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586 So.2d 242
59 USLW 2693
Ex parte Waylon Dwight PERRY.
(Re Waylon Dwight Perry
v.
State).
89-1534.
Supreme Court of Alabama.
April 19, 1991.
Rehearing Denied June 7, 1991.

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Richard M. Payne and Pamela Wilkinson Tucker, Scottsboro, for Waylon Dwight Perry.

Don Siegelman, Atty. Gen., and J. Thomas Leverette, Asst. Atty. Gen., for the State.

KENNEDY, Justice.

Waylon Dwight Perry was convicted of capital murder, and the trial court, accepting the jury's recommendation, sentenced Perry to life imprisonment without parole. The Court of Criminal Appeals affirmed the judgment of the trial court. Perry v. State, 586 So.2d 236 (Ala.Cr.App.1990). We granted certiorari review to address one issue: Whether DNA evidence, which was used to identify Perry as the perpetrator of the crime, is admissible in Alabama. The Court of Criminal Appeals held it admissible. ("DNA" stands for deoxyribonucleic acid. DNA exists in the nucleus of most cells of the body; it is unique to the individual, except in the case of identical twins.)

In July 1988 Bryce Wallace was strangled to death in his house. When law enforcement officers investigated, they found bloodstains on Wallace's clothing and on the front doorknob of Wallace's house. Those bloodstains were later analyzed with a procedure called "DNA print analysis" by Lifecodes Corporation ("Lifecodes"), a New York corporation that performs DNA tests in relation to criminal and paternity lawsuits.

In October 1988 Perry was indicted for Wallace's murder, and in December 1988 he was tried for that offense. The record does not indicate when Perry discovered that Lifecodes had performed the DNA print analysis. By the time the case went to trial, however, Perry's lawyers apparently knew that the State might attempt to introduce that DNA evidence, because, when the State, at the beginning of its case, requested that two Lifecodes scientists be allowed to testify out of order, Perry's lawyers knew who they were and had a cross-examination prepared. Perry's trial lawyers never asked for a hearing outside the presence of the jury to challenge the admissibility of the DNA evidence.

At trial the State called as its first two witnesses Joanne Squeglia and Dr. Kevin McElfresh. Squeglia testified at some length concerning how she performed the DNA testing procedures comparing the DNA of the individual whose blood was on Wallace and on Wallace's front doorknob to Perry's DNA. Dr. McElfresh, the assistant manager of Lifecodes' forensics laboratory, testified that he interpreted the results of the tests Squeglia performed. Dr. McElfresh explained the procedures that Lifecodes normally performs in DNA analysis; when the State asked Dr. McElfresh to state the conclusions that he drew from that analysis, Perry's attorney objected, with this statement:

"For the record, we object to Dr. McElfresh's opinion--his rendering an opinion as to the identity on the blood type in relationship to Waylon Perry because the Lifecodes test has not been proven trustworthy in Alabama. We maintain that it is not trustworthy. There are several things that can cause variations in this type testing; and that his testimony with regard to a conclusion of identity should be excluded."

Dr. McElfresh testified that Perry's DNA "matched" the DNA of the blood found on Wallace and on Wallace's front doorknob. We refer to this testimony as testimony concerning DNA "matching" evidence. Dr. McElfresh also testified that based on a certain chromosome pattern, the probability of finding similar DNA was 1 in 209,100,000. We refer to this testimony as evidence of "DNA population frequency statistics."

Perry argues that the trial court erred by submitting the DNA evidence to the jury without first holding a hearing outside the presence of the jury as to its admissibility. Such a hearing is necessary, Perry argues, because, the trial court otherwise is presuming that the evidence is admissible,

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although DNA evidence is novel scientific evidence that this Court has never held to be admissible. Such a holding, Perry contends, turns the only contention about the DNA evidence to an argument over its proper weight without ever addressing the threshold issue of admissibility.

The State contends that Perry never requested a hearing outside the jury's presence concerning the DNA evidence and that Perry did not object to the introduction of the evidence until the State asked Dr. McElfresh to give his opinions and conclusions concerning the DNA print analysis. The record supports that contention. Perry objected to the admission of Dr. McElfresh's testimony based on the DNA print analysis that identified his blood as the blood on Wallace's body and on Wallace's front doorknob, however. Perry's objection may be viewed as ambiguous--it says in substance that Dr. McElfresh's testimony is inadmissible because Lifecodes' "test" has not been proved "trustworthy," but it does not explain specifically what Perry challenges about Lifecodes' DNA print analysis--but inasmuch as it challenges the admissibility of the DNA evidence because such evidence has not previously been held admissible by this Court and because there is the possibility that DNA testing can produce flawed results, it preserves those issues for review.

Theory and procedures involved in DNA print analysis.

