A. In this country, the R.C.M.P. lab, the Centre for Forensic Scientists, the Montreal Lab, virtually all State crime labs, either have their own DNA section or they employ the FBI's federal facility. And worldwide, just about every country has some sort of program going with DNA right now.

Q. Where do you fit in, doctor, in the historical development, after Jeffrey's discovery where did you fit in to the historical development of the

technique for forensic use in this country?

A. In North America we took somewhat different approach than Jeffrey's original approach, whereas he did a single test and generated enormous amount of information about a person's individual identity from a single test. We decided that it would be more prudent and more applicable to forensic case work to analyze specific regions on the DNA molecule, one after the other and build a composite profile of an individual, one test at a time. So there was a philosophical difference at the beginning, and the role I played along with a lot of other scientists was putting together those tests that would build the profile which Jeffrey could produce with a single test.

Q. And for what organization did you do this?

A. That was with the R.C.M.P.

Q. And is that the -- would you have been involved in the ground floor then in the development of the forensic application of the DNA typing with the R.C.M.P.?

A. With the R.C.M.P. and members of State and Federal labs, the United States, as well as people from the Centre for Forensic Scientists, we were all pretty much at the same level of development. We worked together to put together a system.

Q. I take it from this schematic that you have here, that there are a number of steps involved in this DNA typing process called RFLP?

A. Yes, this is a series of processes that you have to go through to manipulate the DNA, to derive any information.

Q. Before we start, I'm going to ask you to go into those steps, doctor. But before we do, could you just briefly tell us what are you attempting to do with the RFLP test, what are you attempting to identify or what is it designed to do?

A. Simply stated, you want to look at one particular region on a chromosome and measure the distance between restriction sites at that region.

Q. Doctor, if you would describe each of the steps in the DNA RFLP typing test as applied by the R.C.M.P. DNA Laboratory?

A. This is the general schematic and again, like most DNA typing test begins with a question, could sample A and sample B come from the same individual or did they derive or were they donated by different individuals. That's the initial question. The first thing that you have to do, the first step in the procedure is to take the material that's provided to the lab, be it, blood, skin, hair follicles, whatever, semen and get the DNA out of that material. That's a fairly simple and fast procedure and it really, with a few exceptions, it really doesn't matter what the material is, you use a very general procedure to get the DNA out. It begins by breaking the cells, breaking the nucleus and then purifying the DNA from all the cellular debris. And at the end you have this garbled

mass of DNA, one coming from sample A, one coming from B, and this will be the long chains of DNA, all interwined around each other and this is you know, chromosome 1 maybe beside Chromosome 16 they would be wrapped around each other -- and it's an unorderly mess at this point.

Q. The extraction of DNA from a substance, you had mentioned substances before that this test is applied to, for example, the blood, the white blood cells, there are other items, semen, tissue cells, different things of that nature, could you explain, please, what the process is for actually breaking these cells, generally describe the process for breaking these cells, particularly semen stains?

A. Okay, for all these materials, a cell can be broken fairly easy by just using a detergent. Detergent is just a chemical that that membrane that defines the cellular boundaries will break and release the contents of the cell when you add this detergent or a lices buffer, they call it in DNA terms. But all it is is a detergent that will rupture the membrane and release its contents. Now, with respect to semen, sperm cells they're a little more hearty than your average cell in the body, then you have to add other ingredients to break open the sperm head and release its DNA. And we capitalize on that forensically because sometimes in sexual assault cases vaginal swabs will contain skin cells from the vagina of the victim and

semen from the accused. And the initial step that you do is you lice the -- or you break open the epithelial cells or the skin cells which would be from the vagina of the victim and you centrifuge or spin the intact sperm heads and separate them from the ruptured female DNA/ So you start off in the beginning by separating male and female DNA in a sexaul assault by employing that little manipulation at the beginning. Other than that procedure, you proceed on and you break open the sperm once you have separated and analyze the male DNA.

Q. What would you do after you did extract DNA from any of these -- can this also apply to root hair, doctor?

A. Yes.

Q. What would your next step be after you've extracted the DNA?

A. Remember, the whole test is designed to measure the distance between restriction sites at a particular region on the DNA molecule. So the first thing that you do once you have the DNA out of the cell is to cut it with a restriction enzyme, and you add your DNA to a test tube, you add the restriction enzyme, this enzyme protein scans the DNA molecule and every time it sees its sequence that it recognizes and the enzyme that we use forensically recognizes the sequence GG CC. Every time it sees that sequence it cuts the DNA molecule.

Q. Doctor, if I could stop you there, could you tell me after you got the DNA out of the cell or substance, is there anything that you want to know about that DNA in terms of quality or quantity of the actual amount that you've extracted?

A. Okay, quality of DNA refers to its intactness, has the DNA been degraded, is it degraded down to individual base pairs that aren't connected to each other, if so, we can't analyze it, that would be degraded DNA. DNA that we need to analyze has to be in intact chains, so it has to be of long lengths. That's one of the features that you want to measure at the beginning of the test, is the DNA molecule in good shape, is it intact?

Q. Is this before you would digest it?

A. Yes.

Q. Continue.

A. The second thing that you want to know, remembering that all organisms, plants, animals, et cetera and human beings have DNA. You want to know is that DNA from a human? So you have to perform a test to identify or to actually show that the DNA is of human origin and not bacterial or plants or animal origin.

Q. Now, when you are determining the quality of the DNA and that is whether or not it's degraded, could you briefly tell the Court what you would actually do with the DNA that you've extracted?

A. Okay, there's a simple test that you can, taking your DNA and loading it into a slot or a depression and what we call a gel. It's just a thin matrix, that has pores in it. You apply a current across the gel for a length of time and the DNA molecule migrate through the gel according to its size. So very long pieces of DNA won't migrate very far from its origin. And very small pieces of DNA will migrate the fastest and at the end of the procedure will be the furtherest away from the origin. So after performing this test, if all of your DNA is very close to where you placed it before you turned on the current, you know that you are dealing with large intact DNA fragments and that that's a good feature for subsequent tests. If what you are dealing with is very small fragments, that's evidence de facto that the DNA is degraded and that it may not be suitable for these tests. That's the first test that you would perform, look at whether your DNA molecule is -- that you extracted are large or are they very small.

Q. I take it, doctor, you're doing that, you're only taking a small part of the DNA that you've actually extracted, is that right?

A. Yes, if I had, say, thirty units of DNA that I extracted from a forensic exhibit, a unit, just being an arbitrary designation here, I would take one thirtieth of my sample and analyze it in this fashion. Because once I've done this test I can't

go back and work with this DNA. So I only want to take a small portion of my starting material and run this test.

Q. Is that what you call using a yield or test gel?

A. It's a yield gel, it estimates the amount of DNA that was in the forensic specimen and the size of the DNA molecule, a yield gel or a test gel they call it.

Q. Is there anything that will affect how much DNA -- how much good quality DNA or undegraded DNA you can actually extract from a cell, are there any factors that will affect it?

A. The most obvious factor is the amount of starting material, if you have a lot of blood you will get a lot of DNA relative to if you start with a small amount of blood you get a smaller amount of DNA. Beyond those, if you had equivalent amounts of starting material, the thing that obviously will affect or can affect forensic exhibits is environmental factors. Has the blood sample sat out in the environment for a week or a month or a year, that can degrade the DNA.

Q. But you would know this in advance before you actually began your test?

A. Not always, often times, more times than not, you're brought a sample that comes with no historical information, it's simply a semen stain on a bed, it could have been there for a hundred years, ten years or whatever.

Q. But will the yield gel or the test gel help you determine whether or not it's -- it will help you

to determine whether or not it's degraded though as a result?

A. Yes.

Q. Is this technique for actually determining the quality of your DNA, is that used in other forensic labs?

A. Yes.

Q. You were mentioning quantity or determining if it's human, what can you tell us about that, what will you do there?

A. That's a different test, as I mentioned you can have a large amount of DNA extracted from an exhibit, it could be molecules that are in very good shape, very large DNA molecules, but it could all be from bacteria. In that case you're not going to be measuring differences between humans, you're going to be measuring the DNA of bacteria, so that's not what we want to analyze. So you have to ask the question, is this DNA that I've characterized as being of sufficient quantity and quality, is it human yet before you even start your discriminating test. So that's a specific test that you have to do. You ask, how much of this DNA is human?

Q. And what would you do to find out before you started the actual testing process whether or not the DNA that you have extracted, whether it is human, what briefly would you do?

A. One of the ways, the way in which the R.C.M.P. lab and other forensic labs have been doing that is to take again a very small portion of your

DNA, so you're not using your whole sample, simply dot it, apply it to the surface of a nylon membrane, it's like a piece of paper made out of nylon and the DNA will bind to that nylon membrane. And then you separate the strands of DNA molecules and you add a probe that detects only human DNA. And when you compare that to known amounts of human DNA, you can estimate how much of your sample is of human origin, if any or is it all of human origin.

Q. Doctor, who developed this process of determining how much of the DNA extracted is human, who actually developed this process?

A. That was developed for forensic application, the procedure was developed at the R.C.M.P. lab.

Q. And who was responsible for that development in the R.C.M.P. lab?

A. There was myself and Dr. Ron Fourney worked out the initial test procedure, we collaborated with the FBI after that and they co-authored a paper, a publication on the method with us.

Q. You have actually published a paper on this particular method of determining human, amount of human DNA or whether there is human DNA?

A. Yes.

Q. I show you this document here, doctor, do you recognize this?

A. Yes.

Q. Is that the paper you're talking about?

A. Yes.

Q. And it's called, «A SIMPLE AND SENSITIVE METHOD FOR QUANTIFYING HUMAN GENOMIC DNA IN FORENSIC SPECIMEN EXTRACTS», what paper is that published in?

A. It's published in a Journal called Biotechniques it's a technical journal.

MR. WALSH: I would ask this this be entered, my lord.

THE COURT: VD-33.

Q. And is this journal is this distributed or is this published and circulated throughout the scientific community?

A. Yes, it is.

THE COURT: What was the date of publication?

MR. WALSH: It's -- in brackets it says, 1989.

Q. I'll show you another document, doctor, would you look at it for me, please and tell me whether you can identify that document?

A. Yes, I can.

Q. What is it?

A. This is a preprint of a document to be published in The Journal of Forensic Sciences in June of this year.

Q. And what is it related to?

A. The application of this test for human DNA to actual forensic casework examples.

Q. That you have actually been involved in?

A. Yes, these were my cases.

Q. Are you one of the authors of this report?

A. Yes, myself and three other individuals from the R.C.M.P.

Q. And you were one of the authors of this previous report that's just being marked?

A. Yes.

MR. WALSH: I would ask that this document -- it's entitled, «SENSITIVE AND SPECIFIC QUANTIFICATION OF HUMAN GENOMIC DNA IN FORENSIC SPECIMENS: CASEWORK EXAMPLES» and it's a final draft in press for the Journal of Forensic Science for 1991.

THE COURT: VD-34.

Q. Doctor, you've mentioned casework examples, could you explain to the judge how you consider this quantification test to be important, how has it been applied in your casework, what does it enable you to do?

A. Well, in some cases and one of the examples given in that last paper, you can isolate large quantities of DNA from a forensic sample and the example it was a blood stain from the underwear of a murdered little boy. And that particular example we isolated more than sufficient DNA to analyze. It was of good quality, yet none of that DNA was human. So that provides information that there is no need to even do the test, we know at the beginning that the DNA is not human and it's pointless to try to link that DNA to the victim or to someone else. The other example, the DNA, only a small portion of it was human, perhaps somewhere around one percent of that DNA was human. So in that particular case you know at the beginning that most of the DNA is not

human but there is sufficient DNA to analyze if you analyze enough of the sample. You've got to compensate for the fact that it's contaminated with something else.

THE COURT: What would it have been in the boy's case if it wasn't human?

WITNESS: The boy's case, the exhibit was taken the crime occurred in the summer, the body was in a garbage bag in the summer heat for a number of hours, the boy was sodomized and there was blood and feces in that stain and feces is pretty much solid bacteria. The bacteria would in fact feed on the blood stain. So the serologist can identify it as human blood but the bacteria had literally used that as a nutrient source and then they've taken over the exhibit as it were.

Q. Doctor, is a technical term for this identification of human DNA in advance of actually running the test? Have you put a name to it?

