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641 N.E.2d 1342
419 Mass. 15, 63 USLW 2376, 63 USLW 2399
COMMONWEALTH

v.
Thomas J. LANIGAN.
Supreme Judicial Court of Massachusetts,
Norfolk.
Argued Sept. 8, 1994.
Decided Nov. 18, 1994.

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[419 Mass. 16] William C. McPhee, Quincy, Dolores E. O'Neill, Boston, with him, for defendant.
Stephanie Martin Glennon, Asst. Dist. Atty., for the Com.
Before [419 Mass. 15] LIACOS, C.J., and WILKINS, ABRAMS, NOLAN and LYNCH, JJ.
[419 Mass. 16] WILKINS, Justice.

In *Commonwealth v. Lanigan*, 413 Mass. 154, 596 N.E.2d 311 (1992) (*Lanigan I*), this court upheld a pretrial ruling that had excluded the admission of deoxyribonucleic acid (DNA) test results that showed a match between the defendant's DNA and DNA found on the clothes of one of the victims. We did so because it did not appear that the process that the Commonwealth used for estimating the frequency with which the defendant's DNA profile would occur in the population had been generally accepted in the field of population genetics. On remand, the Commonwealth immediately advanced a new and different process for determining the likelihood of a DNA match. On the basis of that new process, a judge ruled in the Superior Court that DNA evidence tending to incriminate the defendant was admissible. 1

At a bench trial in which the defendant stipulated to the evidence against him, including the DNA evidence, the defendant was found guilty of rape of a child and of indecent assault and battery on three minors. We granted the defendant's application for direct appellate review and once again consider the admissibility of DNA test results. See *Commonwealth v. Daggett*, 416 Mass. 347, 622 N.E.2d 272 (1993); *Lanigan I*, supra; *Commonwealth v. Curnin*, 409 Mass. 218, 565 N.E.2d 440 (1991). This time we conclude that an adequate basis for the admission of testimony on the statistical probability of a DNA match is established, and thus the DNA evidence was admissible. Before we may properly reach and discuss the DNA evidentiary [419 Mass. 17] issue, however, we discuss and reject the defendant's argument that the delay in his trial required the dismissal of the charges against him.

1. The defendant argues that two motions for dismissal of the charges against him should have been allowed because of the denial of his right to a timely trial pursuant to Mass.R.Crim.P. 36, 378 Mass. 909 (1979), and because of the denial of his constitutional right to a speedy trial under the Sixth and Fourteenth Amendments to the Constitution of the United States and art. 11 of the Massachusetts Declaration of Rights. We reject both aspects of his argument.

The defendant contends that his motions for dismissal of the charges should have been allowed because three intervals of time should not have been excluded in the calculation of the date by which, pursuant to Mass.R.Crim.P. 36(b), he should have been tried. Only two of them require any analysis. 2

The defendant asserts that the one-year period consumed by the Commonwealth's appeal in *Lanigan I* (from the allowance of his motion in limine to exclude DNA evidence) should have been counted in calculating the time within which rule 36(b) prescribes that he should have been tried. Rule 36(b)(2)(A)(iv) expressly excludes any period of delay "resulting from interlocutory appeals." This exclusion applies to appeals by the Commonwealth. See *Commonwealth v. McCants*, 25 Mass.App.Ct. 735, 740 n. 1, 522 N.E.2d 15 (1988); *Commonwealth v. Stevenson*, 22 Mass.App.Ct. 963, 964, 494 N.E.2d 1040 (1986). That one-year period was properly excluded in the rule 36 calculation.