Many courts have stated that the general scientific theory underlying DNA print analysis is almost universally accepted in the scientific community. See, e.g., Caldwell v. State, 260 Ga. 278, 393 S.E.2d 436 (1990); People v. Castro, 144 Misc.2d 956, 545 N.Y.S.2d 985 (Sup.Ct.1989); State v. Schwartz, 447 N.W.2d 422 (Minn.1989); Andrews v. State, 533 So.2d 841 (Fla.Dist.Ct.App.1988). That underlying scientific theory was well explained in Castro, 144 Misc.2d at 961-63, 545 N.Y.S.2d at 988-89:

"DNA, deoxyribonucleic acid, is the fundamental natural material which determines the genetic characteristics of all life forms. Humans have human form and elephants have elephant form because of differences in the makeup of their respective DNA.

"Every cell that contains a nucleus contains DNA. There are approximately 10 trillion cells in the human body and most contain DNA. Red blood cells, which do not have nuclei, are a significant exception. Although the DNA is much too small to be seen by even the most powerful microscope, if it were stretched out to its full length, it would be about six feet long. Within humans, as a species, much of the DNA is identical. It is this identity of DNA that makes all humans look like humans, rather than dogs or trees. We humans create human offspring by transferring our DNA to our children. The science of genetics studies how and why this happens.

"DNA's fundamental structure, however, does not vary regardless of the type of genetic creature it creates. DNA is composed of a long double helix, which looks like a spiral staircase. The backbone of this molecule (i.e., the handrails and balustrade of the staircase) consists of repeated sequences of phosphate and deoxyribose sugar. Attached to the sugar links in the backbone are four types of organic bases: Adenine (A), Guanine (G), Cytosine (C) and Thymine (T). The steps of the staircase are formed by pairs of these bases (hereinafter, 'base pairs'). A single DNA molecule consists of approximately three billion base pairs. Because of the chemical nature of the bases, only A and T can bond together, and only C and G can bond together. A cannot bond with G, and C cannot bond with T. Thus, the only possible combinations which can form the steps of the staircase are A-T, T-A, C-G, and G-C.

"The sequence of the three billion base pairs along the handrails of the DNA is the key to the information represented by the DNA. This sequence is responsible for producing arms, legs, kidneys or brain cells.

"Of this sequence, approximately 3 million sites vary from person to person. There are enormous differences between

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individuals because of the manner in which the base pairs are arranged. These variations, called polymorphisms or anonymous sequence, occur in different regions of the DNA. Polymorphisms are the basis of DNA identification. They are readily detectable when their lengths are altered by the action of restriction enzymes, thereby giving rise to 'Restriction Fragment Length Polymorphisms' (hereinafter 'RFLP'). The length of the fragment (or molecular weight) is measured by the distance it moves through an electrophoresis gel.

"Each individual's DNA is apportioned into forty-six discrete sections within the nucleus of each cell. These sections are called chromosomes. Twenty-two of these chromosomes come from the mother and twenty-two come from the father. These are genetically arranged in pairs. Additionally, two sex-typing chromosomes, denominated 'X' and 'Y' are present.

"During reproduction the chromosome pairs of the mother and the father split apart and then recombine--one chromosome from the mother and one chromosome from the father--to create the 'new' twenty-two chromosome pairs of their child. Females have two 'X' chromosomes, and males have one 'X' and one 'Y' chromosome, thus giving each human a total of forty-six chromosomes.

"A portion of DNA which is responsible for certain traits is called a gene (e.g., each person has a gene for the production of eyes). All humans have thousands of genes located on the forty-six chromosomes. Each gene is located at a specific site, or locus, upon a specific chromosome. Alternate forms of genes are called alleles (e.g., blue eyed allele, green eyed allele). This total pool of genetic information is known as the human genome.

"In chemical terms, the difference in alleles is explained by the difference in the ways the nucleotides, i.e. base pairs, arrange themselves along the DNA molecule. For example, one very short strand of DNA might look like:

A T T C
* * * *
T A A G

while another might look like:

A T A C
* * * *
T A T G

and a third might look like:

C A A T
* * * *
G T T A

All are slightly different. Each is an allele. In actuality, however, each allele is much longer, i.e., on the order of 1,000-10,000 base pairs. Each base pair consists of a single nucleotide, that one bond between A and T or C and G. However, a very small variation in the order in which these base pairs occur on the DNA molecule can make huge differences. Sickle-cell anemia, for example, is caused by a single base pair on a single chromosome occurring out of order. If that single aberrant base pair were placed properly, the afflicted would not suffer from the disease.

"Obviously, if a DNA profile examined all three million sites of variation, each person's DNA could be individualized. Such an undertaking would be unduly burdensome in terms of time, labor, and cost. As an alternative to this approach, it is accepted that scientists can, in relative terms, discriminate between various people's DNA by examining several of these polymorphic sites. At a particular site or locus, a person may have a substantially unique pattern. For instance, a particular fragment size may occur in a small percentage of the population. By examining the sizes of a sufficient number of fragments at different sites on different chromosomes, statistical procedures permit enough discrimination to establish the unique configuration of any one persons's DNA pattern."

