

## FOR THE RECORD

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# Minimal Y-Chromosome Haplotypes Plus DYS287 in Jewish Populations\*

**POPULATION:** A total of 71 Jewish individuals obtained from the collection of The National Laboratory for the Genetics of Israeli Populations at Tel-Aviv University: 14 Ashkenazi, 21 Sephardic (from Turkey), 23 North African (from Morocco, Libya and Tunisia) and 13 Oriental (from Iraq and Iran)

**KEYWORDS:** forensic science, minimal Y-chromosome haplotype, DYS287, short tandem repeats, Jewish populations

The loci studied were the STRs of the so-called minimal haplotype: DYS19, DYS389I and II, DYS390, DYS391, DYS392, DYS393 and DYS385, plus the Alu Y-polimorphism (DYS287). The five Y-chromosome STRs DYS19, DYS389I and II, DYS390 and DYS391 were co-amplified using approximately 20 ng of genomic DNA in a total reaction volume of 12.5 µL following the method of Gusmão et al. (1) with modifications. Coamplification of the loci DYS385 and DYS392 was performed in a duplex reaction, using approximately 20 ng of genomic DNA in a total reaction volume of 25 µL. The primers used are described in Kayser et al. (2). PCR cycling conditions were as described in Füredi et al. (3) with minor modifications. PCR amplification of DYS393 and DYS287 were achieved in singleplex under standard conditions with the primer sequences obtained from the literature

(2,4). All loci were amplified in a GeneAmp PCR System 2400 (PE Applied Biosystems).

Detection of the amplified products, except the DYS393 and DYS287 systems, was carried out using an ABI 310 automatic sequencer (PE Applied Biosystems). Samples (0.5 µL) were mixed with formamide (20 µL) and the internal standard size (GS-350 ROX) and denatured at 97°C for 5 min. GeneScan 2.1 Analysis software was used for the interpretation of the results. Allele resolution of the DYS393 system was undertaken by nondenaturing conditions, using 6% PAGE on a 0.75 mm thick gel, and DYS287 using 2% agarose gels. Alleles were visualized after gel staining with an ethidium bromide solution (5). In all cases, standard size markers and our own allele ladders were used for allele designation. Proficiency testing of the GEP-ISFH WG (<http://www.gep-isfg.org/>) was carried out as quality control.

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Analysis of data was carried out using ARLEQUIN package (6). Gene diversity was estimated according to Nei (7).

The observed haplotypes are shown in Table 1. Comparison with the haplotypes found in the Y-STR Haplotype Reference Database

TABLE 1—Observed minimal haplotypes (plus DYS287) distribution in the populations studied. (SE = Sephardic, AS = Ashkenazi, OR = Oriental, NO = North African, PO = Pooled, EU = European database. Number of individuals in brackets).

| N   | DYS 19 | DYS 389I | DYS* 389II | DYS 390 | DYS 391 | DYS 392 | DYS 393 | DYS 385 | DYS 287 | SE [21] | AS [14] | OR [13] | NA [23] | PO [71] | EU† [11610] |
|-----|--------|----------|------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-------------|
| h1  | 13     | 13       | 14 (27)    | 22      | 10      | 11      | 13      | 14, 16  | —       | 1       |         |         |         | 1       |             |
| h2  | 13     | 13       | 15 (28)    | 22      | 10      | 16      | 13      | 14, 17  | —       | 1       |         |         |         | 1       |             |
| h3  | 13     | 13       | 17 (30)    | 24      | 10      | 10      | 13      | 17, 18  | +       |         | 1       |         |         | 1       |             |
| h4  | 13     | 13       | 17 (30)    | 24      | 10      | 11      | 12      | 17, 18  | +       |         | 1       |         |         | 1       |             |
| h5  | 13     | 13       | 18 (31)    | 22      | 10      | 10      | 15      | 17, 18  | +       |         |         |         | 1       | 1       |             |
| h6  | 13     | 14       | 16 (30)    | 25      | 9       | 11      | 13      | 13, 19  | —       |         |         |         | 1       | 1       |             |
| h7  | 13     | 14       | 17 (31)    | 25      | 10      | 11      | 13      | 17, 18  | +       |         | 1       |         |         | 1       |             |
| h8  | 13     | 15       | 16 (31)    | 24      | 10      | 11      | 13      | 16, 18  | +       |         |         |         | 1       | 1       |             |
| h9  | 14     | 11       | 19 (30)    | 24      | 12      | 11      | 14      | 17, 18  | +       |         | 1       |         |         | 1       |             |
| h10 | 14     | 12       | 17 (29)    | 24      | 10      | 10      | 15      | 17, 18  | +       |         | 1       |         |         | 1       |             |
| h11 | 14     | 12       | 17 (29)    | 24      | 10      | 11      | 12      | 17, 18  | +       |         | 1       |         |         | 1       |             |
| h12 | 14     | 13       | 15 (28)    | 23      | 10      | 10      | 14      | 13, 13  | —       |         |         | 1       |         | 1       |             |
| h13 | 14     | 13       | 15 (28)    | 24      | 10      | 14      | 12      | 11, 15  | —       |         |         |         | 1       | 1       | 2           |
| h14 | 14     | 13       | 16 (29)    | 22      | 10      | 10      | 12      | 12, 15  | —       |         |         |         | 1       | 1       |             |
| h15 | 14     | 13       | 16 (29)    | 23      | 10      | 11      | 12      | 14, 17  | —       | 1       |         |         |         | 1       | 1           |
| h16 | 14     | 13       | 16 (29)    | 23      | 10      | 11      | 13      | 12, 19  | —       | 1       |         |         |         | 1       |             |