The defendant also objects to the exclusion of the period of delay immediately following *Lanigan I* resulting from the presentation of, and deliberations on, the Commonwealth's attempt to support the admission

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of DNA test results based [419 Mass. 18] on new probability estimates. On the day after the rescript in *Lanigan I* was received in the clerk's office, the Commonwealth requested of a Superior Court judge that he find, pursuant to rule 36(b)(2)(F), that the ends of justice served by granting a continuance for reconsideration of the admissibility of

DNA test results "outweighed the best interests of the public and the defendant in a speedy trial." The judge made such a finding. The Commonwealth was ready to and did forthwith present expert testimony in support of a different DNA frequency calculation from that rejected in Lanigan I. In Lanigan I, this court noted the existence of an approach that appeared likely to be more acceptable than the frequency calculations considered in that case (see Lanigan I, 413 Mass. at 163, 596 N.E.2d 311) and left open the question whether the Commonwealth might be allowed to submit additional frequency estimates (*id.* at 166 n. 13, 596 N.E.2d 311). The ends of justice and the public interest in the resolution of the admissibility of incriminating DNA test results justifies the judge's finding that any period of delay involved in reconsideration of the admissibility of DNA test results should be excluded for rule 36 purposes. This case presented special circumstances concerning a relatively new method of significant potential in the proof of guilt in criminal cases. As required by the rule, the judge set forth adequate reasons for finding that the ends of justice justified excluding the period of delay from the rule 36 calculation.

Certainly the fifty-three month span between the defendant's arraignment and his trial is sufficient to invoke a constitutionally-based speedy trial analysis. See *Barker v. Wingo*, 407 U.S. 514, 530-533, 92 S.Ct. 2182, 2191-2192, 33 L.Ed.2d 101 (1972); *Commonwealth v. Edgerly*, 390 Mass. 103, 104, 453 N.E.2d 1211 (1983). We consider the length of the delay, the reasons for it, the extent of the defendant's assertion of his right to a speedy trial, and the prejudice, if any, to the defendant. 3 The considerable delay was attributable to [419 Mass. 19] the matters related to DNA testing: (a) the obtaining of the test results, (b) the hearing and deliberations in the Superior Court leading to the ruling that the evidence was inadmissible, (c) the appellate process resulting in Lanigan I, and (d) the reconsideration of the admissibility question following this court's opinion in Lanigan I. In none of this was the Commonwealth a culpable cause of delay. In fact, in certain instances, the Commonwealth acted with commendable promptness.

The defendant, who has been incarcerated throughout the pendency of the charges, did not move for dismissal of the charges on speedy trial grounds until more than two years after his arraignment, and now makes no claim that that motion was improperly denied. In April, 1992, while Lanigan I was pending in this court, and again in December, 1992, while a Superior Court judge had the post-Lanigan I admissibility question under advisement, the defendant again moved for dismissal. For reasons we have already set forth in discussing the defendant's rule 36 argument, there were strong public interest reasons justifying the delay. See *Barker v. Wingo*, *supra* 407 U.S. at 531, 92 S.Ct. at 2192; *Commonwealth v. Edgerly*, *supra* 390 Mass. at 105, 453 N.E.2d 1211. Moreover, the defendant agreed to various continuances and sought others. The record does not indicate the defendant's zealous pursuit of his right to a speedy trial.

Most important is the fact that the defendant cannot show that he was significantly prejudiced by the delay. He stipulated to the Commonwealth's evidence at trial and presented no evidence in his defense. There can be no showing that any memory faded or any witness disappeared. Indeed,

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the evidence against the defendant from prospective witnesses who knew him was substantial, quite apart from the DNA test results. It is true that the delay enabled the Commonwealth to support the admission of evidence showing the statistical [419 Mass. 20] probability of a match of the defendant's DNA in the general population and thus to achieve the admissibility of the DNA test results. A late discovery of incriminating evidence or a late determination of the admissibility of incriminating evidence which occurs as a result of a claimed improper delay in the trial of a case does not alone present the kind of prejudice to a defendant's case with which constitutional speedy trial principles are concerned. The prejudice that is relevant is the impairment of the defendant's case by reason of the delay. See *Commonwealth v. Edgerly*, *supra* at 105-106, 453 N.E.2d 1211; *Commonwealth v. Look*, 379 Mass. 893, 901-902, 402 N.E.2d 470, cert. denied, 449 U.S. 827, 101 S.Ct. 91, 66 L.Ed.2d 31 (1980). None is shown here. The defendant's constitutional rights to a speedy trial were not violated.