Techniques for implementing DNA print analysis based on the theory above have also been discussed by other courts. In Schwartz, the Minnesota Supreme Court stated:

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"Three commercial laboratories in the United States currently perform DNA analysis: Cellmark (the company that did the testing in this case) Lifecodes Corporation, and Cetus Corporation. Both Cellmark and Lifecodes employ restriction fragment length polymorphism (RFLP) analysis in their DNA testing. RFLP analysis involves the following steps:

"(1) Extraction: DNA is removed from the specimen and 'washed' with an organic solvent.

"(2) Fragmentation: the extracted DNA chain is then cut into fragments at specific sites by mixing it with a restriction enzyme.

"(3) Gel electrophoresis: the DNA is placed in a gel to which an electrical current is applied, causing separation of the fragments into bands according to their length.

"(4) Southern [transfer]: the DNA bands are transferred to a nylon membrane while retaining the same positions they previously occupied on the gel. The double-stranded bands are then treated with a chemical that causes them to separate into single strands.

"(5) Hybridization: genetic probes (DNA clones) are applied, which bind to a specific, complementary DNA sequence on the membrane; the excess probe is then washed off.

"(6) Autoradiograph (or 'autorads'): the membrane is exposed to an x-ray film and developed so that the DNA banding patterns and their lengths can be visualized. Finally, the autoradiograph is interpreted by comparing the DNA print to another DNA sample to determine if they match based on band length."

447 N.W.2d at 425. Schwartz's description of the procedures involved in the DNA print analysis technique employed by Lifecodes is consistent with Dr. McElfresh's description of the same techniques.

The interpretation of the autorads is the basis for DNA "matching" evidence and DNA population frequency statistical evidence. Castro, 144 Misc.2d at 967, 545 N.Y.S.2d at 992, provides this explanation concerning interpretation of autorads:

"After the autorad has been produced the results must be interpreted. The bands on the autorad in different lanes must be examined to determine if they 'match'. The bands in various lanes on the autorad are visually inspected to see if they co-migrate. If a match is declared, the issue is reduced to determining the likelihood that the match is unique. A match is said to occur if the sizes and number of the detected RFLPs in various lanes are indistinguishable within a permissible degree of error. They are then measured either manually or by a digitizer attached to a computer. Whatever standard of measuring error is used to determine if the bands are indistinguishable must also be used when calculating the frequency of the band in the population.

"The 'uniqueness' question is answered according to the principles of population genetics, using the same matching rule or standard deviation."

144 Misc.2d at 967, 545 N.Y.S.2d at 992.

The Frye Test and admitting novel scientific evidence.

In Alabama, whether novel scientific evidence is admissible is determined normally by using the test established in Frye v. United States, 293 F. 1013 (D.C.Cir.1923). In Frye, a criminal defendant sought to introduce evidence concerning a systolic blood pressure lie detector test. In affirming the trial court's exclusion of the evidence, the court wrote:

"Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance

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in the particular field in which it belongs."

293 F. at 1014.

Other courts have discussed what Frye requires to permit the introduction of DNA evidence and whether the Frye requirements should be modified somewhat in relation to the admission of DNA evidence. Cf. State v. Pennington, 327 N.C. 89, 393 S.E.2d 847 (1990); State v. Ford, 392 S.E.2d 781 (S.C.1990); Castro; Cobey v. State, 80 Md.App. 31, 559 A.2d 391 (1989); United States v. Two Bulls, 918 F.2d 56 (8th Cir.1990). For example, in Castro, the court, addressing the admissibility of DNA evidence, wrote:

"The court has advanced the following three prong analysis to aid in the evaluation and resolution of the issues presented:

"Prong I. Is there a theory, which is generally accepted in the scientific community, which supports the conclusion that DNA forensic testing can produce reliable results?

"Prong II. Are there techniques or experiments that currently exist that are capable of producing reliable results in DNA identification and which are generally accepted in the scientific community?

"Prong III. Did the testing laboratory perform the accepted scientific techniques in analyzing the forensic samples in this particular case?

"In dealing with DNA identification tests, some courts have considered all three questions as part of the inquiry under Frye. (See People v. Lopez, [NYLJ (Jan. 6, 1989) Sup.Ct. Albany County]; Andrews v. State [533 So.2d 841, 843 (Fla.Dist.Ct.App.1988)] Giannelli, The Admissibility of Novel Scientific Evidence; Frye v. United States, a Half-Century Later, 80 Columbia Law Review 1197 at 1201 (1980)).

"Others, in guarding the province of the trier of the facts, have indicated that the third question goes to the weight of the evidence, not the admissibility under Frye. (See People v. Wesley, supra, 140 Misc.2d at 317, 533 N.Y.S.2d 643; State v. Richard Cauthron, no. 88-1-1-012533; Giannelli, supra, notes 23, 24.)

"It has been observed that: 'Perhaps the most important flaw in the Frye test is that by focusing attention on the general acceptance issue, the test obscures critical problems in the use of a particular technique.' Giannelli, supra, at 1226.