A. Human -- that's the technique and it's called slot blot quantification, it's just a technical term.

Q. Why does knowing in advance, doctor, before you run the test, why is it important to know whether or not the DNA that you've extracted is human, apart from the fact that it may just waste time in running the test, what's so important about that?

A. Well, if only -- if like the one example, only a small proportion of the DNA is human, you can

still analyze it but you have to analyze more of the material to compensate for the fact that only a small proportion of it is human. So that's information you need at the beginning to make the test work.

Q. Doctor, this slot blot quantification technique that you've been describing in determining the quantity of human DNA extracted from a forensic specimen, is this a technique that's considered to be reasonably reliable in your opinion?

A. Yes.

Q. Is it a technique that it's considered in your opinion generally accepted in the scientific community?

A. Yes, it's -- people have been using techniques like this for other purposes in other fields, this is simply a forensic adaptation.

MR. FURLOTTE: My lord, I wonder if wer're going to continue with all these leading questions or if -- or is this allowed in extracting evidence from expert witnesses? You know, ask questions like, is this slot blot, is it reasonably reliable and is it accepted generally accepted in the scientific community? If those aren't leading questions --

THE COURT: Well, why don't you phrase your question, what do you have to say about -- what do you have to say about the general acceptability of this and so on?

MR. WALSH: Fine, my lord.

Mr. Furlotte expects -- I have no problem, my lord, I will rearrange my questions.

THE COURT: I don't find it particularly objectionable, what you're doing --

MR. WALSH: Most of the transcripts I've read, the judges have found it to be helpful to actually lead your experts to those actual areas.

THE COURT: I think one gives a fair amount of liberty in this sort of thing.

MR. WALSH: But I will rearrange -- rephrase my questions and I expect Mr. Furlotte when his expert testifies will comply with the same requirements. Fine, my lord.

THE COURT: Mr. Furlotte, if you feel that the witness is being led into belief -- or saying things that he shouldn't be saying or wouldn't want to say, speak up. We'll give Mr. Walsh a little bit of liberty short of that.

MR. FURLOTTE: Well, give him some, there's no doubt about that but enough is enough.

Q. Doctor, perhaps we'll move along and I'll rephrase some of the way I do this. The test gel or the yield gel determining the quality of the DNA that you extract, could you give your opinion please as to the general acceptance of such a technique in the scientific community for forensic purposes?

A. For the scientific community in general, that's a test that's done by any number of different labs, for any number of different applications

if they want to ask the question, how much DNA do I have. That's the test that was in practice labs for years long before forensics ever came along to use DNA.

Q. What, if any, opinion would you have as to its reasonable reliability for forensic purposes?

A. It's a reliable test and it's a widely used test.

Q. All right, doctor, we've extracted the DNA and you've quantified it and determined the quality of it, what would be the next step that you would do for forensic purposes as applied by the R.C.M.P. lab?

A. The next step is so you have DNA, you know it's of sufficient quantity, quality and that it's human, now, you're back to this question, could the DNA from sample A and sample B have come from the same individual? And again, we measure that indirectly by looking where on these DNA molecules restriction enzymes cut. And the restriction enzyme that we employ forensically is called HAE III, is just -- is again another catalogue number to describe that particular enzyme, H-A-E roman numeral III and it cuts every time it sees a sequence, GG CC, after the second G and before the first G it will cut the DNA molecule. And it will cut the DNA molecules, the DNA molecule in each cell it will cut thousands and thousands of times as the sequence GG CC will occur thousands of times in each cell. The positions where it cuts in each

cell or at a given spot on a chromosome will vary between different individuals. If you are looking at a hypervariable or a polymorphic region. That's the typing we do. We add the enzyme to DNA, the enzyme does all the work and it scans the molecule, finds where GG CC is, cuts these long molecules into short fragments.

Q. These enzymes is there another name for them, is there a formal name for them?

A. Restriction endonuclease.

Q. And are there different types of restriction endonuclease?

A. Yes, and they're distinguishable by the organism that produces them and by the sequence that they cut at, not all enzymes will recognize GG CC, other enzymes will cut when they see the sequence GAATTC. And virtually every combination that you think of of those four codes there will be short sequences there that an enzyme will cut at.

Q. When were these enzymes endoncleases discovered either discovered or prepared?

A. In the early 1970's.

Q. And did that result in any award for the discoverer?

A. Again, the Nobel Prize.

Q. And doctor, when you were developing the R.C.M.P. laboratory, was there any consideration given as to the appropriate, you say, HAE III, is that the name for the enzyme you use at the lab?

A. Yes.

Q. Was there any thought given or research done into whether or not that would be an appropriate restricton endonuclease for use in the R.C.M.P. laboratory?

A. Yes, along with the other labs, principally in North America, because we were all at the same level of development, one of our first tasks was to decide of these several hundred different restriction endonuclease to use from, which one would we build our system on, so that was one of the first questions that we had to ask. We did a lot of research into defining what would be the most appropriate enzyme to use in the forensic world.

Q. Did you publish your findings?

A. Yes.

Q. I'm going to show you this document here, please, it's entitled, «HAE III- A SUITABLE RESTRICTION ENDONUCLEASE FOR RESTRICTION FRAGMENT LENGTH POLYMORPHISM ANALYSIS OF BIOLOGICAL EVIDENCE SAMPLES», would you look at that for me, please and whether you recognize it?

A. I do.

Q. Are you one of the authors of that report?

A. Yes, I am.

Q. Does that relate to the development of that restriction endonuclease for R.C.M.P. laboratory DNA use?

A. Yes, this is a joint publication between the R.C.M.P. and the FBI.

Q. And that is published in?

A. Journal of Forensic Sciences.

Q. Thank you, doctor.

MR. WALSH: I am looking for the year, my lord, I know you are going to ask me. It was received for publication on May 17th, 1989, and accepted on June 19th, 1989. I would ask that that be marked on this hearing.

THE COURT: That's VD-35.

Q. Doctor, I believe it's appropriate now, correct me if I'm wrong, whether you wanted to go to another slide to describe what the -- what a restriction enzyme would do?

A. Yes, up until now I've just been saying, you add the enzyme and it cuts the DNA fragments, I'll give you a better visual picture of how these enzymes or the results of these enzymes actually.

Q. Okay, doctor, I am going to show you this paper here, is this an accurate replication of what you have on the screen now in the slide?

A. Yes, it is.

MR. WALSH: I would move to have this marked on the hearing entitled, «Fragments of DNA released by HAE III restriction enzyme digestion», with the Court's permission, my lord.

THE COURT: VD-36.

Q. Go ahead, doctor.

A. This slide is just the letter code of a short piece of DNA and you'll notice that it's the two strands, I've untwisted them, just so you can read the Code, A is paired with T, G paired with C, et cetera down the length of the molecule.

Now, it's highlighted here are HAE III recognition sites, GG CC and there are two of them in this direction here. If you want to measure the distance separating them, these two pieces of DNA, you simply add the restriction enzyme, it scans the length of the molecule, finds these sites, after the second G before first C cuts the molecule. So it would make two cuts in this piece of DNA. And now, we've released the -- the reason that this is so essential to the technology is that if it's someone else's DNA, this G and this C were changed to T and A, the enzyme wouldn't cut here. It would cut at some site, if this were a longer molecule, eventually there'd be another GG CC down here. And now, we have a longer fragment at that particular place than in this individual has a shorter one. So now, we've got a feature between two individuals due to a single base difference but in one individual it will give a long fragment, say, here down to this site and the other individual a short one. Now, we've got a feature that we can distinguish in these two individuals from each other based solely on one change in the DNA sequence.

Q. Doctor, on the slide you've indicated, you've demonstrated two cuts, have you been able to determine in your research, how many cuts you would expect the enzyme cutter HAE III would make on a DNA molecule?

A. The bulk of the DNA in humans is cut on average into fragments of less than four or five thousand base pairs playing. So if you are starting off with chains that are of total length three billion, you are going to cut that into little fragments of upwards to several thousand. So there will be many, many sites.

Q. In the RFLP test as applied by the R.C.M.P. laboratory, what, if any, test is conducted to determine if the digestion is complete? If you digest or attempting to digest this DNA that you've extracted, how can you tell whether or not it did what it was supposed to do or didn't cut between A and T or didn't cut between G and C like it was meant to do?

A. Okay, you know from the yield gel, the size of the DNA to start with. After you digest it you do the exact same thing again. Again, another test gel, but this time if the enzyme work the fragments aren't going to be large, they're going to small because the enzyme cut it. So that's an indication that, yes, the enzyme did work.

Q. Just so I understand, you take another little bit of DNA --

A. From the digestion --

Q, -- and run it in a separate test.

A. Yes.

Q. On a test gel?

A. Yes.

Q. Okay, and you have a way, by what you see in the test gel will help you determine whether or not the enzyme cut or not?

A. Yes, if the test gel shows you that I still have lots of DNA and it's all very -- it's all in very large sizes, then I know the enzyme didn't work, the enzyme should have cut into the small sizes.

Q. Doctor, again, I will be careful the way I phrase this, what, if any, opinion do you have as to the reasonable reliability of the use of the restriction enzyme, the use of restriction enzymes particularly HAE III for forensic purposes?

A. Again, for forensic purposes or for other purposes, restriction enzymes have been used for a long time and they're basically the cornerstone of a lot of research in all fields. They're viewed as extremely reliable in both research and clinical work, that carries over to forensics as well.

Q. What, if any, opinion, would you have with respect to the general acceptance of such restriction enzymes for forensic use, particularly HAE III in the scientific community?

A. Again, like for any application or any enzyme the use of a restriction enzyme is something that's viewed as reliable and accepted.

Q. I know you've developed a paper and it's been marked as evidence on why you've chosen HAE III for the R.C.M.P. lab and the FBI use that as well, is that correct?

A. Yes.

Q. Would you perhaps just give the Court a couple of reasons why it was important to use HAE III and not some other cutter, some other enzyme?

A. Other enzymes could have been used, HAE III based on our fairly long list of criteria was chosen to be the best enzyme for our purposes. There's several reasons for that. One it's inexpensive, that wasn't a major concern but it's nice that it is inexpensive. The prices of different enzymes can vary as much as a hundred fold. This is one of the less inexpensive enzymes. And that's mainly due to the ease with which it can be isolated and manufactured. Another consideration was that it would be compatible with the regions of DNA that we wanted to analyze. If we picked five hypervariable regions on the chromosomes, HAE III has to be an enzyme that will recognize differences at those regions. So we had to match the hypervariables regions to an enzyme. Another consideration was, how will this enzyme perform with forensic samples, samples that aren't of pristine quality that we find in a normal clinical lab. Some enzymes are very sensitive to contaminating elements, dirt, pH changes, things like that that you can't always control with forensic samples because you don't know an awful lot about how the sample has been treated in the past. This enzyme

works over a wide range of temperatures, a wide range of salt conditions, it's a very hearty enzyme and it's very difficult to inhibit this enzyme. It's a very robust enzyme for the task. That's some of the criteria that we base that decision on.

Q. Thank you, doctor.

THE COURT: Just before you leave that and I hope you don't mind me butting in here with an odd question --

MR. WALSH: Not at all.

THE COURT: -- now and again, what about England and some other jurisdictions like that, do they use HAE III or do they use something else and why?

WITNESS: That's a good question. The European community as I mentioned before, they started before us, they committed to a different enzyme before the North American labs made this decision, they committed to enzyme called HINF 1, recognized as a different site and instead of GG CC, it cuts every time it sees G A and then the third base can be anything, say, G A N, it could be G A T or C. So it's G A N T C, that's its site, it's a five base recognition site. They made that decision as a forensic community prior to these studies being done. And we felt no obligation, they had their reasons for their decisions. They again worked with the regions that they chose to analyze. It worked well with Jeffrey's

fingerprinting technique. He was the one who literally taught those labs in the beginning and transferred the technology to them. So they adopted his enzyme. Again, it's inexpensive and it works certainly well with forensic samples. It's not as robust an enzyme as this enzyme. In North America we didn't feel a compelling need to be -- for our system to be compatible with Europe and the rest of the world. We wanted to have a unified system in North America and that was the focus of the working group.