2. We come then to the admissibility of the evidence relating to the results of DNA testing. As we have already noted, a test comparing the defendant's DNA and DNA obtained from the clothes of one of the victims indicated a match. Over the defendant's objection, evidence of the match and of its statistical significance was submitted to the judge as the trier of fact. Evidence of a match based on currently used testing processes is meaningless without evidence indicating the significance of the match. See *Commonwealth v. Curnin*, 409 Mass. 218, 222 & n. 7, 565 N.E.2d 440 (1991). The defendant's challenge is to the admission of expert opinion evidence as to the statistical significance of the match, that is, evidence of the probability of a random match of the defendant's DNA in the general population. Based on various assumptions, the expert testimony concerning the probability of a match of the defendant's DNA in the general population ranged from 108,000 to one to 311,000 to one. His argument is that the process by which the probability of a random DNA match was determined is not generally accepted in the scientific community and thus lacks a necessary basis for its admission in evidence.

The expert testimony concerning the probability of a random DNA match was based on what the Commonwealth argues is a conservative approach that, it says, overcomes the [419 Mass. 21] existence of any dispute in the scientific community over the use of the so-called product rule. Under the product rule, the frequency in the population base of each allele disclosed in the DNA test is multiplied to produce the frequency of the combination of all the alleles found. See *Commonwealth v. Curnin*, supra at 224 n. 10, 225 n. 11, 565 N.E.2d 440. The product or multiplication rule is based on the assumption that the population does not contain subpopulations with distinct allele frequencies, and, therefore, each person's alleles constitute statistically independent random selections from a common gene pool. *Id.* at 225 n. 11, 565 N.E.2d 440. The validity of the use of the multiplication rule thus depends on the absence of population substructure. If there is population substructure, the assumption of complete statistical independence of alleles is not valid.

The Commonwealth's so-called conservative approach was recommended in a 1992 report by a committee of the National Research Council of the National Academy of Sciences, entitled "DNA Technology in Forensic Science" (hereinafter the NRC Report). The committee assumed for the sake of discussion that population substructure may exist and provided a method for estimating population frequencies in a manner that, in its view, would adequately account for it. NRC Report at 12. The committee recommended the use of what it called the ceiling principle, which it said was conservative in the sense that the estimated frequencies would be based on assumptions favorable to a criminal defendant. *Id.* at 13.

We have previously considered the admissibility of expert testimony concerning the significance of DNA test results that showed a match between the defendant's DNA and DNA found at a crime scene. In *Commonwealth v. Curnin*, supra, we concluded that there was "no demonstrated general acceptance or inherent rationality" of the means

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used to arrive at the stated probability (59,000,000 to one) that someone other than the defendant would have the same alleles as were shown in the DNA tests. *Id.* at 222, 227, 565 N.E.2d 440. The court considered not only whether the Commonwealth had demonstrated that the community of scientists involved generally [419 Mass. 22] accepted the theory or process (*id.* at 222, 565 N.E.2d 440, citing *Frye v. United States*, 293 F. 1013 [D.C.Cir.1923]), "but also whether the conclusion reached from the DNA test results was so logically relevant that the evidence could be admissible even if there were no general acceptance of the process by involved scientists" (*Commonwealth v. Curnin*, supra 409 Mass. at 223 n. 8, 565 N.E.2d 440). We held that the evidence should not have been admitted based on what was then demonstrated about the probabilities of a DNA match, but noted that perhaps "the relevant scientific community can generally agree on a means of arriving at a conservative estimate of the probability of another person having the same alleles and thus resolve all uncertainties and variables in favor of the defense." *Id.* at 226-227, 565 N.E.2d 440.