"The compelling logic of this observation leads this court to conclude that a different approach is required in this complex area of DNA identification. The focus of this controversy must be shifted. It must be centered around the resolution of the third prong.

"It is the view of this court that given the complexity of the DNA multi-system identification tests and the powerful impact that they may have on a jury, passing muster under Frye alone is insufficient to place this type of evidence before a jury without a preliminary, critical examination of the actual testing procedures performed in a particular case. (See Beeler and Wiebe, DNA Identification Tests and the Courts, Washington Law Review, Vol. 63: 903, 936-937, notes 172-175 [1988]).

"Accordingly, the first two prongs of the analysis deal strictly and exclusively with the Frye issue. The third prong is the subject of a pre-trial hearing on the question of the admissibility of the particular evidence presented in this case."

144 Misc.2d at 959-60, 545 N.Y.S.2d at 987-88.

In Two Bulls, a case of first impression in the federal circuit courts, the Eighth Circuit Court of Appeals adopted a standard similar to Castro's. After holding that Frye and Rule 702 of the Federal Rules of Evidence would require the establishment of similar foundations to allow the admission of DNA evidence, the court wrote:

"We hold that it was error for the trial court to determine the admissibility of the DNA evidence without determining whether the testing procedures used by the FBI lab in this case were conducted properly. In weighing the overall admissibility of such evidence, the court should

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hear testimony from experts on both sides as to the scientific acceptability and reliability of any novel scientific tests. The trial judge should rule as a matter of law (1) whether the DNA evidence is scientifically acceptable, (2) whether there are certain standard procedures that should be followed in conducting these tests, and (3) whether these standards were followed in this case. Cf. Caldwell [v. State], 260 Ga. at 286, 393 S.E.2d at 441. If the trial court is preliminarily satisfied that these requirements have been met the evidence should be admitted and the jury should be allowed to determine the weight that should be allocated to it.

"We order Two Bulls' conviction vacated and the conditional plea set aside. We remand the case to the trial court with instructions to hold an expanded pre-trial hearing on the admissibility of the DNA evidence. The trial court is to decide (1) whether the DNA evidence is generally accepted by the scientific community, (2) whether the testing procedures used in this case are generally accepted as reliable if performed properly, (3) whether the test was performed properly in this case, (4) whether the evidence is more prejudicial than probative in this case, and (5) whether the statistics used to determine the probability of someone else having the same genetic characteristics is more probative than prejudicial under Rule 403."

918 F.2d at 61.

The Supreme Court of South Carolina, addressing the admissibility of DNA testing, described its modified Frye standard for admissibility of novel scientific evidence:

"A new scientific method of proof is admissible at trial if the method is sufficiently reliable. State v. Bullard, 312 N.C. 129, 148, 322 S.E.2d 370, 381 (1984); 1 Brandis on North Carolina Evidence, § 86, at 385 (1988). Reliability of a scientific procedure is usually established by expert testimony, and the acceptance of experts within the field is one index, though not the exclusive index, of reliability. See State v. Bullard, 312 N.C. at 147, 322 S.E.2d at 380; State v. Peoples, 311 N.C. 515, 532, 319 S.E.2d 177, 187 (1984). Thus we do not adhere exclusively to the formula, enunciated in Frye v. United States, 293 F. 1013 (D.C.Cir.1923), and followed in many jurisdictions, that the method of proof 'must be sufficiently established to have gained general acceptance in the particular field in which it belongs.' Id. at 1014. Believing that the inquiry underlying the Frye formula is one of the reliability of the scientific method rather than its popularity within a scientific community, we have focused on the following indices of reliability: the expert's use of established techniques, the expert's professional background in the field, the use of visual aids before the jury so that the jury is not asked 'to sacrifice its independence by accepting [the] scientific hypotheses on faith,' and independent research conducted by the expert. State v. Bullard, 312 N.C. at 150-51, 322 S.E.2d at 382."

Pennington, 393 S.E.2d at 853.

Each of the cases from which we have quoted, as well each case that we have reviewed concerning the admissibility of DNA evidence, including cases from jurisdictions that do not follow Frye, note one similar concern with the admission of the evidence: however accepted and proper the scientific theory underlying DNA evidence analysis is, and however acceptable the techniques for DNA testing based on that theory, there remains the possibility for error in the interpretation and performance of the tests. Caldwell; Pennington; Ford; Castro; Schwartz; Cobey; Spencer v. Commonwealth, 238 Va. 275, 384 S.E.2d 775 (1989), cert. denied, 493 U.S. 1036, 110 S.Ct. 759, 107 L.Ed.2d 775 (1990); Andrews; People v. Harbold, 124 Ill.App.3d 363, 79 Ill.Dec. 830, 464 N.E.2d 734 (1984); Two Bulls. As the court in Castro said, " 'Perhaps the most important flaw in the Frye test is that by focusing attention on the general acceptance issue, the test obscures critical problems in the use of a particular technique.' " 144 Misc.2d at 960, 545 N.Y.S.2d at 987, quoting Gianelli, The Admissibility of Novel Scientific Evidence;

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Frye v. United States, a Half-Century Later, 80 Col.L.Rev. 1197, 1201 (1980). As regards the concern for the problems in the use of a particular technique, the sole source of disagreement seems to be whether Frye or some

other source of law requires that for DNA evidence to be admissible, it must be shown that there was no error in the interpretation and performance of the tests.