Q. Just for the stenographer, doctor, would you spell that last enzyme, the one that they use in England?

A. HINF I.

Q. Thank you, doctor. Do you have anything further, doctor, with respect to the digestion of DNA?

A. No.

Q. Would you tell us, please, what would be the next step that you would follow after the DNA has been digested and you've checked to see whether or not it worked, the digestion worked properly?

A. The next step is you have to have a way to measure the distance between these restriction sites. If one individual distance between these HAE III sites have that region on, say, chromosome 1 is this distance and in another individual it's twice that distance, I have to have a way of measuring the distance between those sites, determining how large the fragment is that I'm interested in.

Q. At this time, doctor, you've put another slide up, I'm going to ask you to look at the paper I have in my hand and tell me whether or not it's an accurate description of what's on the screen?

A. Yes, it is.

MR. WALSH: I would ask that that be marked, it's entitled, «The Sieving Properties of an Electrophoretic Agarose Gel».

THE COURT: VD-37.

Q. Doctor, if you want to have an opportunity to take a glass of your water, feel free.

THE COURT: I had in mind we would go until what about a quarter past three, that gives you quite a long haul, doctor. Do you want to break before that or do you need to --
What did you have in mind this afternoon, timing?

MR. WALSH: Well, my lord, I would at least -- I'm hoping against hope to be able to get through a large part of the teaching of the -- explaining the process. I'm hoping to get as far down through the steps as I possibly can.

THE COURT: But do you see finishing with this witness this afternoon?

MR. WALSH: No.

THE COURT: On your direct that is?

MR. WALSH: No, my lord, I'm -- well, I don't think so.

THE COURT: What time, do you suggest, it's -- he's been on his feet for an hour and a half now.

MR. WALSH: Excuse me, my lord.

THE COURT: He's been going for an hour and a half now.

MR. WALSH: 3:15 is fine, my lord.

THE COURT: 3:15, we'll take fifteen minutes off then and then we'll carry on for another two or three hours.

MR. WALSH: That's fine, thank you, my lord.

Q. All right, doctor, after you've digested it and you've determined whether or not the digestion has worked and assuming it has worked, what would you do next?

A. I have all of these fragments from the long DNA molecule and they are all of different sizes. You have to have some way of organizing them from largest to smallest and putting them in and categorizing them by sizes, just a cartoon oversimplification of how you would separate or organize all those thousands of fragments into -- according to their size. Here we have a large fragment, a smaller fragment, a fragment that's even still smaller. And this just shows, it's a schematic of this agarose gel that you would use to analyze the length of the fragments showing that the smaller fragments, if you had all the fragments located at the top of the gel and you turned on -- you put them under the influence of an electric current, the fragments would migrate and the smaller ones would migrate fastest because there would be the least resistance from the pores of the gel. The medium

ones, well, they bounce off the pores and they take a little longer, they migrate a little slower, and the larger ones would have the hardest time getting through this maze of pores from one end to the other. If you run this for a set period of time, a number of hours and then turn off the current, these migrate at the fastest rate, so they will have travelled the furtherest, these migrate because they are a little larger at somewhat slower rate and the slowest rate for the largest fragments. So at the end of the time that you had this current applied, these fragments don't go very far and they will remain near the origin where you started the test, and the smaller ones will be located in a progressive gradient down to the smallest size fragments that have gone the furtherest. So now you've got all your DNA fragments organized according to their size or their length.

Q. All right, doctor, perhaps at this time if you would, would you describe for the Court what an agarose gel is, so we can have a picture in our mind what it is and I am going to ask you to describe how you would put DNA into an agarose gel and from different samples?

A. It's a flat sheet of a jelly like material that has pores in it. So if you can imagine something about the size of an 8 x 10 piece of paper, yet it has, say, the thickness of a pad of paper,

and it's composed of this jelly like material with pores in it. That's essentially what we are dealing with a sheet of this. At one end of that sheet you'll have depressions in the surface of that slab of jelly and in those depressions you load your DNA sample, you apply your DNA sample. Once all the samples are applied so they're all at the starting gate, if you will --

Q. Are they put in each -- a separate DNA sample in each depression?

A. Yes, each sample goes in a separate depression, so you don't mix the samples all up.

Q. And those depressions represent lanes in the gel?

A. Yes, those will be their starting lanes, if you can envision a track race each runner starts in his own lane and they all start at the same position.

Q. And that is the DNA from each separate sample that you want to test?

A. Yes. And then you apply the current or analogis to the track race, to the starter's gun and they will run at different rates according to their size. If it was a track race they would run according to their physical fitness and their running ability. In this case it's the size of the fragment. At the end of the race if they should stop the race, the one who runs the fastest will have gone the furtherest from the starting line. The one who runs the slowest will be the closest to the starting line. And

with the case with DNA, the largest fragments will have gone the shortest distance from the initial starting post. And you can tell, you can correlate how far they've migrated to their size.

Q. Okay, doctor, at this point, if you perhaps could tell us in the RFLP typing process, what items would you normally put in, if you wanted to run a test on a gel, what items would actually go in those separate lanes?

A. The one thing that's essential are running DNA fragments of known size, we call these marker fragments. If you have a number of fragments of known size and you apply them in one of these lanes at the end of the test, you can say, well, a fragment of a hundred base pairs migrated ten centimeters. A fragment of three hundred base pairs migrated eight centimeters. A fragment of one thousand base pairs only migrated one centimeter. So this gives you a ruler at the end that you can compare how far the different fragments migrated and say, well, this migrated approximately the same as this known fragment of three hundred base pairs.

Q. Apart from a marker -- this is known DNA that is put in a --

A. DNA have known sizes.

Q. Known sizes and it's put into one -- or how many lanes would it normally be put into?

A. Multiple lanes, so you can determine that rate of migration across the width of the gel or across all of the lanes.

Q. What, if any, limitations is there with respect to the number of lanes that you have on a gel?

A. Well, depending on the width of the gel, there's a limited number of depressions that you can make in the gel, generally, the system that we were using at the R.C.M.P. when I was there the maximum number of lanes in a gel system we had was twenty two. So you could load twenty two different samples out for analysis.

Q. Apart from the known DNA fragments of known size, what other types of things would you actually load into these lanes in a gel before you ran a test or at the commencement of the test?

A. The only other thing that you run with each of the tests of, say, unknown DNA's that you're testing, you run DNA's of known individuals and in the R.C.M.P. system we ran a known female DNA and a known male DNA as part of every test.

Q. And they were would be separately put in separate lanes?

A. Yes.

Q. And apart from your molecular weight markers, your markers and your known DNA, a male and a female, what other substances would actually be loaded in from a forensic case?

A. From a forensic case you load the known and the unknown samples pertinent to a particular case. If you have blood standard from an accused individual and have blood stain from a crime sceen you load those DNA's on the same gel in different lanes.

Q. What, if any, precautions, doctor, are taken with respect to the amounts of DNA that are actually put in each lane?

A. Well, you know from test gels initially how much DNA you have to work with and you know how much DNA you can run in each gel. There's a finite volume of fluid that you can put in each of these wells because they are -- they have fixed dimensions. So that's a limiting factor. And the other factor is that you can't analyze too much DNA in each lane. Those are things that you know when you make judgments, depending on each sample.

Q. And after they're loaded into -- just so I understand, doctor, after you load these samples into the wells, into the lanes, you apply a current to them?

A. Yes.

Q. So I take the current goes from what -- positive-- from negative to positive?

A. Yes.

Q. So the lanes, the top where you load them would be at the negative end of the gel?

A. Right.

Q. Then, what, if anything, what if any controls are used to determine whether or not the electrophoresis was correctly done?

A. At the end of the entire procedure the gel can be stained, there's stain that you can immerse the gel in, that's stained DNA. So you can

actually look at the gel and visualize the DNA fragments that were separated.

Q. What is this stain called?

A. Ethidium bromide.

Q. Is there anything that's loaded in at the outset with the samples?

A. Yes, the sample is loaded with a dye, and the dye is -- the dye serves a couple of purposes when you load the gel your sample has to fall into it and you can see it in the well, the second purpose is that a dye will migrate with the current as well, and you know how fast the dye itself migrates through the gel. So at the end of the procedure you know how far the dye should have migrated.

THE COURT: When you say, can see, you're not talking about --

WITNESS: Visually with your eyes.

THE COURT: With your eyes?

WITNESS: Yes.

THE COURT: Not through a microscope?

WITNESS: No, with your eyes. At the end of the procedure the blue dye is coloured blue and you will see it at the end of the gel and not at the beginning. And that's there, for instance, these procedures you generally put the DNA in the gel, turn on the power and go home and in the morning the test is done. So if there, say, a power failure overnight the dye wouldn't have migrated to the bottom and you will have known that at some point during the night, the power probably went off.

THE COURT: But are these quantities of DNA that you put in the slots, in your gel or the troughs in your gel, are they such in size that you can do it manually with your own eyes?

WITNESS: They're small volumes but they're called micro pipe hats, they're called, they're just little syringe like thing.

THE COURT: An eye dropper or syringe type thing.

WITNESS: That you can suck up the material and then apply it in the well.

Q. Are special precautions taken in actually loading items into the well?

A. Yes.

Q. What kind of precautions are taken?

A. Well, you don't want to load the same sample overload the sample, like put too much sample in a well so it will leak over the sides and into the adjacent well, because now you're analyzing samples and the wells that they shouldn't be in, things like that.

MR. WALSH: Perhaps, I just have a couple more questions, my lord, if I may and we could break, if that's agreeable.

THE COURT: Okay.

Q. Doctor, you mentioned ethidium bromide, and now you've talked about this dye or loading dye, where does ethidium bromide come into it, when do you apply it and why do you apply it?

A. After the DNA molecules have been separated through the gel and you want to visualize how those molecules were separated. You simply take

the gel, immerse in a solution of this dye, ethidium bromide. Ethidium bromide goes into the gel, where there's DNA in those lanes, the dye will actually go in between the strands and bind to the DNA. And the binding of the dye to the DNA, if you shine ultraviolet light on that gel then DNA will glow, it will give off a fluorescence that you can see visually. And then you can tell that, yes, there is DNA in each of those lanes. You can tell that yes, it migrated as I would expect a normal digest of human DNA to migrate. Again, it's a visual check that the electrophoresis worked and that it's given you the expected result.

Q. Does the R.C.M.P. lab, the application of the ethidium bromide, is that something that's used in all the labs or is there any variation?

A. Ethidium bromide is dye that's been used for years again in all applications of DNA. Technology could look at DNA at various steps in the procedure. It can be used in different ways, you can add the dye to the gel at the beginning of the separation process and the DNA will be stained as it migrates, that's one way you can do it.

Q. Now, this is separate from the tracking dye or the loading dye?

A. Correct, you add it as part of the gel. So the gel itself contains a certain percentage of this dye and as the DNA molecules migrate through the gel, it picks up the dye and at the end of the

procedure the next morning, the DNA is already stained, that's one way you can do it.

Another way you can do it is the way we do it at the R.C.M.P., at the end of the procedure you add dye to the gel and stain the DNA that way.

Q. And why did you adopt that particular procedure after electrophoresis as opposed to before?

A. The initial reasons had very little to do with technical concerns, it was more safety concerns. This dye is a carcinogen, it causes cancer, it mutates cells including humans. It's a dangerous chemical to work with. That being the case, it's also hard to dispose of this chemical. So you want to use this chemical in very small amounts. So it's easy to stain the gel afterwards with a small amount of this chemical, rather than use large amounts of it in your gel and in all the buffers that are used in the separation procedure So it keeps down the volumes of a very hazardous chemical. It keeps the chemical away from all of your equipment. So it's a more safety concern than a technical concern initially.

Q. That's initially, what, if anything, has occurred since though the initial technical concern?

A. It came to the attention through the working--through the technical working group that we have with DNA methods, some of the labs were analyzing their DNA by having the dye incorporated in the gel throughout the procedure. And what we found and the concern that they expressed was that

sometimes DNA didn't migrate through, that is if you analyzed a lot of DNA, versus a small amount of DNA, it wouldn't migrate according to its precise size. That it didn't migrate in an accurate fashion. And there had been previous literature, old scientific literature that stated the separation of DNA in the presence of this DNA can alter its mobility in the gel.