We next considered the admissibility question in the earlier appeal in this case that led to our opinion in *Lanigan I*. Since the release of our 1991 opinion in *Commonwealth v. Curnin*, supra, the NRC Report had been released. That report noted that the question was considerably debated by population geneticists whether the databases used for determining probabilities were appropriate for the process used (i.e., the product rule). *Lanigan I*, supra 413 Mass. at 162, 596 N.E.2d 311. We held in *Lanigan I* that the process used had not received general acceptance by population geneticists and upheld the pretrial ruling that the DNA evidence was not admissible. *Id.* at 162-163, 596 N.E.2d 311. We noted the recommendation of the NRC Report that for forensic purposes a "ceiling frequency" be used for DNA frequency calculations. 4 *Id.* at 163, 596 N.E.2d 311. As we have said earlier, on remand after *Lanigan I*, the Commonwealth successfully turned to the ceiling principle in support of the admission in [419 Mass. 23] this case of DNA test results and of evidence of the statistical probability of a random match.

Several other courts have also noted the potential that the ceiling principle would resolve any admissibility problem because it would produce a conservative estimate (or, perhaps one should say, an overestimate) of the frequency with which a defendant's DNA (or, more accurately, particular alleles) would appear in randomly selected population groups. See, e.g., *State v. Barney*, 8 Cal.App. 4th 798, 821-822, 10 Cal.Rptr.2d 731 (1992); *State v. Sivri*, 231 Conn. 115, 161, 646 A.2d 169 (1994); *State v. Vandebogart*, 136 N.H. 365, 382-383, 616 A.2d 483 (1992). At least three courts have even treated the ceiling principle described in the NRC Report as sufficiently accepted so as to permit the admission of probability testimony based on that principle. See *State v. Bloom*, 516 N.W.2d 159, 167 (Minn.1994); *State v. Anderson*, 118 N.M. 284, ----, 881 P.2d 29, 47 (N.M.1994); *State v. Cauthron*, 120 Wash.2d 879, 908-909, 846 P.2d 502 (1993). But see *People v. Wallace*, 14 Cal.App. 4th 651, 660, 17 Cal.Rptr.2d 721 (1993). On the other hand, there have been challenges to the general acceptance of the ceiling principle as a means of eliminating the effects of the dispute as to whether the product rule properly may be used to calculate the probability of a random match of a defendant's alleles. The defendant cites various scientific opinions

and studies that suggest or indicate that the ceiling principle is not necessarily conservative. 5 Before we discuss the significance[419 Mass. 24]

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of criticisms of the ceiling principle, it is important that we set forth the standard for determining the admissibility of scientifically-based expert testimony.

Our test for the admissibility of expert testimony based on scientific knowledge has usually been the Frye test, "that is, whether the community of scientists involved generally accepts the theory or process. *Frye v. United States*, 293 F. 1013 (D.C.Cir.1923)." *Commonwealth v. Curnin*, supra 409 Mass. at 222, 565 N.E.2d 440. See *Commonwealth v. Mendes*, 406 Mass. 201, 204-206, 547 N.E.2d 35 (1989). The test has a practical usefulness because, if there is general acceptance in the relevant scientific community, the prospects are high, but not certain, that the theory or process is reliable. The ultimate test, however, is the reliability of the theory or process underlying the expert's testimony. See *Commonwealth v. Kater*, 388 Mass. 519, 527, 447 N.E.2d 1190 (1983). Thus we have recognized the risk that reliable evidence might be kept from the factfinder by strict adherence to the Frye test. See *Commonwealth v. Curnin*, supra 409 Mass. at 223 n. 8, 565 N.E.2d 440. See also *Commonwealth v. Ghee*, 414 Mass. 313, 320, 607 N.E.2d 1005 (1993); *Commonwealth v. Mendes*, supra 406 Mass. at 213, 547 N.E.2d 35 (Liacos, C.J., dissenting), and cases cited. Perhaps the relevant scientific community has not yet digested and approved the foundation of the theory or process, but the theory or process is so logically reliable that evidence should be admitted even without its general acceptance by involved scientists. In some circumstances, perhaps without adequately articulated reasons, we simply have decided that Frye principles do not apply in deciding on the admissibility of expert testimony apparently based on a scientific theory or process. See Geiger, *The Judicial Gatekeeper: Should Massachusetts Apply Daubert to [419 Mass. 25] Screen Expert Testimony?*, 79 *Mass.L.Rev.* 94, 98-99 (1994).

