R. E. Gaensslen,[1] *Ph.D.; Suzanne C. Bell,*[2] *M.S.; and Henry C. Lee,*[3] *Ph.D.*

Distributions of Genetic Markers in United States Populations: II. Isoenzyme Systems

REFERENCE: Gaensslen, R. E., Bell, S. C., and Lee, H. C., **"Distributions of Genetic Markers in United States Populations: II. Isoenzyme Systems,"** *Journal of Forensic Sciences,* JFSCA, Vol. 32, No. 5, Sept. 1987, pp. 1348-1381.

ABSTRACT: All published and unpublished population frequency data that could be located for U.S. populations is tabulated and presented for the isoenzyme systems phosphoglucomutase, esterase D, adenylate kinase, acid phosphatase, glyoxalase I, adenosine deaminase, 6-phosphogluconate dehydrogenase, glutamic-pyruvic transaminase, carbonic anhydrase II, and glucose-6-phosphate dehydrogenase. Results obtained by combining data for comparable racial/ethnic groups are also presented. The results obtained with combined data may give better information on frequencies for the U.S. population at large than is obtainable from studies conducted in restricted geographic areas.

KEYWORDS: forensic science, genetic typing, demography, population genetics, genetic markers, genotypic frequencies, phenotypic frequencies, isoenzyme systems, human red cell isoenzyme polymorphism, phosphogucomutase system, esterase D system, adenylate kinase system, red cell acid phosphatase system, glyoxalase I system, adenosine deaminase system, 6-phosphogluconate dehydrogenase system, glutamic-pyruvic transaminase system, carbonic anhydrase II system, glucose-6-phosphate dehydrogenase system

The growth and development in forensic serology in the past 25 years has revealed a substantial number of genetic marker systems from which routine parentage testing protocols may be constructed [*1-3*] and for the partial individualization of blood and physiological fluid stains [*4-10*]. Interpretation of the significance of typing results in criminalistics applications and calculations of the probability of paternity in nonexclusion parentage cases both require knowledge of genotypic and phenotypic frequencies in applicable populations.

Thousands of frequency studies on various genetic marker systems have been carried out on many populations throughout the world, the most complete compilation of them being

Supported in part by Grants 76-NI-99-0107 and 78-NI-AX-0001 from the National Institute of Justice, U.S. Department of Justice, Washington, DC to REG. Various aspects of this work were presented in part at the 8th Annual Meeting of the Northeastern Association of Forensic Scientists, Albany, NY, 1982; the 35th Annual Meeting of the American Academy of Forensic Sciences, Cincinnati, OH, 15-19 Feb. 1983; and the International Symposium on Forensic Applications of Electrophoresis, FBI Academy, Quantico, VA, 1984. Received for publication 18 Sept. 1986; accepted for publication 3 Nov. 1986.

[1]Professor and director, Forensic Sciences Program and Laboratories, University of New Haven, West Haven, CT.

[2]Research chemist, Los Alamos National Laboratories, Los Alamos, NM.

[3]Chief criminalist and director, Connecticut State Police Forensic Science Laboratory, Meriden, CT.

the extraordinary work by Mourant et al. [*11*]. Genetic marker frequency data from the many different studies of U.S. populations, however, has not to our knowledge been thoroughly compiled. In this paper, we summarize all the published and some unpublished population frequency data that could be located for United States populations for 10 isoenzyme systems, along with some results obtained by combining data from different studies. This paper along with a previous [*12*] and a planned subsequent one provide a summary and analysis of U.S. population data for 22 genetic marker systems.