Q. This is ethidium bromide?

A. Yes, and that wasn't a new observation, it was an old observation. And since the forensic application of this technique hinges on the DNA molecule migrating in a reliable and reproducible manner that's dependent on the size of the fragment and not other factors, like the amount that you're analyzing, this is not a desirable feature of having ethidium bromide in the gel and having it exert that effect on the mobility wouldn't be desired. So we initiated a study at that point to determine whether the presence of ethidium bromide at the beginning of this process could lead to erroneous results, applying this technology to forensics.

Q. Doctor, did you publish anything with respect to your results?

A. Yes.

Q. I'll show you this document here, would you look at it for me, please and tell me what it is and if it represents that publication?

A. It's a paper and myself and Dr. Fourney, another member of the R.C.M.P. lab published in a journal called, Applied and Theoretical Electrophoresis, this is a journal that's devoted to the technology of separated molecules through this type of gel, and it was published in 1990.

Q. And what's the title of paper?

A. «AGAROSE GEL ELECTROPHORESIS OF LINEAR GENOMIC DNA IN THE PRESENCE OF ETHIDIUM BROMIDE: BAND SHIFTING AND IMPLICATIONS FOR FORENSIC IDENTITY TESTING».

Q. And you are one of the authors of that paper?

A. Yes.

Q. And as a result of that study you've decided to do what with ethidium bromide?

A. We decided to continue doing things the way we were excluding the ethidium bromide from the beginning of the process and staining at the end of the process, because that gave the most accurate results.

MR. WALSH: I would ask that that paper be marked on the voir dire, my lord.

THE COURT: VD-38.

MR. WALSH: Perhaps, my lord, it might be appropriate to take our break.

THE COURT: Just one question there, what do other jurisdictions use, do the FBI do this or the Americans?

WITNESS: At the time we initiated that study a lot of labs were actually incorporating it at the beginning of the procedure. We presented this work to the working group, all of the State labs that were doing it at the beginning of the procedure dropped that procedure and started doing the staining at the end. The exception of that, the FBI lab still stains at the beginning, they did not change.

THE COURT: We will break there for fifteen minutes.

COURT RECESSES FOR 15 MINUTES AT 3:20

COURT RESUMES AT 3:45

ALL COUNSEL PRESENT

ACCUSED PRESENT

MR. WALSH: My lord, if we can continue.

THE COURT: Sure, if you change your mind about wanting a chair there, Dr. Waye, shout out.

DR. JOHN WAYE, still under oath, continued to testify:

DIRECT EXAMINATION CONTINUED BY MR. WALSH:

Q. Doctor, we had left your point that we had stopped at the break, we had just introduced a published paper into evidence on the Agarose Gel Electrophoresis of Linear Genomic DNA in the Presence of Ethidium Bromide, is that paper circulated, published and circulated within the scientific community?

A. Yes.

Q. His lordship had asked you a question and you had testified with respect to -- for example, a difference in the digesting enzyme used, for

example, in England, by some of the labs in England and by the R.C.M.P. lab in particular, does that in any way invalid either system or in any way a critical difference in the RFLP technique?

A. If you wanted the systems to be comparable as if you did an analysis in England and you wanted to try to match it to a sample you analyzed in North America, you couldn't compare those results directly to each other unless you used the same loci and the same enzyme. But other than that, the results generated in England are perfectly valid results, generated in North America are perfectly valid, you just can't compare them to each other. That's the only consequence of using a different system.

Q. Doctor, is the -- again, I'll be careful the way I phrase this, I would like your opinion, doctor with respect to the reasonable reliability of gel electrophoresis of human DNA including ethidium bromide staining after electrophoresis but before transfer, could you give me an opinion on that in terms of its reasonable reliability?

A. Again, gel electrophoresis is a routine technique used throughout molecular biology and the practice of staining with ethidium bromide after electrophoresis rather than before electrophoresis is scientifically recognized proper way to do the procedure. And that's been known for many years, long before forensics every came into the picture, it is reliable, it is accepted and it is widely used.

Q. For forensic purposes?

A. Yes, as well as other applications.

Q. Fine, and your opinion in relation to its scientific acceptance in the forensic community, that would cover, your answer would cover that opinion as well?

A. The use of electrophoresis, yes, adopted by forensic communities of course.

Q. And the staining of ethidium bromide at the end of the electrophoresis?

A. Yes, it's recognized as one of the two ways in which it can be done. And I think the majority of the labs recognize it as the better of the two ways.

Q. Doctor, what -- unless you have something further on the electrophoresis, if not, I'll ask if you would move to the next step that you would do in the RFLP technique? Doctor, you've put another slide up, I'm going to ask you to look at this paper document I have, is this an accurate depiction of what's on the slide?

A. Yes.

MR. WALSH: I would ask that that be entered on the voir dire, my lord.

THE COURT: VD-39.

MR. WALSH: It's entitled, «Appearance of DNA Fragments on X-Ray Film».

Q. Doctor, I would ask you either to explain the next process in the process and/or the significance of the slide that you presently have up on the screen?

A. This slide effectively jumps to the end of the procedure. You've separated the fragments out perhaps loading them into a slot, if you can consider the word, Appearance to be a slot at one end of the gel, applying a current at this end of the gel and having the fragments migrate in this direction. The large fragment would migrate a short distance from the slot, the smaller fragments would migrate further from the origin or the slot that you loaded it in. And that's the way it would appear in the lanes at the end of the procedure. If you could identify these fragments somehow by perhaps making them radioactive and placing x-ray film on them, the end result of the procedure is that you would have detected two fragments, one large and one small and you can distinguish them from each other. And that's the visual impression you're left with at the end of the test.

Q. Would you tell us, doctor, please, if you could the next step after electrophoresis, after you've stained with ethidium bromide, the ethidium bromide that you've previously testified entitles you to do a number of things to determine if the electrophoresis was correctly done, am I right?

A. Yes, it's a visual check that the electrophoresis or the separation worked. It again verifies something you already knew that the restriction enzyme had cut the DNA into smaller fragments, and that the lanes ran straight and all the lanes

ran properly, it's a visual check.

Q. Doctor, maybe we can leave that just so that perhaps to clarify, I know that you've put that slide on just to give an advanced warning of what you would expect to see, but it says, Large Fragment and Small Fragment on that schematic, yet the fragments shown are of the same length, could you explain that, please?

A. Yes, if we had a slot that was, say, perhaps the size of the word, Appearance here and you loaded all your DNA in that slot and separate it, you're not separating out the molecules as a long bar like this, what you are doing is you're separating out thousands of DNA molecules all of which are too small to even see, and they all as a whole fill this slot. So at the end of the procedure you have thousands of DNA molecules all the same size and they would effectively have the same shape as the slot the same dimensions as the slot, they'd just be moved down.

THE COURT: Okay, when you say appearance, are you talking about visual appearance or micro-- or appearance through a microscope or --

WITNESS: You can't see the DNA molecules.

THE COURT: You can't see them?

WITNESS: No. When you stain it, you can see it but you -- this wouldn't be the beginning of the molecule and this the end of the molecule, that would be the end of one DNA molecule and

there'd be hundred and thousands of DNA molecules and there'd be the end of another one over here and they're all intertwined around each other, they just all migrate to the same spot. And you look at them collectively, all the -- we call these bands, they all look like the same dimensions because the starting well is one dimension.

Q. All right, doctor, I am going to ask you to continue, please, after the electrophoresis and after ethidium bromide staining and after you've determined that in your opinion whether or not the electrophoresis process had worked properly, what would you do next?

A. Okay, this is a slide that we've already seen before, showing the beginning of this process.

Q. Perhaps, before we go, doctor, I am going to ask to have that mentioned on the record.

THE COURT: VD-30, I believe.

Q. You have VD-30 on the screen, continue, doctor?

A. So we've cut the DNA into pieces of varying sizes, loaded them into slots and here I've shown a gel looking down on the surface of one of these gels and you have three slots in this particular gel, located here, here and here. The third slot, these are the markers or standards or the ruler that I described before, these would be fragments, a mixture of different fragments of known size, you'll have pure fragments of large size and pure fragments of small size, and various sizes in between. You

load those as a mixture in one lane and that at the end of the procedure we'll provide you with a ruler, you know how big this one is, you know how big this one is, et cetera, et cetera, like the gradients on a ruler at the end of the procedure to determine how big the fragments are. The rest of the DNA, sample B, sample A you load in separate lanes, so all of the DNA fragments and you turn on -- turn on the current and they will migrate at rates according to their size. You got to remember there's many, many thousands of fragments. So at the end of the procedure you really don't see them all stacked up according to size, what you see is a smear. Virtually every spot along this whole length will have fragments of different sizes, very small ones down here, very large ones up here and that's shown over here, at the end of the procedure you have large fragments closest to the origin, smaller ones down at the bottom and a continuous gradient of fragment sizes in between.

Now, this has no features that I can use to distinguish sample A from sample B, other than I can tell that there's DNA in these lanes because it's a -- when you stain with ethidium bromide at the end, it's a glowing smear of DNA. So there's nothing that I can tell just looking at this glowing smear that will tell me that sample A or sample B could or couldn't have come from the same individual at this point.

And we are left with a further dilemma that we have all this DNA separated in an orderly fashion but it's in a very flimsy jello-like material. And if you can imagine a slab of jello, perhaps the thickness of a pad of note paper and it's very flimsy material, it can dehydrate and dry out, it will crack, it's not a permanent separation of these fragments, it's not a very good matrix or material to work with in subsequent tests. So what is done at that point, if I can show you the slab of gel here with all fragments separated out is we lay a nylon membrane, this is of the same dimensions of the gel, it's a thin nylon membrane, like a piece of paper but it's made of nylon. You can pull and tug on it and fold it up and it won't rip. You lay that on the surface of the gel and the DNA you push fluid through the gel and the DNA migrates with the fluid on to the surface of the membrane. So now you've taken all these fragments that are separated and you've transferred them on to the surface of a nylon membrane. And they stick in their positions where they were separated, and now they're on a permanent nylon membrane which isn't going to degrade over time and you can analyze this year, next or ten years from now.

Q. What is this transfer process called?

A. It's the Southern transfer method.

Q. And how accepted is that in the scientific community?

A. It was developed in 1975 and it's been used again in all walks of molecular biology since that time. In fact, it's one of the most widely cited methods in biology.

Q. Is that -- Southern transfer is that named after anybody in particular?

A. That refers to the person first described as simply the procedure of taking the gel and transferring the DNA on to a membrane, his name was Ed Southern.

Q. And the reason for the transfer from the gel to the membrane?

A. So you can create a permanent record of the fragments that you've separated by electrophoresis.

Q. Which is easier to work with the membrane or the gel?

A. Oh, the membrane.

Q. Do you do anything in the actual transfer process, do you do anything other than transfer your DNA fragments from the gel to the membrane, do you do anything to the actual fragments themselves?

A. Yes, either just prior to transfer or all during the transfer procedure, you separate the strands of the DNA molecules.

Q. Is that that denaturization you were talking about?

A. Denaturization, yes. See, all these fragments that you've separated they're in their double stranded form. Before you transfer them to the membrane you simply immerse the entire gel in a

solution that's alkaline or high pH. What that does is it breaks the bonds between the strands, you still have the DNA fragments in the same position but now they're single stranded and they're not in that double helix form any more.

Q. Just so we refresh our memory, doctor and to see if I'm correct, what you're in fact doing, as you've described before you're separating the bonds between A and T and G and C all down through the molecule.

A. Correct.

Q. Fine.

A. You denature the molecule, it's in a single stranded form but it's still separated from the largest to the smallest as it was on the gel, it's just now in a single stranded form and those single stranded molecules you move out of the gel on to the membrane, yet because the membrane is placed flush against the gel they transfer to the same position that they've migrated to. So you have the single stranded DNA molecules bound to the surface of a membrane, so it's a permanent, they're there to be analyzed at any point.

Q. Doctor, could I have your opinion please as to reason -- your opinion as to the reasonable reliability of denaturization and Southern transfer as used for forensic purposes in this type of test?

A. They're reliable for all sorts of application in molecular biology, forensics just being one of them, it's a very reliable technique.

Q. And in your opinion in relation to its scientific acceptance, its acceptance generally in the scientific community for forensic purposes?