We do not determine whether it is Frye's standard of "general acceptance in the particular field in which it belongs" that makes it a requisite to admissibility to prove that there was no error in the interpretation and performance of the tests. Like every other court that has addressed the admissibility of DNA evidence, we recognize the possibility of error in the interpretation and performance of the tests as a legitimate concern, however. Accordingly, considering both this concern and the Frye test, we hold that the following three-pronged test, substantially similar to that announced in Castro, is the test by which to determine the admissibility of the contested evidence:

I. Is there a theory, generally accepted in the scientific community, that supports the conclusion that DNA forensic testing can produce reliable results?

II. Are there current techniques that are capable of producing reliable results in DNA identification and that are generally accepted in the scientific community?

III. In this particular case, did the testing laboratory perform generally accepted scientific techniques without error in the performance or interpretation of the tests?

We believe that our statement of the third prong says in substance what the court in Castro meant.

Admissibility analysis under the three-pronged test.

Prong I: The theory.

Considering both the record in this case and the holdings of other courts that have addressed this issue, we hold that as to the DNA "matching" evidence there is a theory, generally accepted in the scientific community, that supports the conclusion that DNA forensic testing can produce reliable results. Caldwell; Pennington; Ford; Castro; Schwartz; Spencer; Andrews; see also People v. Wesley, 140 Misc.2d 306, 533 N.Y.S.2d 643 (N.Y.Co.Ct.1988). We described that theory earlier. As we explain in detail presently, we do not hold that this portion of the test was met concerning the DNA population frequency statistical evidence (e.g., in Perry's case, Dr. McElfresh's testimony that the probability of finding similar DNA was 1 in 209,100,000).

Prong II: Techniques.

Considering the holdings of other courts that have addressed this issue, we hold that there are current techniques that are capable of producing reliable results in DNA "matching" and that are generally accepted in the scientific community. Caldwell; Ford; Pennington; Castro; Schwartz; Spencer; Andrews. Again, we do not hold that this portion of the test was met concerning DNA population frequency evidence.

Prong III: Performance and interpretation of accepted techniques.

The third prong asks: In this particular case, did the testing laboratory perform generally accepted scientific techniques without error in the performance or interpretation of the tests?

In order to answer this question, we must make two inquiries. First, were the techniques used by the testing laboratory generally accepted in the scientific community? Second, was there error in the performance or interpretation of the tests?

Regarding the first inquiry, we recognize and are almost persuaded by the holdings in other cases that have involved the question whether Lifecodes' techniques are generally accepted in the scientific community. In each instance, Lifecodes' techniques were held to be generally accepted in the scientific community. Caldwell; Ford; Castro; Spencer; Andrews. The

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record before us does not support such a holding, however. Apart from specific testimony on the "Southern transfer" portion of the procedures used by Lifecodes (step 4 in the description of DNA analysis, supra), Squeglia and Dr. McElfresh testified in a limited, conclusory manner that the techniques they used were generally accepted in the scientific community. Considering the import of this issue, we will not hold that that testimony of Squeglia and Dr. McElfresh, who both have an obvious interest in validating Lifecodes' techniques, was sufficient to support a holding that those techniques are generally accepted in the scientific community.

We note that if in the future it is proved to this Court that certain techniques are generally accepted in the scientific community and then those same techniques are exclusively used in other cases, it may be possible to hold as a matter of law that the techniques are generally accepted in the scientific community.

The evidence in the record before us is not sufficient for us to determine whether there was error in the performance or interpretation of the tests. 1 Perry cross-examined Dr. McElfresh on this issue, but Perry did not provide his own evidence to establish that there was error in the performance or the interpretation of the tests. The cases that we have discussed in relation to other issues of admissibility strongly suggest that DNA evidence can

meet every other requirement of admissibility but nevertheless fail on this requirement. Caldwell; Ford; Castro; Schwartz; Pennington; Two Bulls. Caldwell and Castro exemplify this.

In Caldwell, the Supreme Court of Georgia addressed a defendant's "concerns [about] Lifecodes' quality control [and] the manner in which it declares a 'match.' " 260 Ga. at 279, 393 S.E.2d at 437. Addressing those concerns, the court wrote:

"The dispute centers on the techniques and procedures followed (or not followed) by Lifecodes in this case. Initially, then, we need to decide whether such concerns go merely to weight or whether they implicate admissibility also.