The Commonwealth urges us to adopt the reasoning of *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993), in which the Supreme Court determined that, by adoption of Rule 702 of the Federal Rules of Evidence, the Frye test had been abandoned in the Federal courts. *Id.* at ---, 113 S.Ct. at 2794. That rule, which is the same as Rule 702 of the Massachusetts Proposed Rules of Evidence, reads as follows: "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise."

In its *Daubert* opinion, the Court recognized that general acceptance by the scientific community was a relevant factor in determining the admissibility of expert testimony based on a scientific theory or technique. *Id.* at ---, 113 S.Ct. at 2797. But such acceptance, the essential ingredient of the Frye principle, is not the sole test. *Id.* The Court thought relevant the question whether the theory or technique can be or has been tested. *Id.* at ---, 113 S.Ct. at 2796-2797. Peer review and publication of the theory or process is pertinent but also not an indispensable predecessor of admissibility. *Id.*

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at ---, 113 S.Ct. at 2797. The *Daubert* opinion finds a requirement of reliability implicit in rule 702, which on its face uses helpfulness to the trier of fact as the test of admissibility of expert testimony based on scientific knowledge.

The general proposition set forth in the *Daubert* opinion seems sound, although that opinion gives little guidance for the application of that proposition to the facts of a given case. See *id.* at ---, 113 S.Ct. at 2799 (Rehnquist, C.J., concurring in part and dissenting in part). The expert's opinion must "have a reliable basis in the knowledge and experience of his discipline." *Id.* at ---, 113 S.Ct. at 2796. The overarching issue is "the scientific validity--and thus the evidentiary relevance and reliability--of the principles that underlie a proposed submission." *Id.* at ---, 113 S.Ct. at 2797. The trial judge has a significant function to carry out in deciding on the admissibility of a scientific expert's opinion. [419 Mass. 26] If the process or theory underlying a scientific expert's opinion lacks reliability, that opinion should not reach the trier of fact. Consequently, the judge must rule first on any challenge to the validity of any process or theory underlying a proffered opinion. "This entails a preliminary assessment of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue." *Id.* at ---, 113 S.Ct. at 2796. The judge thus has a gatekeeper role. Of course, if the judge rules the opinion evidence admissible, that ruling is not final on the reliability of the opinion evidence, and the opponent of that evidence may challenge its validity before the trier of fact.

We accept the basic reasoning of the Daubert opinion because it is consistent with our test of demonstrated reliability. We suspect that general acceptance in the relevant scientific community will continue to be the significant, and often the only, issue. We accept the idea, however, that a proponent of scientific opinion evidence may demonstrate the reliability or validity of the underlying scientific theory or process by some other means, that is, without establishing general acceptance. This consideration has some application to the issue in the case before us, but the parties' significant arguments bear on the acceptability of the ceiling principle by the relevant scientific community.

The ceiling principle was adopted to make irrelevant the dispute among population geneticists over the question whether the product rule may properly be used to express numerically the probability of finding a DNA match in a random selection of the appropriate population. Among those experts who support using the product rule, many of whom the Commonwealth cites in its brief, and among those experts who believe that the ceiling principle solves any problem in the use of the product rule, the answer given by the ceiling principle is, respectively, either irrationally conservative and thus absurd or a reasonable means of producing admissible probability evidence untainted by the potential problems of population substructuring. The great weight of [419 Mass. 27] opinion appears to be in one or the other of these two groups of experts. Unanimity of opinion among the relevant scientists is not essential even under the general acceptance test. See *Lanigan I*, supra 413 Mass. at 162, 596 N.E.2d 311.