TABLE 1—Continued.

| N                           | DYS<br>19 | DYS<br>389I | DYS*<br>389II | DYS<br>390 | DYS<br>391 | DYS<br>392 | DYS<br>393 | DYS<br>385 | DYS<br>287 | SE<br>[21] | AS<br>[14] | OR<br>[13] | NA<br>[23] | PO<br>[71] | EU†<br>[11610] |
|-----------------------------|-----------|-------------|---------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----------------|
| h17                         | 14        | 13          | 16(29)        | 23         | 10         | 11         | 13         | 15, 16     | —          |            |            |            | 1          | 1          |                |
| h18                         | 14        | 13          | 16(29)        | 24         | 10         | 11         | 13         | 12, 16     | —          |            |            |            | 1          | 1          | 1              |
| h19                         | 14        | 13          | 16(29)        | 25         | 10         | 12         | 12         | 16, 17     | —          |            | 1          |            |            | 1          |                |
| h20                         | 14        | 13          | 17(30)        | 23         | 10         | 11         | 12         | 13, 15     | —          |            |            |            | 1          | 1          | 8              |
| h21                         | 14        | 13          | 17(30)        | 23         | 10         | 11         | 13         | 13, 15     | —          | 1          |            |            |            | 1          | 2              |
| h22                         | 14        | 13          | 17(30)        | 23         | 10         | 11         | 13         | 14, 16     | —          |            |            |            | 1          | 1          | 1              |
| h23                         | 14        | 13          | 17(30)        | 24         | 10         | 12         | 13         | 14, 15     | —          | 1          |            |            |            | 1          |                |
| h24                         | 14        | 13          | 17(30)        | 24         | 10         | 13         | 12         | 11, 14     | —          | 1          |            |            |            | 1          | 7              |
| h25                         | 14        | 13          | 18(31)        | 21         | 11         | 11         | 14         | 16, 16     | +          |            |            | 1          |            | 1          |                |
| h26                         | 14        | 13          | 18(31)        | 23         | 10         | 11         | 12         | 13, 18     | —          |            | 1          |            |            | 1          | 5              |
| h27                         | 14        | 13          | 18(31)        | 23         | 10         | 13         | 13         | 14, 16     | —          | 1          |            |            |            | 1          | 1              |
| h28                         | 14        | 13          | 18(31)        | 24         | 11         | 13         | 13         | 15, 16     | —          |            |            | 1          |            | 1          |                |
| h29                         | 14        | 13          | 18(31)        | 24         | 12         | 11         | 13         | 17, 17     | +          |            | 1          |            |            | 1          |                |
| h30                         | 14        | 14          | 15(29)        | 22         | 11         | 10         | 13         | 18, 20     | +          |            |            |            | 1          | 1          |                |
| h31                         | 14        | 14          | 15(29)        | 23         | 10         | 10         | 14         | 13, 13     | —          |            |            |            | 1          | 1          |                |
| h32                         | 14        | 14          | 15(29)        | 23         | 10         | 10         | 14         | 13, 19     | —          | 1          |            |            |            | 1          |                |
| h33                         | 14        | 14          | 15(29)        | 23         | 10         | 11         | 14         | 13, 14     | —          |            | 1          |            |            | 1          |                |
| h34                         | 14        | 14          | 16(30)        | 23         | 10         | 11         | 12         | 13, 19     | —          | 1          |            |            |            | 1          |                |
| h35                         | 14        | 14          | 16(30)        | 25         | 10         | 10         | 13         | 14, 16     | —          |            | 1          |            |            | 1          |                |
| h36                         | 14        | 14          | 17(31)        | 22         | 10         | 11         | 13         | 14, 15     | —          |            |            | 1          |            | 1          |                |
| h37                         | 14        | 14          | 17(31)        | 23         | 10         | 11         | 12         | 13, 19     | —          | 1          |            |            | 1          | 1          | 1              |
| h38                         | 14        | 14          | 17(31)        | 23         | 12         | 13         | 14         | 16, 17     | —          |            |            | 1          |            | 1          |                |
| h39                         | 14        | 14          | 17(31)        | 23         | 12         | 13         | 14         | 17, 17     | —          |            |            | 1          |            | 1          |                |
| h40                         | 14        | 15          | 14(29)        | 23         | 10         | 10         | 14         | 13, 13     | —          |            |            | 1          |            | 1          |                |
| h41                         | 14        | 15          | 15(30)        | 24         | 10         | 13         | 13         | 18, 19     | —          |            |            |            | 1          | 1          |                |
| h42                         | 15        | 11          | 17(28)        | 21         | 12         | 12         | 13         | 18, 19     | +          |            |            | 1          |            | 1          |                |
| h43                         | 15        | 11          | 19(30)        | 21         | 12         | 11         | 15         | 12, 13     | —          |            |            |            | 1          | 1          |                |
| h44                         | 15        | 12          | 15(27)        | 24         | 10         | 14         | 13         | 13, 16     | —          |            |            |            | 1          | 1          | 1              |
| h45                         | 15        | 12          | 16(28)        | 24         | 11         | 11         | 13         | 13, 17     | —          | 1          |            |            |            | 1          |                |