"We recognize that, while the DNA identification procedures and technology used in this case have been widely used in laboratories for years in experimental and diagnostic settings, the transfer of this technology to a forensic setting is comparatively recent. As noted previously, there are three private laboratories in this country doing forensic DNA analysis. One of them uses procedures entirely different from those explained above (and the record in this case does not explain what those procedures are). The other two use essentially the same technology, but their protocols are different, and they use different restriction enzymes and different probes. The FBI has recently set up its own forensic DNA lab, using still different restriction enzymes and probes. One consequence of this is that the database generated by each system for use in probability analysis is unusable by the other laboratories.

"In other respects, there may be disagreements at present about, for example, what is a match. Because of 'band shift,' two lanes of identical samples may not run exactly the same, raising questions such as: How much variation can exist before a match is not a match? What tests, if any, should be run to determine whether a difference in the pattern on two lanes of an autoradiograph is due to band shift?

"In light of the novelty of the use of DNA analysis in forensics, the complexity of the tests, and the present lack of national standards governing such tests,

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we conclude the trial court was correct when it determined not just whether the general scientific principles and techniques involved are valid and capable of producing reliable results, but also whether Lifecodes substantially performed the scientific procedures in an acceptable manner. Compare [State] v. Schwartz, 447 N.W.2d 422, 428 (Minn.1989); People v. Castro, 545 N.Y.S.2d 985 (Sup.Ct.1989). We believe this approach is consistent with Harper v. State, supra, 249 Ga. at 524-526, 292 S.E.2d 389 [(1982)].

"This does not mean that the trial court must exclude novel scientific evidence unless convinced there is no possibility of error. No procedures are infallible. If, for example, a sample was accidentally mislabelled, and the laboratory compared two samples from the same source believing it was comparing a sample of evidence with a sample from the defendant, the result would be a false match. Or, if the laboratory mistakenly or carelessly added sample material from the defendant to the evidentiary sample, and the evidentiary sample was very degraded, leaving no bands on the autoradiograph, the bands from the defendant's sample in evidence lane would match the bands in the lane assigned the defendant's sample, and, again, a false match would occur.

"Obviously, a laboratory needs to take precautions at all stages of its testing procedures. The defendant's experts testified about various ways that errors conceivably could occur, including mislabelling and crossmixing of samples, bacterial contamination, less than perfect chemical preparations, and so forth. We agree with the trial court's assessment that Lifecodes' protocol is adequate to meet these concerns. More significant were criticisms about: (1) the manner in which a match was declared; (2) Lifecodes' failure (initially) to test for band shift; and (3) the probability estimates."

260 Ga. at 286-87, 393 S.E.2d at 441-42. The court ultimately concluded that in Caldwell Lifecodes' declaration of a "match" was proper. 260 Ga. at 288-89, 393 S.E.2d at 443.

In Castro, the court held a portion of the DNA evidence admissible and a portion inadmissible because Lifecodes, the testing laboratory, had made errors in the performance of the tests. The court discussed potential problems with the performance and interpretation of DNA tests:

"When scientists use Southern Blots for clinical or diagnostic purposes they use fresh or dried blood samples from a known source. Thus, if a particular experiment gives an uninterpretable result, the scientist need only obtain more blood from the patient and re-perform the experiment. In forensic cases, however, the sample--say a blood stain found at a crime scene, or a semen sample obtained from a rape victim--is limited. If the experiment goes awry, there is no way to redo it. Thus, for forensic purposes, there is only one bite of the apple. The forensic scientist must take special pains to be sure that proper controls were utilized to ensure that the experiment was performed correctly. Additionally, forensic samples are frequently contaminated by material which mixes with the blood at the scene, or by bacteria which grows in the sample. If these contaminants contain DNA, that DNA will show on the

autoradiograph along with the human DNA. Thus, the forensic scientist must also have a method for determining which DNA is human and which DNA is nonhuman. Unlike the clinical scientist who can simply obtain more sample which is uncontaminated, the forensic scientist must make the best interpretation possible with what is available.

"The forensic scientist also faces problems in interpreting the autoradiograph which clinical scientists do not. The clinical scientist knows who the subject is and can obtain blood samples from the subject's parents. Thus, the clinical scientist can run lanes of the subject's parents' DNA alongside that of the subject. This procedure allows for relative certainty in measuring the kilobase size of a given allele. Since the allele in question must have been transmitted to the subject

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by one of the parents, a comparison of the three DNA samples can resolve ambiguities about whether one allele in fact matches another. The forensic scientist does not have this luxury. The forensic sample comes from an unknown source whose parent can be anybody in the world. Thus, the forensic scientist must use other means to resolve ambiguities, or face the fact that the autoradiograph is uninterpretable and the evidence is rendered worthless."

144 Misc.2d at 969-70, 545 N.Y.S.2d at 993-94.

Finally, in regard to whether there was error in the performance or interpretation of the tests, we note that this challenge to admissibility will be available even if the challenge under the first portion of the third prong is determined as a matter of law.