This is a rapidly developing field, and new understanding may be expected as more studies and tests are conducted. Judges must be willing and able to adapt to these changes. Criticisms of the ceiling principle largely call for more tests. Some criticisms suggest that the result in all instances may not be conservative. None of the criticisms brought to our attention indicates that the ceiling principle produces a probability prediction in this case that errs to the defendant's disadvantage. See Lempert, *DNA, Science and the Law: Two Cheers for the Ceiling Principle*, 34 *Jurimetrics J.* 41 (1993) (commenting on criticisms of the ceiling principle, including some on which the defendant relies [see note 5 above], and concluding that the criticisms are not fundamental and can be accommodated). Application of the ceiling principle in this case increased the probability of a match from only one in more than 2,000,000 (*Lanigan I*, supra at 156, 596 N.E.2d 311) to a range of one in 311,000 to

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one in 108,000. We conclude that the Commonwealth has established the reliability of the process underlying its expert testimony on probability and thus the evidence of the probability of a DNA match in a randomly selected population was properly admitted.

Judgments affirmed.

1 There is no merit to the defendant's argument that the post-*Lanigan I* proceedings should have been held before the judge who had ruled previously on the admissibility of DNA evidence in this case.

2 The defendant misreads the record in arguing that the judge who denied his second rule 36 motion for a dismissal excluded forty-five days, instead of the thirty days prescribed by rule 36(b)(2)(A)(vii), for the period during which the defendant's motion in limine to exclude DNA evidence was under advisement in the Superior Court.

3 For Sixth Amendment purposes, it has been said that the right to a speedy trial is "not primarily intended to prevent prejudice to the defense caused by passage of time." *United States v. MacDonald*, 456 U.S. 1, 8, 102 S.Ct. 1497, 1502, 71 L.Ed.2d 696 (1982). "[T]hat interest is protected primarily by the Due Process Clause and by statutes of limitations. The speedy trial guarantee is designed to minimize the possibility of lengthy incarceration prior to trial, to reduce the lesser, but nevertheless substantial, impairment of liberty imposed on an accused while released on bail, and to shorten the disruption of life caused by arrest and the presence of unresolved criminal charges." *Id.*

4 Citing the NRC Report at 3-13, we said in *Lanigan I*: "The use of a ceiling frequency, which would represent the greatest observed frequency of particular alleles within a given number of randomly selected population groups, automatically would provide for the greatest, and therefore most conservative, estimate of the frequency of a DNA profile. One of the principles behind the recommendation of a ceiling frequency is the notion that any error in calculating profile frequencies that is caused by population substructure should accrue to the benefit of the individual against whom the DNA testing is being used." *Id.* at 163, 596 N.E.2d 311.

5 See Cohen, *The Ceiling Principle is not Always Conservative in Assigning Genotype Frequencies for Forensic DNA Testing*, 51 *Am.J.Hum.Genetics* 1165, 1166-1167 (1992) (suggesting that the ceiling principle does not always produce a conservative result, pointing to an example in which the result may be unfairly inculpatory, and urging exploration of alternative methods of estimating a match probability); Slimowitz, *Violations of the Ceiling Principle: Exact Conditions and Statistical Evidence*, 52 *Am.J.Hum.Genetics* 314, 315, 322 (1993) (describing circumstances in which the ceiling principle can fail to be conservative and is not always mathematically reliable, and calling for more research); Krane, *Genetic Differences at Four DNA Typing Loci in Finnish, Italian, and Mixed Caucasian*

Populations, 89 Proc. Nat'l Acad. Sci. USA 10583, 10583, 10586, 10587 (1992) (recommending more studies but commenting that "the interim ceiling principle [recommended by NRC report for use until more data are gathered] is a significant improvement over the conventional product rule for estimating the probability of matching DNA profiles." Although no theory "guarantees that estimated match probabilities will always be conservative," the relevant considerations "are not likely to seriously compromise most estimates derived from the interim ceiling principle"); Weir, Population Genetics in the Forensic DNA Debate, 89 Proc. Nat'l Acad. Sci. USA 11654, 11656-11658 (1992) (criticizing certain aspects of the Report, suggesting more studies, but not pointing to any failing of the ceiling principle that would make its use unreliable for forensic use).