| h46                         | 15        | 12          | 17(29)        | 23         | 10         | 11         | 12         | 12, 16     | —          | 1          |            |            |            | 1          |                |
| h47                         | 15        | 12          | 17(29)        | 23         | 10         | 14         | 13         | 15, 15     | —          |            |            | 1          |            | 1          |                |
| h48                         | 15        | 12          | 17(29)        | 24         | 13         | 11         | 12         | 14, 19     | —          |            |            |            | 1          | 1          |                |
| h49                         | 15        | 12          | 17(29)        | 24         | 13         | 11         | 13         | 14, 19     | —          |            |            |            | 1          | 1          |                |
| h50                         | 15        | 12          | 18(30)        | 23         | 10         | 11         | 14         | 14, 15     | —          |            |            |            | 1          | 1          |                |
| h51                         | 15        | 12          | 19(31)        | 23         | 10         | 11         | 12         | 15, 16     | —          | 1          |            |            |            | 1          |                |
| h52                         | 15        | 12          | 19(31)        | 23         | 12         | 11         | 12         | 13, 16     | —          |            |            | 1          |            | 1          |                |
| h53                         | 15        | 12          | 19(31)        | 23         | 12         | 11         | 12         | 12, 19     | —          |            |            |            | 1          | 1          |                |
| h54                         | 15        | 13          | 16(29)        | 23         | 9          | 11         | 12         | 13, 16     | —          |            |            |            | 1          | 1          | 11             |
| h55                         | 15        | 13          | 16(29)        | 25         | 10         | 10         | 12         | 14, 19     | —          |            |            |            | 1          | 1          |                |
| h56                         | 15        | 13          | 17(30)        | 24         | 13         | 12         | 12         | 11, 13     | —          |            | 1          |            |            | 1          |                |
| h57                         | 15        | 13          | 17(30)        | 25         | 12         | 11         | 14         | 11, 14     | —          |            | 1          |            |            | 1          |                |
| h58                         | 15        | 13          | 18(31)        | 21         | 13         | 11         | 12         | 15, 18     | —          |            |            | 1          |            | 1          |                |
| h59                         | 15        | 13          | 18(31)        | 24         | 12         | 14         | 12         | 18, 19     | —          |            |            |            | 1          | 1          |                |
| h60                         | 15        | 13          | 19(32)        | 23         | 11         | 11         | 12         | 13, 13     | —          |            |            | 1          |            | 1          |                |
| h61                         | 15        | 13          | 21(34)        | 21         | 12         | 11         | 14         | 11, 16     | —          |            |            |            | 1          | 1          |                |
| h62                         | 15        | 14          | 17(31)        | 23         | 12         | 9          | 15         | 13, 19     | —          |            |            |            | 1          | 1          |                |
| h63                         | 15        | 15          | 15(30)        | 23         | 10         | 14         | 12         | 10, 18     | —          | 1          |            |            |            | 1          |                |
| h64                         | 16        | 12          | 16(28)        | 22         | 10         | 11         | 12         | 14, 15     | —          | 1          |            |            |            | 1          |                |
| h65                         | 16        | 12          | 16(28)        | 22         | 10         | 11         | 14         | 14, 14     | —          | 1          |            |            |            | 1          |                |
| h66                         | 16        | 12          | 16(28)        | 22         | 10         | 11         | 15         | 14, 14     | —          | 1          |            |            |            | 1          |                |
| h67                         | 16        | 13          | 16(29)        | 24         | 9          | 10         | 12         | 14, 16     | —          |            |            |            | 1          | 1          |                |
| h68                         | 16        | 13          | 17(30)        | 25         | 10         | 10         | 13         | 11, 14     | —          |            | 1          |            |            | 1          |                |
| h69                         | 16        | 13          | 17(30)        | 25         | 10         | 11         | 14         | 11, 14     | —          | 1          |            |            |            | 1          | 8              |
| h70                         | 17        | 13          | 16(29)        | 23         | 10         | 11         | 12         | 14, 17     | —          | 1          |            |            |            | 1          |                |
| h71                         | 17        | 13          | 17(30)        | 23         | 10         | 11         | 13         | 14, 17     | —          | 1          |            |            |            | 1          |                |
| Number of haplotypes        |           |             |               |            |            |            |            |            |            | 21         | 14         | 13         | 23         | 71         |                |
| Discriminatory capacity (%) |           |             |               |            |            |            |            |            |            | 100        | 100        | 100        | 100        | 100        |                |
| Haplotype diversity         |           |             |               |            |            |            |            |            |            | 1.000      | 1.000      | 1.000      | 1.000      | 1.000      |                |
| ±                           |           |             |               |            |            |            |            |            |            | ±          | ±          | ±          | ±          | ±          |                |
| Standard deviation          |           |             |               |            |            |            |            |            |            | 0.015      | 0.027      | 0.030      | 0.013      | 0.002      |                |