A. It's accepted throughout molecular biology for all sorts of uses, forensic being one of them.

Q. Continue, doctor.

A. So, again, you have all the fragments separated out, they're single stranded and now, they're placed on a membrane so you have a permanent record of those fragments. You still have no features on that membrane which by eye you can distinguish Sample A from Sample B.

Q. Okay, doctor, you've put another slide up on the screen, I am going to ask you to look at the paper reproduction I have here and ask you -- can you tell me whether or not that is an accurate depiction of what's on the screen?

A. It is.

MR. WALSH: My lord, if I could have this entered, please.

THE COURT: Have you a title for this, Mr. Walsh?

MR. WALSH: My lord, this would be the second part of the DNA typing test, if I could see what number that was.

THE COURT: VD-30, this follows on after --

MR. WALSH: This would be the second part of VD-30.

THE COURT: And this would be VD-40.

Q. Doctor, I take it you are going to move to another step in the RFLP procedure?

A. Yes.

Q. Please, doctor, continue.

A. Remember there's -- in each of these samples there'll be thousands of samples, you've separated them according to size and now you denature them so they're single stranded. So you have them organized in that fashion, now, you want to look at fragments that coincide to one particular region on a chromosome. So you'll want to be looking at specific fragments from specific areas of interest, a hypervariable or a polymorphic region. And the way we do that, I explained a long time ago, once you have them, once you have the fragments denatured, you can detect specific fragments by synthesizing or obtaining short pieces of DNA which are complementary to the sequence that you want to identify. These are called probes and it's just a DNA molecule that's single stranded and you've labelled it some way so you can detect its presence. At the R.C.M.P. labs and throughout research a common way to label or tag these probe pieces of DNA is to make them radioactive. And we can follow radioactivity in the lab, the presence of radioactivity. So you have a piece of DNA which is complementary to the fragments of all these thousands that you want to analyze.

Q. Now, doctor, this DNA you did not obtain from the samples, this is something that you've actually prepared yourself?

A. Yes, this is a laboratory agent, this is a lab chemical that you'll use in the test. You purchase it from a company, it has nothing to do with the questioned or the known samples.

Q. Have you any experience in actally preparing -- excuse me, have you any experience with probes particularly in their preparation or in their use?

A. Yes, I have.

Q. Have you developed any probes yourself?

A. Yes, I've isolated probes, human DNA probes, animal DNA probes.

Q. Human DNA probes are they used -- have they been picked by anyone in terms of use in other -- for other purposes or for forensic purposes?

A. Yes, a lot of the probes have been use to map diseased genes. That is if you have -- you've characterized a piece of DNA from, for instance, one of the ones that comes to mind, a piece of DNA that I characterized for Chromosome 17. The piece of DNA happened to lie very close to a gene for neurofibromatosis, a genetic disease, it was used in that fashion by other researchers to map that disease and find the gene and the defect that causes that disease.

Q. You would use a probe or develop a probe for a particular area of the chromosome you want to look at?

A. Yes.

Q. So it would be used not only in forensics, in medical research and in medical diagnostics and in research?

A. Yes.

Q. And what kind of probes have you actually developed, doctor, yourself?

A. Many different types of probes, probes that are polymorphic, some that aren't, some that are structural elements of chromosomes, others that are variable regions of chromosomes that have no structural or no obvious function, different pieces of DNA.

Q. Are any of the probes that you've developed are they used in the RFLP procedure by the R.C.M.P. or by any other labs?

A. Two of the probes that I developed are used in the R.C.M.P. lab.

Q. And what would those probes be?

A. The initial probe to determine whether the DNA is human or not was a probe that I developed as a graduate student. The constant marker probe, I alluded to it earlier, a region that's the same in all individuals, that you use as a control from Chromosome 7, I developed that again as a graduate student.

Q. Are those probes used by any other labs?

A. Forensically they're used by a number of different labs for those same purposes.

Q. Have you written with respect to cloning, excuse me, have you written with respect to the cloning

of probes or the preparation of probes and the technology associated with probes?

A. Yes.

Q. I am going to show you this document, doctor, would you tell me what it is?

A. This is a paper that was published in the proceedings of a meeting that took place at the FBI Academy in Quantico, Virginia in 1989 and the Symposium, it was called an International Symposium on the Forensic Aspects of DNA Analysis, and the paper I presented and the manuscript that was eventually published is called, Cloning and recombinant DNA technologies for the development of hybridization probes.

Q. Why did you prepare that paper and at whose request did you prepare that paper?

A. I was invited to contribute that paper by the FBI. The purpose of that meeting was forensic investigators from around the world were coming to that meeting to learn about DNA and the FBI thought that we could cover a lot of the basics about probes, about DNA structure, about DNA variability, all the grass roots' issues, all the basic issues concerning the technology and this is one of the areas that I have expertise in and they asked me to prepare a paper on that.

Q. And what year would that have been published approximately?

A. It was presented in 1989 and I just received from the publisher the final proceedings book about a month ago.

Q. This is noted to be a final draft, does this reflect what's in the final product that you received a month ago?

A. I believe so.

MR. WALSH: I would ask to have this entered as an item, my lord.

THE COURT: VD-41.

MR. WALSH: Yes, my lord.

THE COURT: You've given copies of these to Mr. Furlotte?

MR. WALSH: Yes, my lord, notice in advance of all these papers that I've -- that I was intending to produce and the schematics as well. I'm not saying that there may not be some that we'll -- through these proceedings I might not have had opportunity to provide Mr. Furlotte but if any --

MR. FURLOTTE: I don't have all the schematics but I'll get them after.

MR. WALSH: I'm surprised about that.

THE COURT: If there's anything that you haven't got, I'm not asking you each time if you want to see these before they're marked but shout out if you do.

Q. All right, continue, doctor, we are dealing with probes, I just wanted to determine your background with respect to probes, continue, please, the use of probes in the RFLP procedure?

A. The use of the probe is called a hybridization reaction, and it's a long word for a simple process. What you want to do is introduce the probe to the membrane surface where your target

DNA is, where the sample DNA's are and if the probe matches a region that it's complementary to, it will hybridize, it will form a hybrid, you have target DNA and probe DNA and it's called a hybrid, a hybrid duplex molecule. So the procedure is called hybridization. But effectively what it is is the probe, you put in a solution, I have it in a tray here, so you have a solution containing a radioactive probe, you put your membrane in that solution and you incubate it for a set period of time. During that time the probe will cover the whole membrane and it will form those complementary bonds with the target sequence that it's complementary to, and actually stick to the target DNA, fragments that you're interested in.

So now if I can go to the membrane here. We've got sample lanes 1 or where Sample A and Sample B were, you have thousands of fragments all in their single stranded forms here. The probe is only recognizing two different fragment sizes in each of the samples, that's because, remember, we are dealing with hypervariable DNA. So in your DNA chances are you are going to have two different fragment lengths, one inherited from your mother and one inherited from your father. Now, the probe will detect that you've inherited this fragment from your mother and this fragment from your father or vice versus, you can't tell by looking at this.

And for the second individual a different fragment length from mother or father or vice versa. But what you do is, you now have radioactivity on the fragment sizes that correspond to that one particular region of the DNA that you are interested in.

Q. Doctor, the probe is the complementary section of the DNA that you wish to fix on your sample, will it actually fix on the identical sequence, as complementary strand or are there any conditions that are required before it will fix identically?

A. It will bind to sequences that are identical or close to identical or have close to identical sequences, it will also bind to sequences which are somewhat similar to it as well. It will also bind where there's no DNA on the membrane, it will just sit on the membrane. Remember, you've immersed the entire membrane in this radioactive soup.

Q. So what do you do as a result -- what would you do to make sure that the probe only was binding or only did in fact bind to an identical sequence, its complementary sequence?

A. Or a sequence that's very close to identical -- what you do is you wash the membrane and you wash the membrane under high temperature and low salt conditions and under those conditions, we know from theoretical and empirical studies that the probe will only bind then to sequences which are identical or near identical.

Q. In the development of the probe, is there a difference between a cloned probed and a synthetic probe?

A. Yes.

Q. What is the difference and what do the R.C.M.P. use and why?

A. Probes can be of two types, if you know a sequence or if you know the actual nucleui sequence or the order of the bases that you want to detect you can write out that sequence, send it off to a company and they have machines that will synthesize DNA molecules of the sequence that you desire, called a snythetic probe.

The other type of probe is called a cloned probe. What a clone probe is, is you take a piece of DNA and then you isolate it from a human cell, a piece of DNA you are interested in. You introduce that piece of DNA into a bacterial cell or some other non-human host cell that you can grow much like they grow organisms that make antibiotics and other things, you can grow them in large batches and break open the bacterial cell, the bacterial cell will produce copies, millions and millions of copies of your human piece of DNA and you can use that as a probe. There's two different ways you can do it, a synthetic probe or an actual piece of human DNA, and that result is pretty much the same.

Q. And what do the R.C.M.P. used cloned or synthetic?

A. Cloned probes.

Q. And doctor, do we know anything about the polymorphic region of the DNA identified by the probes or the probes are attempting to identify?

A. Well, the previous characterizations, again, these are not done generally by forensic labs but they're done by the genetics community, they identify how many different types or what degree of variation you can expect in the population at a particular area and the types of variation that a probe will detect. Those things are known. The sizes of the fragment, the ranges of sizes of fragments that a probe will detect, those things are usually known before you use a probe.

Q. Are they recorded anywhere, when you say, known, how would you actually -- if you wanted to find out what a particular probe will identify, what chromosome, what polymorphic areas of the chromosome, where would you go to find that information out?

A. Again, internationally there's been in existence for quite a number of years now an organization called Human Gene Mapping Committee. And it's an international group that meets every year and every other year they have a major convention and if you have a piece of DNA that you've characterized, you can enter it into their library for other researchers to characterize. Everything that's known about the piece of DNA is published in this large phone book type of document, every other year they publish this

large document and you can go to Chromosome 1 and if somebody says, well, this probe recognizes D1S7, well, you flip to Chromosome 1, you look to at D1S7, it will tell you which enzymes will detect polymorphisms, how much variability there is in the population, it will often give you frequencies of the different forms in the population and cite all the publications relevant to that region of the chromosome.

Q. Where is this library?

A. It's maintained, it's published in the Journal every other year, Cited Genetics and Cell Genetics. The library itself, additions to it and the information et cetera is published by the Yale Gene Mapping Library.

Q. At Yale University?

A. Yes.

Q. And who is the head of that particular library?

A. Dr. Ken Kidd.

Q. And this committee, this is formed, this is a committee that meets regularly?

A. Yes, there will be committees and subcommittees for each chromosome and subcommittees for diseases on particular chromosomes, it has to do with every piece of DNA in the human body. So there's many subcommittees and subspecialties under the umbrella of the human gene mapping.

Q. Do you mean, doctor, that there would be a committee for one chromosome, like, for example, Chromosome 1, there would be a committee for that?

A. Yes.

Q. And what's the purpose of each of those -- and that's a committee for each of the chromosomes up to forty six?

A. Up to twenty three, the two sets.

Q. The twenty three, the two sets?

A. Twenty two and the two sets.

Q. Okay, and in this particular -- these committees, what is their actual purpose, what are they attempting to do, these subcommittees?

A. They're goal is to isolate as many pieces of DNA from the human cell to find exactly where there are in the chromosomes and literally have a map point from one end to the other end of the chromosome. And once you have that type of information, if you're interested in a genetic disease, all you have to do is correlate it with a certain piece of DNA that has already been characterized, correlate the disease with the piece of DNA that's located near the diseased gene and you can find out what the defect, eventually knowing function of all the DNA in the human cell.

Q. Is this library, doctor, is this for information obtained by scientists just in United States or just in North America or how --

A. This is worldwide this effort and the meetings are often held in Europe, they're held throughout the world.

Q. And this library is for worldwide information obtained by scientists?

A. Yes.

Q. Continue, doctor.

A. As I said, the probe will recognize the specific regions that are complementary to the probe. Now, you've literally tagged the fragments of interest with this radioactivity. You still don't have anything visual to look at. We've shown where the radioactivity is with colour here but radioactivity isn't coloured or dark. You can detect it with a guider counter, that will make noise or you can signal on a meter. But you still don't have anything visual to look at. The way we create a visual image of where the radioactivity is on a membrane is we simply overlay on top of the membrane a piece of x-ray film. This is common x-ray film, if you broke your arm and went to the hospital, they'd use a similar type of x-ray film. And you leave it on there for a certain period of time, hours to days, during which time the radioactivity that's on the membrane will come in contact with the film and will react to the surface of the film and when you develop that x-ray film, now, you have dark, we call them bands or fragments on the x-ray film, something you can look at, images on the x-ray film. And that's the final product.