To summarize our discussion of the third prong of the admissibility test, we hold that the evidence in the record before us is insufficient for us to determine whether there was error under either of the two inquiries that must be addressed in the third prong of the analysis. As in the preceding sections, we do not address our discussion in this section to the DNA population frequency statistical evidence.

Population Frequency Statistics.

Dr. McElfresh testified that in his analysis to determine whether Perry's blood "matched" the blood found on Wallace's clothing and front doorknob, he examined three sets of chromosome groupings. In relation to that testimony, Dr. McElfresh also testified:

"Q. In regard to all three of those appearing in an individual, did you perform a statistical analysis in that regard?

"A. Yes. And that analysis simply--the probability of finding all these three things in one individual is the probability of the first times the probability of the second times the probability of the third; and that number is overall we would expect to find that pattern for all three chromosomes once in 209,100,000 times.

"Q. Is that what makes DNA so unique?

"A. Yes. That is, in effect, the measure of the uniqueness between individuals of DNA."

Courts addressing the admissibility of DNA evidence have distinguished between the admission of testimony that one sample of DNA "matches" another sample of DNA (the kind of testimony discussed in other sections of this opinion) and the admission of testimony concerning the frequency with which a given DNA pattern might occur statistically or might occur in a given population, which we denominate "DNA population frequency statistics." See, e.g., Caldwell; Castro; Schwartz; Harbold; Two Bulls. We explain presently why proper proof of DNA population frequency statistics requires additional evidence from DNA "matching" evidence.

We use the same three-pronged test that we stated earlier for testing the admissibility of evidence of DNA population frequency statistics. Restated specifically for this purpose, the test is:

I. Is there a theory, generally accepted in the scientific community, that supports the conclusion that DNA population frequency statistics, as above defined, can give reliable results?

II. Are there current techniques that are capable of producing reliable results in DNA population frequency statistics, as above defined, and that are generally accepted in the scientific community?

III. In this particular case, did the testing laboratory perform generally accepted scientific techniques without error in the actual performance or interpretation of the tests? (The same two inquiries required by this prong in regard to DNA matching evidence are also required for DNA population frequency statistics.)

The entire foundation for Dr. McElfresh's statistical testimony was his testimony that "We have a database of blood samples from all over the country and we

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ask the question have we ever seen bands in this position.... We have asked the question 'How many people would we have to look at before we saw another person like this?' " Such limited, conclusory evidence is insufficient to allow admissibility under any of the individual parts of the test stated above, much less all of it.

There are both scientific/mathematical and legal reasons for distinguishing between the admissibility of DNA "matching" evidence and the admissibility of DNA population frequency statistics. Stated simply, the evidence necessary to show a "match" does not by itself indicate the frequency with which a given DNA pattern might occur statistically or might occur in a given population; to establish population frequency generally requires data on the relevant populations involved as well as data for the mathematical, statistical analysis.

The legal reasons for distinguishing between the admissibility of DNA "matching" evidence and the admissibility of DNA population frequency statistics involve the potential impact of the population frequency testimony on the jury: DNA "matching" testimony may say that everyone's DNA is unique, but the impact of that testimony is not as strong as quantitatively stating that 1 in 209,100,000 people might have DNA similar to the DNA in the blood found at the scene of the killing. In Schwartz, the Minnesota Supreme Court, addressing DNA population frequency statistics, wrote:

"In a trilogy of cases culminating with State v. Joon Kyu Kim, 398 N.W.2d 544 (Minn.1987), we held that while expert interpretation of scientific results is not foreclosed, a limitation on the use of population frequency statistics is necessary because of the danger that such evidence will have a 'potentially exaggerated impact on the trier of fact' (citations omitted). In [State v.] Boyd, 331 N.W.2d 480, 482 (Minn.1985), we emphasized that:

"[I]t is [not] necessarily wrong to inform the jury of the underlying statistical evidence but that there is a real danger that the jury will use the evidence as a measure of the probability of the defendant's guilt or innocence, and that the evidence will thereby undermine the presumption of innocence, erode the values served by the reasonable doubt standard, and dehumanize our system of justice.

331 N.W.2d at 483 (citing Tribe, Trial by Mathematics: Precision and Ritual in the Legal Process, 84 Harv.L.Rev. 1329, 1355 (1971)."

447 N.W.2d at 428.

We agree with Schwartz's assessment that DNA population frequency evidence creates a "potentially exaggerated impact on the trier of fact." We are concerned that the testimony unduly encourages the trier of fact in its determination of whether the State has proven guilt beyond a reasonable doubt to focus solely upon a numerical conclusion and to disregard the weight of other evidence. See Harbold, 124 Ill.App.3d at 382-83, 79 Ill.Dec. at 845, 464 N.E.2d at 749.