N = Number of haplotype.

\* In parenthesis DYS389II nomenclature according to Roewer et al. (8).

† Y-STR Haplotype Reference Database (<http://ystr.charite.de/>). DYS287 not included.

TABLE 2—Gene diversities at the loci studied in Jewish populations (Number of alleles in parenthesis).

| Locus    | Sephardic    | Ashkenazi    | Oriental     | North African | Pooled       |
|----------|--------------|--------------|--------------|---------------|--------------|
| DYS19    | 0.7266 (5)   | 0.6027 (4)   | 0.4980 (2)   | 0.6391 (4)    | 0.6671 (5)   |
| DYS389I  | 0.6209 (4)   | 0.6027 (4)   | 0.7213 (5)   | 0.6541 (5)    | 0.6600 (5)   |
| DYS389II | 0.7166 (6)   | 0.6230 (5)   | 0.7451 (5)   | 0.7752 (6)    | 0.7680 (7)   |
| DYS390   | 0.5946 (4)   | 0.5949 (3)   | 0.4618 (3)   | 0.7263 (5)    | 0.7200 (5)   |
| DYS391   | 0.0914 (2)   | 0.4394 (3)   | 0.6976 (4)   | 0.6242 (5)    | 0.5234 (5)   |
| DYS392   | 0.4720 (6)   | 0.9715 (3)   | 0.7806 (6)   | 0.5726 (4)    | 0.6181 (7)   |
| DYS393   | 0.6098 (3)   | 0.6943 (4)   | 0.6748 (4)   | 0.6428 (4)    | 0.6884 (4)   |
| DYS385   | 0.8958 (11)  | 0.7660 (8)   | 0.8518 (10)  | 0.9306 (17)   | 0.9537 (30)  |
| DYS287   | 0.0000 (1)   | 0.5000 (2)   | 0.2606 (2)   | 0.2279 (2)    | 0.2809 (2)   |
| Average  | 0.5253 (4.7) | 0.6438 (4.0) | 0.6324 (4.6) | 0.6436 (5.8)  | 0.6533 (7.8) |

(<http://ystr.charite.de/>) indicated the lack of the commonest European haplotypes in the Jewish populations studied. Gene and haplotype diversities, as well as forensic parameters (Tables 1 and 2), indicated that the nine Y-polymorphisms studied in Jewish populations are highly discriminating.

This dataset is available to any interested researcher upon request to the authors.

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