Q. The location of those bands on the x-ray film is a product of what?

A. It correlates with the size of those fragments.

Q. How far they've travelled?

A. Correct. Again, going back to the gel initially,

that would be the origin of the separation. This would be the largest fragment, the second largest, the third largest, the fourth largest.

Q. And each pair of bands represents a separate lane?

A. Correct, this would be where Sample A was analyzed, where Sample B was analyzed.

Q. Doctor, if we could just for a moment, are there different, we've talked about different kinds of probes, are there probes that will, you've pointed out a probe that will actually look at one particular area. Are there probes that will actually look at a number of areas all at once?

A. Yes.

Q. What is the difference and what are their names, what are they called?

A. They're actually the same type of probes, they're just used under different conditions. Initially, Alec Jeffrey, the person who coined the term, DNA fingerprint, he was using the same type of probe except when he analyzed DNA from a single individual, he didn't get one, two bands per individual, what he got was very complex pattern of thirty to fifty bands. And that's because the condition that he washed the probe in, allowed the probe not only to recognize that it correponded to but also related fragments located on other chromosome.

Q. And that's called what kind of probing?

A. That's called a multilocus approach, as opposed to

a single locus. Here we are looking at one region, if I didn't wash this at high temperature and low salt, the probe would in fact stick -- it would detect these bands, it would also detect a whole series of other bands, so you end up with a very complex pattern. And Dr. Jeffrey's observations were that other than identical twins he couldn't find two individuals that would have the same complex pattern.

Q. Who uses multilocus probing now and who uses single locus probing?

A. In North America I'm not aware of any forensic labs that are using multilocus approaches. In Europe several labs began using the multi-locus approach, to my knowledge most of them have switched to the single locus type of analysis or in the process of switching.

Q. Why is that, doctor?

A. There's several reasons. One is a much more sensitive approach, you can obtain results with smaller amounts of DNA using this approach, that's one of the reasons. Another reason is that if you have a complex pattern consisting of thirty to fifty bands, if your sample that you're starting off with is actually a mixture of DNA from two individuals, you'll have no way of sorting out which of the bands came from which person. If you use an approach that generates two bands for individual, if in fact the material I analyzed in this lane was a mixed sample from A and B, well, I get four bands.

So you have to find expectations in it, it creates a lot more ease in interpreting these results when you are dealing with mixed samples, say, two people raping somebody, and the semen sample you get is a mixture of two accused individuals, which can very well happen in forensic scenarios.

Q. So I take it then, the R.C.M.P. are using single locus probing?

A. Yes, and I -- as this technology catches on, I'd be surprised if any labs would stay with the multilocus approach. It's been the experience that a lot of labs started that way for historical reasons because that was the first approach developed. They since evolved into what people have called the second generation RFLP typing.

Q. Could you tell us, please, doctor, what probes the R.C.M.P. lab use for DNA typing? What probes were selected, perhaps you could give us that answer first, what probes were selected?

A. There's a number of them. There's a probe that detect a locus on Chromosome 1, Chromosome 2, Chromosome 4, Chromosome 10, Chromosome 16 and Chromosome 17. These are the ones that detect the variable regions.

Q. Highly polymorphic regions?

A. Yes.

Q. And what other probes are used in the actual technique?

A. There's a probe that detects sequences that are specific for the Y chromosome. So if your DNA is from a male, you'll get a fragment on the x-ray film. If it's from a female you don't get any result. The other probe you use is a constant band, is a constant or non-polymorphic or a monomorphic region on Chromosome 7. Both females and males have two Chromosome 7's. So all individuals will give the same results. So if I analyzed with that probe, you'd have, say, this band in this individual and the same band in the next individual and if I analyzed every one in this room, I'd get the same result. That's one of the approaches we use as well, because we know what the results should be if everything did work.

Q. Were these probes haphazardly selected or was there any kind of research or study or consideration given as to why you were going to use any particular probe for your technique?

A. Again, as a working group and predominantly, the R.C.M.P. and the FBI at the beginning, we went to the scientific community, identified a large number of candidate regions to look at, looked at a number of different enyzmes and at the end of that study came up with probes or loci to look at that were compatible with the enzyme we thought was the best Hae III, and were compatible with the sizes of our gel, et cetera and formed a system that we could use with one enzyme and one gel system.

Q. Doctor, you've talked about a different probe, you use on Chromosome 1, Chromosome 10, Chromosome 10 and you said that those were probes that identified highly polymorphic areas. Why, then, doctor, would it be important to use a probe that identifies an area the same in everybody, this monomorphic probe you talked about? Why would you use that in the typing test if what your purpose is to try and differentiate?

A. It provides no information as to where a sample came from but the result at the end of the test is something that you can predict. You know that when you -- we know for a fact that when we analyze with D7, D2, the constant region, the fragment we should detect should be 2,731 base pairs in length, we know that. If the test works and it works properly all the individual samples that we analyze should give you a result -- should give you a single fragment and it should be of that size or close to it within reasons of the technology.

Q. What parts of the test does it tell you worked?

A. The entire test, it tells you that the enzyme cut and it cut to completion. It tells you that the transfer worked properly and it tells you that the hybridization at least with respect to that probe worked properly.

Q. What does the term band shifting mean and how does this relate to what we're dealing with here?

A. Band shifting is when a sample either migrates too fast or too slow, it doesn't migrate reliably as a function of the fragment size or the size alone.

Q. When you are doing a test and you have all these probes available to you, is there any particular sequence that the probes are placed in, could you explain to the Court how you would actually go about applying your probes, is there a sequence, is there a particular manner or a method that you would use or order?

A. Well, I think in my experience there is no particular order that I apply the variable probes. I think if you were getting all of your casework in with a regular schedule for logistics you'd probably want to analyze all your casework with one probe and do all that in one week and then move on to your next probe the next week and do it in some sort of reasonable fashion that way. I'm not aware of exactly how they do it in routine casework with the R.C.M.P. which order that or if there is a set order that they run these variables probes. The point is that you do run the variable probes first and you run the controls, the constant probe and the sex typing last.

Q. What, if any, controls would be in place, doctor, to ensure that the probes are, for example, not doing what you believe they're supposed to be doing, for example, whether the probes are contaminated or whether or not they're something wrong with the probe?

A. Okay, you generally purchase these probes from companies. So they send you a tube and they say, that this is a piece of DNA recognizes locus D1S7, that's the particular locus on Chromosome 1 and that's hypervariable. And you basically take it as an article of faith that what you're selling you will detect that region of the chromosome. One way you can check that indeed what they sold you is the correct probe or what your technician took out of the freezer was indeed that vial and not the vial from the next chromosome over. With every one of these gels you run a control DNA, that's a human DNA that you've run over and over and over again with each of the probes and you recognize the pattern will give with that particular probe. So if somebody gave you the wrong probe, either the manufacturer or your lab technician, you won't get the expected result. And you'll know that there's either been a probe mix up from the manufacturer or a probe mix up in your lab, sometimes two probes mixed together and you're analyzing two sequences at the same time. You will be able to tell that by looking at your controls.

Q. Now, when you say, the controls, those are the male and female DNA that you've put in the gels that you've referred to earlier?

A. On each gel you have a male and a female control, and that's done, the reason they have two individuals on each gel controls is to control

for your sex typing. The fact that you don't get a signal, if you use just the female control, the male probe wouldn't give you a result and scientifically it's hard to draw conclusions from a negative result. But if you get a negative result with a female and a positive result with the male, then you can -- the probe has behaved as expected and you know that the sex typing probe worked, say, you include both of those in.

Q. Could you give me your opinion, doctor, as to the reasonable reliability of the use of the probes that you've mentioned in -- for forensics?

A. Again, like all of this RFLP procedure, it's borrowed technology that was in existence for many years, throughout molecular biology, it's reliable for those applications and it's reliable and accepted for forensics.

Q. And your opinion in relation to its acceptance generally in the scientific community?

A. It's accepted.

Q. Doctor, if, again, you were going through the steps and if you apply a probe, if you applied one probe, what would you do after you applied one particular probe, say, for example, I took the probe for the first chromosome and I applied it in the fashion you've described, what would you actually do next?

A. Okay, what I've done, I've generated this result, so I've identified the patterns that these two samples have at that region on Chromosome 1. If I wanted then, to say, well, what do these two

samples look like on Chromosome 2. What I simply do, I take this membrane, I put it in the solution, I heat it up and remember, heat will take -- heat will denature the molecules, so the probe will leave the membrane, the bonds will be broken, the probes goes out into solution and now I have my membrane with the DNA still on it that I want to analyze and now the probe is gone. And now I can repeat this entire procedure using the probe from Chromosome 2. And I will get a different pattern depending on what these individuals look like for their Chromosome 2 hypervariable locus. At the end of that procedure I can repeat it again.

Q. Does anything happen to the DNA each time you strip or take your probe or wash your probe off, after you've found your pattern and you wash your probe off to put on another probe, does it do anything to the DNA that's on the membrane?

A. Each time that you boil this membrane, heat it up to remove the probe, a small amount of the DNA you're analyzing, that's on the membrane it also comes off as well, it's a fairly harsh procedure. So If I wanted to say, we call this stripping, this heating procedure, if I wanted to do this a hundred times by the end I probably wouldn't have too much sample left on that membrane to analyze. But if I wanted to do it ten times the amount of DNA that I would lose each cycle isn't that great and I'd still be able to get a result most samples at the end of the

ten cycles. A small amount of DNA is lost each time.

Q. Doctor, would you ever have occasion or would it be considered to be acceptable to reprobe with the same probe, as opposed to actually finding a different probe each time, would you ever find occasion or would it be acceptable in your opinion to reprobe with the actual same probe?

A. Yes, that can be done, you'll get the same result. Generally, why things like that would be done, say, at the beginning of the procedure you're using a probe that for one reason or another wasn't very radioactive or you didn't have much of the probe and you did this test, sometimes the result might be very faint. At that point you can repeat with a better probe preparation, that might be one reason. Another reason that you might want to repeat this procedure with the same probe is if you for one reason or another had a lot of background, which I mean -- what I mean by background radioactivity your washing procedure didn't remove all the radioactivity that was bound non-specifically to the membrane. If you had a lot of this background which will cloud over the presence of these bands, you can simply repeat the procedure over again. That might be a reason for repeating it.

Q. Doctor, if we are looking at an actual autorad or -- is that what you're -- I don't know if you've used the term yet, but the x-ray in which

the fragments appear, is that what it's called an autorad?

A. Yes.

Q. And the process is autoradiography?

A. Autoradiography.

Q. Fine. Doctor, in that particular process, if I was looking or anyone in this courtroom was looking at the actual product, the x-ray, would we expect to find white bands or would we find black bands or would we find red bands and would we find the bands to be of the same density and colour, can you address that issue, please?

A. Okay, the x-ray film itself will be -- if you held it up to the light you can see through the x-ray films, it's translucent and what you will see is dark black spots on the membrane which are shown here to be dark bands, they will be black in colour against translucent gray x-ray film or a clear x-ray film.

Q. Would you expect to find any density, colour density differences between bands in the gel, for example, would one be darker than the other band or would you expect that?

A. The darkness of a band is primarily a function of how much radioactivity is located on the membrane which is a function of how much DNA you analyze. The more DNA you analyze the more radioactivity can bind to it and the darker the band will be. If you have a sample that doesn't contain much radioactivity there is very little target for the probe to bind to and if you load

that beside a sample with a lot of DNA this band would be much more intense, much more dark than the band in the adjacent lanes.

Q. In your forensic experience, doctor, have you ever run across that where certain lanes of certain samples your bands would be much darker than other samples in other lanes?

A. What happens quite often, both in clinical and in forensic work, any time where it's difficult to control the absolute amount of DNA's that you're comparing from sample to sample, you're going to have intensity differences. Even clinically if I'm analyzing a sample that I don't have much starting material compared to a sample, I have a lot of material, you will have these intensity differences and forensically what often is the case is that you're very limited in what you're analyzing from a crime scene. There's very little material and those would give you the faintest results or the least intense results.