These concerns can be properly addressed in an analysis of whether the probative value of the evidence outweighs its prejudicial effect. Even if population frequency statistics are otherwise admissible under the test set out in this discussion, if the prejudicial impact of the evidence outweighs its probative value, the evidence is not admissible. Ex parte Smith, 581 So.2d 531 (Ala.1991). See also Two Bulls, at 61 (trial court should determine "whether statistics used to determine the probability of someone else having the same genetic characteristics is more probative than prejudicial under [Federal] Rule [of Evidence] 403").

Procedures for challenging DNA evidence.

Earlier, we stated that Perry contends that the trial court erred by submitting the DNA evidence to the jury without first holding a hearing concerning its admissibility. As we explain presently, we do not hold that the trial court has necessarily erred.

We do hold, however, that if the admissibility of DNA evidence is challenged,

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the trial court should conduct a hearing outside the presence of the jury to address the considerations raised in this opinion. That hearing can be conducted either as a preliminary hearing or when the court chooses, but it should be held outside the presence of the jury, because the admissibility of the evidence is what is challenged. This is not an unusual or unduly burdensome procedure; trial courts routinely hear motions in limine prior to the offer of evidence at trial and routinely conduct evidentiary hearings. See Two Bulls, at 60.

DNA evidence is discoverable, at least by the defendant. The defendant's fair trial and due process rights, Art. I, § 6, Alabama Constitution, as well as Rule 16.1, A.R.Crim.P., clearly require that the prosecution allow the defendant access to the DNA evidence. See also Schwartz, 427-28. Discovery by the State of DNA evidence in the possession of the defendant should be conducted in accordance with Rule 16.2, A.R.Crim.P.

To produce uniformly sufficient information to allow a proper, well-informed determination of the admissibility of DNA evidence and to produce uniformity in DNA evidentiary hearings, we further suggest the following guidelines, which we take substantially from Castro, 144 Misc.2d at 978-79, 545 N.Y.S.2d at 999:

1. The proponent of the DNA evidence, whether defense or prosecution, should give discovery to the adversary, which should include, upon request: (1) Copies of autorads, with the opportunity to examine the originals. (2) Copies of laboratory books. (3) Copies of quality control tests run on material utilized. (4) Copies of reports by the testing laboratory issued to the proponent. (5) A written report by the testing laboratory setting forth the method

used to declare a match or non-match, with actual size measurements, and mean or average size measurement, if applicable, together with standard deviation used. (6) A statement setting forth observed contaminants, the reasons therefore, and tests performed to determine the origin and the effects thereof. (7) If the sample is degraded, a statement setting forth the tests performed and the results thereof. (8) A statement setting forth any other observed defects or laboratory errors, the reasons therefore and the effects thereof. (9) Chain of custody documents. (10) A statement by the testing lab, setting forth the method used to calculate the allele frequency in the relevant population. (11) A copy of the data pool for each loci examined. (12) A certification by the testing lab that the same rule used to declare a match was used to determine the allele frequency in the population. (Note that the discovery provisions in (10), (11), and (12) specifically address evidence of DNA population frequency statistics.)
2. The proponent shall have the burden of going forward to establish that the tests and calculations were properly conducted. Once this burden is met, the burden of proof shifts to the adversary to prove, by a preponderance of the evidence, that the tests and calculations should be suppressed or modified.
Judgment.

Perry has not proved that the trial court committed reversible error; the State did not prove that either the DNA matching evidence or the population frequency statistical evidence was admissible under the tests established in this opinion. Normally, if the appellant does not prove reversible error, we simply affirm the judgment. Because of the novelty of the issues presented in this case, because only with this opinion have we established methods for admitting DNA evidence in Alabama, because the record does not sufficiently indicate whether the evidence was admissible, and considering the potentially devastating impact on Perry's defense caused by the DNA evidence presented at trial, we remand this cause to the Court of Criminal Appeals with instructions for it to remand for the trial court to conduct an evidentiary hearing to determine the admissibility of

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both the DNA "matching" evidence and the DNA population frequency statistical evidence. If the trial court determines that either the "matching" evidence or the population frequency statistical evidence is inadmissible, then the admission of the testimony was improper and the trial court should enter an order granting Perry a new trial. If the trial court determines that the contested evidence is admissible under the tests prescribed in this opinion, it should then determine if the admission was otherwise proper. It should then enter an appropriate order, either modifying or leaving undisturbed its judgment of conviction.

REMANDED WITH INSTRUCTIONS.

HORNSBY, C.J., and MADDOX, ALMON, SHORES, ADAMS, HOUSTON and STEAGALL, JJ., concur.

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1 We are aware of the testimony of Squeglia and Dr. McElfresh that a DNA test cannot indicate a match when there is no match, because the test will simply fail to provide any results if it is improperly performed. Similar claims were made by scientists in Wesley, Andrews, and Castro. From these statements, the State contends that a match, if made, cannot be flawed. We strongly reject both this contention and the testimony supporting it as hyperbole. Our discussion, particularly of Castro and of Caldwell, indicates that there can be errors in both the performance of the tests and their interpretation, both of which can lead to an improper "match."