Q. But does the difference in density between the bands does that affect or does that invalid the test in any way, is the colour important, is the density of the colour important in terms of reading the x-ray?

A. It's the distance that the band is from the origin, whether this band is ten times darker than this band doesn't affect how far it's migrated from the origin.

Q. Is autoradiography, in your opinion -- could I have your opinion as to its reasonable reliability for forensic purposes?

A. Yes, with other branches of molecular biology, for forensic purposes autoradiography is an accepted technique.

Q. And in your opinion as to its acceptance in the general scientific community?

A. Yes, it's accepted.

Q. Doctor, is there anything that can be done with the autorad, the x-ray, that's developed for, for example, demonstrative purposes, for court demonstration for example, is there anything you can do with that to assist people to read it or to look at it?

A. There's a number of things you can do, just like an overhead transparency, I can put it on an overhead projector and project those dark bands on the screen much like this. I can place the x-ray film on a light box, take a picture of it and make a slide to present like that. I can take a picture of it and have an actual paper picture made up of the x-ray film with the bands on it. You can do any of the photographic reproductions of that x-ray film for visual effect.

Q. Can you make duplicates of your x-rays?

A. Yes, there's machines that you can take your original x-ray and it will make duplicate x-rays.

Q. What does the term positive print mean?

A. Positive print is -- you have a photographic paper which you -- you put the x-ray over top of the photographic paper, flash a light down through the x-ray and wherever the bands were you get a dark band on the photographic paper. So what it does is gives you a paper image of the x-ray.

Q. Are there -- I don't want to complicate matters, doctor, but you're talking about two bands per lane at least in this demonstration, there's two bands in each lane, one band you indicate -- one band in the lane is from the father and one band is from the mother representing each of the chromosomes. Would you ever have occasion where you would find one band in a lane?

A. Yes, if the father and the mother, if the chromosomes that you inherited from the father has the same length of fragment as the chromosome you inherited from your mother, on the x-ray film you'll just see one fragment. It's not that you didn't inherit a chromosome from either of your parents, either one of your parents, it's just that they happened to have fragments of the same length, and in those instances, you'll have a single band pattern as opposed to a two band pattern.

Q. Is that because both bands are in the same location?

A. Yes.

Q. And when it's in that case, can you tell that there is in fact two bands there?

A. Not looking at the x-ray, it presents itself as a single band.

Q. Is there a technical name for having two bands in a lane as opposed to having one band?

A. No, the technical term genetically for inheriting the same thing, the same form of a locus, the same allele from mother and father is called a homozygous.

Q. And if you inherit two separate lengths?

A. Yes, if your mother and father differ at a different locus, that's what is called a heterozygous for that purpose. Homozygous means they're the same there, heterozygous mean they're different there.

Q. Doctor, is membrane stripping and reprobing in the fashion you've described, in your opinion, could you give me your opinion as to its reliability, its reasonable reliability for forensic purposes?

A. It's a reliable process, again, for any field, any applications in Southern blotting and reprobing and that applies as well to forensics.

Q. And likewise your opinion as its acceptance generally in the scientific community?

A. It's a standard and accepted procedure.

Q. Is there any limitations on the number of probes that I could actually apply to a -- in an RFLP typing test, say, for example, I have run a number of samples in a gel and I've transferred it to a membrane and I have -- say, for example, I have the probes that you've identified available to me, four, five or six probes available, is there any limitations on the scientist's

ability to actually use those probes or have those probes identify an area of the DNA that you're looking at?

A. The number of probes, limitations to the number of probes?

Q. The number, yes.

A. I guess they're up to some five or 6,000 in different regions in the genome DNA that they've characterized. I guess the biggest concern would be the practical concern, how much time do you have, each one of these cycles, we call it, takes roughly about a week to complete from beginning to end. So you'd be spending your lifetime if you wanted to analyze hundreds and hundreds of probes in a successive manner like that. The other limitation is the number of times that you can run through these cycles, so remember you lose a little bit of your target each time. So it's a finite number of cycles you can do.

Q. And is there any, for forensic purposes, is there any agreed upon number of probes that are actually used in forensic labs?

A. For identity testing?

Q. Yes.

A. Probes that are this variable and again, the number of probes is generally determined, it's a matter of theoretical concern, a matter of practical application and the amount of time you can devote to a case and the amount of time you need to devote to distinguish between two individuals. But generally people use four,

four to five different probes of this nature to distinguish between samples.

Q. Doctor, another thing I would like for you to clarify, please, in the application of the probe, say, for example, I have four or five probes, say, I have four probes, is it, would I expect that the -- and I had a sufficient amount of DNA, would you expect to get a result on each probe or would you expect no result the number of probe at the end. What I'm saying is the first probe you applied, if you were to get a reading would you expect necessarily to get a reading on the second probe but maybe not on the third or is there any particular order. Is one probe more sensitive than the other is what I'm getting at?

A. Some of the probes are somewhat more sensitive than others. But in general, if you have sufficient DNA to get a good result with the first probe, it's no problem to proceed through the next four or five probings plus the control probes at the end. If you're having -- if you're at the level of detection for the first probe, it's not surprising that when you try successive cycles you're met with unsuccessful results.

Q. But do certain of the forensic probes used by the R.C.M.P., do some of them -- are they more sensitive than others, they will detect smaller amounts of DNA than another one would, for example?

A. Yes, it's a -- the relative differences and sensitivity aren't great. There's some probes that, there might be, say, in the order of two fold more sensitive. So if I was dealing -- if I was at the level of detection or the amounts of DNA are very small and I know I'm really pushing the technology to detect something, I can generally predict which probe I should start with in those cases, I start with the one that's two times more sensitive and the least sensitive probing in my panel.

Q. Do you have anything further on this particular aspect, doctor or do you wish to summarize the matter at this time?

A. I have nothing further here, I don't think.

MR. WALSH: Perhaps if we could have the lights, please.

THE COURT: Just one question there, on the timing, you said it would take about a week to run through this cycle?

WITNESS: Yes.

THE COURT: And how is that time distributed or *why* is a week required in other words?

WITNESS: And that doesn't include the DNA isolation or determining of its, if it's human, et cetera, that takes you from the point where it's on the membrane and you want to do this hybridization. The stripping of the membrane doesn't take very much time at all. In the course of an afternoon you could prepare the probe and add it to the membrane. It's incubated overnight, so that takes you into the next day,

and then you wash the membrane and that doesn't take very long. Now, the time consuming part of this whole procedure is when you put the x-ray film on the membrane. You have to leave it on the membrane for a period of time before you develop the x-ray and see the image. That period of time could vary from half a day, a day, upwards to over a week. So when I say, a week, that's a conservative and probably an average cycle time.

THE COURT: And then the time required for the preliminaries down to the membrane stage -- from the time you get your sample or the time you get your specimen?

WITNESS: When you receive your specimens it takes roughly a day to isolate the DNA from the cells, the better part of a day to characterize the DNA as to its amounts, its quality and whether its human. The better part of a day again to cut it with the enzyme, check that the enzyme work and document the procedure to that point, at which time you run the gel, again that's overnight and the transfer procedure is set up the next day and allowed to transfer again overnight. So the better part of a week to go from receiving the exhibits and getting the membrane, and then roughly a week or so every successive cycle after that.

Q. Do you need the slide for the next step? You can have a seat, doctor. Doctor, if you could tell me, please, what, if any, laboratory --

THE COURT: About how long did you have in mind going now, Mr. Walsh, I'm not trying to push you.

MR. WALSH: No, no, in fact, it's getting late, I realize that. If I could be given another luckily we might be done by five o'clock or the part I think we can get to by five o'clock. I would like to get to the part-- up to the part where I ask the doctor how they go about interpreting the autorads, what process do they use to actually interpret whatever fragments, they find on the autorads, if I could get up to that particular part, I think it might be a logical place to stop, because it's getting late in the day. The interpretation part and the other aspects, we could perhaps leave in the morning, because I don't see any likelihood that we can get through to the actual end of this, of the doctor's direct examination.

THE COURT: Okay.

Q. Doctor, what, if any, laboratory record is kept of each step of the RFLP process as you've described?

A. A standard note keeping practice is followed throughout the procedure. You'll log in exhibits when they come in, description of exhibits, who you received them, when you received them, you'll extract the DNA. At the end of that procedure your test gel, again, that's a gel that's stained with ethidium bromide, the DNA itself will give off a fluorescence, you can take a picture of that and have a record of why you

thought there was a lot of DNA and it was of good quality. So it's a visual record, that's permanent.

Q. Is that what they call a Polaroid?

A. Yes, it's just a Polaroid picture of the gel with the fluorescence. And that's something that other scientists can look at and hopefully draw the same conclusions as you did.

Q. Is this done for each of the steps you've described?

A. That's done for the initial stage in telling how much DNA you have and its quality. That's done again when you check a portion of your restriction digest to see if it was complete. So you have a picture of that documenting, that yes, I went from very large fragments on the first Polaroid to a smear or very small fragments indicating that the restriction enzyme did work.

Q. Would you take a Polaroid at any other step?

A. You'd take a Polaroid when you take your entire sample after all those measures and you run your actual analytical gel, the one that you're going to probe -- transfer and probe later, at the end of that we stain with the dye, the ethidium bromide. Again, take another picture of that and have a permanent Polaroid of that as well in your notes.

Q. Can that be interpreted by other scientists and looked at?

A. Yes.

Q. And that's for the purpose of assessing whether the steps have been -- whether or not the steps have been done correctly?

A. Yes, it's a visual documentation of where you are in the procedure and that things have worked up to that point.

Q. And apart from this visual documentation, what about this note taking is this kept throughout the whole process?

A. Yes, that's just good scientific practice.

Q. Are there any -- perhaps I could ask you what a protocol is, before I lead into my next question, could you tell the judge please what a protocol is or the Court?

A. A protocol is just a written cookbook, if you will, of the procedure, it tells you from beginning to end the steps involved in the procedure. And after you develop a procedure you generally will write out and document your protocol, so you can transfer that technology to others without having to teach them. You can hand that to people, you can send that to people, it will describe your system and they can evaluate your system from the written text of how to do a --

Q. Are there protocols in existence in relation to the RFLP process at the R.C.M.P. DNA laboratory?

A. Yes.

Q. Doctor, I am going to show you this document here, would you look at it for me, please, describe it if you could?

A. This is an outline of the RFLP procedure as it existed in the R.C.M.P. lab in October of 1989.

Q. Are you familiar with this protocol?

A. Yes.

MR. WALSH: I would have this, my lord, with your permission entered on the voir dire.

THE COURT: This will be VD-42. You said, as of November?

WITNESS: November, 1989.

MR. WALSH: October, 1989, my lord, is on the document.

THE COURT: October, '89.

Q. I'll show you this document here, would you look at it for me, please and tell me whether or not you can identify it and what it is?

A. Yes, this is an updated version of the same protocol, there's a few minor changes made, it was done in March of 1990 and reflected some of those changes that were made to our procedure.

Q. Could you, perhaps -- perhaps, first of all --

MR. WALSH: With your permission --

THE COURT: VD-43.

Q. Would you put -- if you would, doctor, would you describe some of the changes that were documented between those protocols?

A. As far as my recollection is, the second protocol expanded and added a few more details than were included in the first one, there really weren't any changes in the actual method between the first version and the second version.

But it did expand on how to do the technology.

Q. Why was this expansion necessary or felt to be necessary?

A. At the time of the first protocol, there were really just three of us working in the lab and doing the RFLP technique and we were the ones who put together the system. So at each step along the way, when we wrote down the protocol we weren't very verbose in the details. The second updated protocol we were beginning to train people, so we added a few more details so people could follow, the audience was changing, so we added a few more details to it.

Q. Who were the three people that, you've indicated there was three of you, who would they be?

A. Myself, Dr. Ron Fourney and Dr. John Bowen.

Q. Doctor, I am going to show you this particular document, and ask you if you can identify that, please?

A. This is the manual, I believe, that is currently in use at the R.C.M.P. and it's dated January, 1991.

Q. Have you ever had occasion to use the typing procedure under that particular manual?

A. Yes, I have.

Q. When was the last time you used the procedure under that particular protocol, approximately, doctor?

A. Mid January of 1991, this year.

Q. And you were using it for any particular case, forensic case?

A. I was doing it for the Bourguignon case, which I testified in, I had additional tests to do.

MR. WALSH: If I could have this entered, my lord.

THE COURT: VD-44. Do I understand, this is the successor to the other two protocols, is this the R.C.M.P. lab protocol?

WITNESS: Yes, it is.

Q. Doctor, my next question was what if any difference or what if any changes, have you noted in the most recent protocol the one dated January, 1991?

A. Again, the training in the DNA technology at the R.C.M.P. has expanded considerably.

Q. Training, what do you mean by that?

A. Training of investigators to do DNA analysis, so, again, more details were added to the original protocol, so less experienced people would be able to follow the recipe. And in addition to adding more details, the protocol was updated to include a couple of changes that were made to the procedure.

Q. Would you tell us what those changes were and in your opinion why they were made and what, if any, effect they have on the validity of RFLP procedure?

A. The principal change that was made, there was a couple of changes made but the principal change dealt with the membrane and the membrane's manufacturer. For the first two protocols we were using a membrane that was supplied by a company

named Amersham. We experienced sometime just before I left the R.C.M.P., some variability in the quality of the membrane coming from that manufacturer. And at the same time we were evaluating membranes from other manufacturers that had increased the efficiency of the transfer and the efficiency with which we could detect these regions with small amounts of DNA. It was a membrane of superior quality and performance in our test. Once that was evaluated in the system, we switched membranes. So that was incorporated in the procedure and the actual buffer that we used to drive the transfer reaction we switched to the buffer that was compatible and in fact developed for that new membrane. Those two changes both deal with making the transfer more efficient and more sensitive.

Q. What about probes, what, if any, other probes were developed or used over the time or incorporated over time?

A. Okay, there was an additional probe added between the first two manuals and the most recent one. It's a probe that, it hadn't been characterized when we initially put together the protocol manual. It was developed in the research community, tested on forensic samples, found to be a very informative and a very sensitive probe by the labs who evaluated it and they incorporated it as part of the testing procedure, when they put together --

Q. Probing on what chromosome?

A. Chromosome 10, the code name is D10S28.

Q. And doctor, these changes in your opinion, do they do anything, do they affect anything critical to the system, to the RFLP system?

A. Other than increasing our ability to make the test work and to make the test work in a sensitive manner, there is no change in the reliability. It improved the process, it improved our ability to use the process on forensic samples.

Q. These protocols, as you've identified them, could I have your opinion, please, as to their -- as to their reasonable reliability in terms of producing reliable results?

A. In my opinion, they're very reliable.

Q. And with respect to your opinion as to their acceptance generally for forensic purposes in the scientific community?

A. I view them as quite acceptable, in fact the bulk of the text in there is taken directly from protocols that are being used in research in clinical labs, the protocols are rewritten for forensic uses.

Q. Is there any difference, doctor, between the-- now that you mention that, is there any difference between the laboratory record keeping, you've described, note taking and Polaroids, et cetera, is there any difference between that, is there any difference between laboratory record keeping in protocols for forensics compared to their clinical and research labs?

A. In my experience in the clinical lab, the record keeping process and the chain of documentation they have with every analysis is in gross excess of what you'd see in a clinical lab. Although it's important to have good clinical notes, there'd be very little time to actually do the test if in a clinical lab you follow that type of documentation for continuity, et cetera. In the clinical lab you can repeat the test again, so there is a difference there. But generally the level of documentation in the forensic lab is excessive compared to research or clinical environments.

Q. And is that opinion -- is your opinion the same for the R.C.M.P. DNA lab?

A. Yes.

Q. Doctor, the last thing I'll ask, subject of course to his lordship, the last thing I am going to ask you to do today is to just very briefly summarize the procedure that you've described to this point in terms of the RFLP technique. I understand that you have a chart available for that purpose?

A. Yes.

MR. WALSH: My lord, this chart that I have here, again, I would suggest it would not be necessary to mark it, it represents a chart.

Q. Is this an accurate reproduction of the documents that have been filed previously?

A. Yes.

MR. WALSH: That would be VD-30 and VD-40, if I'm correct, Mr. Clerk.

Q. They're an accurate reproduction and perhaps, I'll ask you, doctor, if you would to just summarize for people at the end of the day what he has done up to this point in time in terms of the process?

A. Again, if I wanted to answer the general forensic question, could Sample A and Sample B have come from the same individual? You isolate the DNA from the sample and that really is independent of what type of sample it is, be it, semen, blood, et cetera. Cut the DNA with an enzyme, restriction enzyme, it recognizes a particular site, separate the fragments on this agarose gel matrix and large fragment to small fragment, transfer those fragments after I've separated the strands, denature them, I do that first. Transfer them on to a membrane, now we have a permanent record of the fragments from large to small, they're mobilized on a nylon membrane, that's a permanent record. Take the membrane, immerse it in fluid that contains radioactivity probe. Now, the probe is just a honing device for that region that will tell people, different people from each other, the probe will go to the fragments that correspond to that region that you're interested in and to detect where the probe is you simply put x-ray film on top of the membrane, leave it for a period of days to a week, and the x-ray film will reflect the

fragments where the probe is found. This one has got the fragments migrate from the top to the bottom of the membrane which corresponded to the gel is a function of the size of the fragments. In this particular case, you've got the largest fragment here, the second largest, the third largest, the fourth largest and what you have is fragments of different sizes in these two samples. Now, if everything worked properly with this procedure, Sample A and Sample B have different size fragments for this particular region of DNA and the conclusion, if everything worked well with this test, that is, if these DNA ran properly, the solutions would be that these two samples did not come from the same individual.

Q. And that is because why?

A. Because they're variable fragments or of different lengths at that particular region.

Q. And if they matched or consistent with coming from the same individual, where would you expect to find those bands?

A. I'd have the bands in the same relative position relative to the top of the gel, there'd be a band here, if Sample A were to match Sample B came from the same individual, I would expect another band here and another band or vice versa, the bands in Sample B matching the bands in Sample A. And that would be a conclusion you'd draw at that point, again, if everything worked

well is that these samples could have come from the same individual. If they are different and indeed these differences are an accurate reflection of the fragment lengths, it's not a matter of could be from different individuals, there are from different individuals in this case. So it's an absolute exclusion.

Q. Doctor, I believe we have a chart that would show from the schematic purposes, an inclusion, I am going to -- I have a paper reproduction, is this an accurate reproduction on this chart?

A. Yes.

MR. WALSH: If I could have this entered, my lord, it will be the last item today.

THE COURT: Yes, VD-45.

Q. Now, whereas, doctor, on VD-40, you showed where there was an exclusion because the bands did not match, I understand that this schematic, VD-45, my lord --

THE COURT: VD-45.

Q. -- shows something different, would you explain it?

A. This is a little more detail forensic case, where you have a blood standard, say, from a victim, a piece of evidence, say, a blood stain from the scene of a crime of unknown origin and again, two blood standards from two suspects, Suspect 1 and Suspect 2. When you complete this analysis, you know a couple of things, one that the evidence sample, the fragments you detect are clearly distinguishable from the

victim. So the blood left at this scene did not come from the victim.

Q. For the record, you are comparing Lanes A and B on that?

A. A and B, that's the first piece of information. That's an absolute, the blood found at this crime scene isn't from the victim.

Now, the question is, which one -- which one, if any, of the suspects, could this blood have come from? Well, Suspect 2 in Lane B, if you compare that to the evidence is clearly a different pattern and again, you have an absolute exclusion. If everything worked well here and these bands are an accurate reflection of their true sizes, this sample could not have come from this individual. That's the conclusion you would draw.

What we do have here is the bands in the same relative position on the gel and on the membrane, on the x-ray film, comparing the evidence to Suspect 1 in Sample C. What this means is that it's consistent with the evidence, the blood stain and the blood from Suspect 1 coming from the same individual.

Q. So in this case, doctor, the bands in Lane B in your opinion from a schematic point of view would match the lanes in -- the bands in Lane C?

A. Yes.

Q. That would be an indication that they were consistent with coming from the same source?

A. The blood stain and the blood standard you obtained coming from the same source, coming from

Suspect 1, if that blood is drawn from Suspect 1.

Q. Now, this schematic would be for one probing?

A. Yes.

Q. This would be repeated and if it was repeated for the second probing you would expect to find bands in the same location or a different location?

A. A different location.

Q. And that is because you are looking at a different section of the DNA fragments?

A. Yes.

Q. And that would be repeated for the third probe and the fourth probe, however many probes you'd want to use or could use?

A. Well, as long as you kept -- if you did the second probing and for the sake of argument, we'll assume that on the second probing we had the same sort of band configuration, two bands here that didn't match the evidence. If on the second probing I had a band and Suspect 1, it was up here and down here and didn't match the evidence, nor did the one from Suspect 2. Now, that I've eliminated both, regardless of whether they've matched in the first probing I've eliminated both suspects now. And you don't-- there's no need to carry on, you don't have any -- it didn't come from the victim, it didn't come from either suspect. If I did the second probing and I got again a match between the evidence in Suspect 1, then, again I've strengthen that conclusion that these came from the same

individual. And I could proceed on to a third locus, a third probing, again, to see if I can -- if they match at that one. You can proceed on and on and on.

Q. The theory being that the more probings that match between the suspect and the sample, the higher the probability is that they came from the same person?

A. Correct, and not from somebody else who just fortuitously happens to have that pattern.

MR. WALSH: Unless there is something else, doctor, you would like to add. At this time, my lord, I wish to finish my direct examination and continue it in the morning.

THE COURT: When we get to the -- you said at the end of a certain portion of this witness's evidence, you were going to stand him aside.

MR. WALSH: When I read the point, my lord, where Dr. Waye has finished -- reaches the point where I'm going to ask his opinion with respect to the evidence obtained in this case, I am going to ask that Dr. Waye be stood aside until next week, because before he can give that opinion Dr. Bowen will have to, among other evidence, provide evidence of the testing that he did in this case.

THE COURT: I may be asking you at that stage, Mr. Furlotte, whether you want to cross examine at that point. Although I would think probably you'd want to leave it until the very end.

MR. FURLOTTE: You what?

THE COURT: I would ask you if you want to cross examine tomorrow at the completion of the direct evidence or do you want to leave it until all the evidence of this witness is in, and I say, I would think that you would want to leave it until the very end. I think I would give you the privilege, subject to any great objection Mr. Walsh would suggest. Do you see any difficulty about that, if Mr. Furlotte were given that option?

MR. WALSH: No, my lord, whatever he finds would facilitate his cross examination, the Crown is prepared to certainly agree with or to go along with it.

THE COURT: Well, in other words when Dr. Waye finishes tomorrow and is stood aside, I'll be saying to you, then, go ahead and cross examine at this point, if you want to before we let him go.

MR. FURLOTTE: And I expect that you would do as much.

MR. WALSH: Does Mr. Furlotte have any particular opinion at this point in time whether he wants to cross examine Dr. Waye tomorrow.

MR. FURLOTTE: My opinion at this time is that I expect to cross him tomorrow.

MR. WALSH: That just simply gives me a little better way to gauge and Dr. Bowen can gauge his time in that way. Thank you.

THE COURT: Before we finish, Sheriff Dickens, can you hear back there, how is that loud speaker?

SHERIFF: Very good, my lord.

THE COURT: Pardon.

SHERIFF: Very good, my lord.

THE COURT: Would you mind repeating what was said this afternoon?

Thank you very much, Sheriff.

Well, we will recess then until 9:30 in the morning, if that's agreeable.

COURT ADJOURNS MAY 1, 1991 AT 5:10 P.M.

COURT RESUMES MAY 2, 1991 AT 9:30 A.M.

COUNSEL PRESENT

ACCUSED PRESENT

THE COURT: This is the continuation of the same trial, everyone is present with the exception of Mr. Sleeth, the same counsel are present, Mr. Sleeth is not present. And Mr. Ryan is indisposed, I believe, this morning, Mr. Furlotte.

MR. FURLOTTE: He hasn't contacted me but I know he was quite sick yesterday.

THE COURT: Well, he called me about eight o'clock this morning and said that he'd been to the doctor and I think the doctor had told him he should take this morning off and he felt he -- he said he had been talking to you perhaps that was yesterday.