Methods

The conventions used in presenting the tabular data as well as the methods used in combining comparable data from different population studies were fully described in the previous paper [*12*]. Briefly, within the separate tables, each representing a different isoenzyme system, data are tabulated separately for Caucasian, Negro, Hispanic, Chinese, or Asian populations. Each population studied is identified by location and a reference is given. References to population studies are given a "*T*" (for "Table") prefix in the tables, and are separately compiled at the end of the paper. Data for each phenotype within each system are reported using a *NNN* (%.%) format, where *NNN* represents the number of individuals who possessed the phenotype and %.% represents the percentage rounded to one decimal place. The total number of people studied is also given, and is not always the sum of the major phenotypes because rare phenotypes were observed. The notes in each table provide data for rarer types, unusual or descriptive features of a population, or explanations about the calculations. Data from PGM1 system subtype studies, that is, the data in Table 2, were used to compute three-phenotype PGM frequencies which are included in Table 1 in cases where this was not done in the original paper.

Two calculations were used to combine all the data for a particular racial/ethnic class within a genetic marker system, where a sufficient number of different studies were available for comparatively similar groups within that class. The first sums the numbers of individuals for all data sets showing numbers, and a percentage value for each phenotype is computed from the resulting totals, yielding what is referred to as the "numerical total." The second weights the percentage distributions for each phenotype according to the number of individuals typed and yields what is referred to as the "weighted mean of proportions," or "WMP." A weighted standard deviation of proportions (WSDP) was also calculated for each WMP. Details were given in the previous paper [*12*].

All available data was included in the tables for completeness, but in some circumstances a data set was not used in the calculations. These circumstances included cases in which one study included the data from another study by the same author(s) and those in which only a gene frequency result was reported.

Gene frequencies were calculated by gene counting for data sets in which there was sufficient information to enable the calculation. A chi-square value was calculated for every data set for which gene frequencies could be meaningfully calculated and for the corresponding numerical totals. In the tables where gene frequency data are presented, data sets having χ^2 values corresponding to $0.01 < P < 0.05$ or $P < 0.01$ are indicated. Small phenotypic classes can make disproportionately large contributions to the chi-square statistic. When a phenotypic class involved in the calculation contained 5 or fewer, Yates' correction [*13,14*] was used in the χ^2 calculation. In the case of the ACP1 system, the CA, CB, and C phenotypic classes were combined for purposes of calculating chi-square.

The gene, genotypic, and phenotypic nomenclature rules suggested by Shows et al. [*15*] have been followed for all the systems. 6-Phosphogluconate dehydrogenase (PGD) nomenclature follows Parr and Fitch [*16*].

Most computations were carried out on a Data General MV 8000 mainframe computer with programs written in FORTRAN.

Results and Discussion

In Tables 1 through 12 are reported the phenotypic distribution and, where applicable, the estimates of gene frequencies for the phosphoglucomutase, locus 1 (PGM1), esterase D (ESD), adenylate kinase (AK), red cell acid phosphatase (acid phosphatase, locus 1; ACP1), adenosine deaminase (ADA), glyoxalase I (GLO), 6-phosphogluconate dehydrogenase (PGD), glutamic pyruvic transaminase (GPT), carbonic anhydrase II (CA2), and glucose-6-phosphate dehydrogenase (G6PD) systems, respectively.

In recent years, a growing number of laboratories have become able to determine PGM1 subtypes and a separate table (2) was compiled for presentation of the population data available. The several studies as well as the combined data showed good fit based on Hardy-Weinberg equilibrium expectations. Additional frequency studies would be desirable to enlarge the PGM1 subtype data base, however.

Most data sets and most combined totals for particular racial/ethnic groups for most systems yielded good fit to equilibrium expectations based upon chi-square. The combined totals which did not include Negro data for the ACP1 system (Table 6), Caucasian data for the PGD system (Table 9), and Negro female data for G6PD (Table 12). In the ACP1 case, the greatest contributions to χ^2 arise from there being more A and fewer BA types than expected. In the PGD case, there were fewer C types expected than observed. Since the class is small, however, the chi-square value may be somewhat misleading. In the case of G6PD, no simple explanation is apparent, and the estimates must be regarded as poor. Combined total data for both Caucasians and Negroes in GPT (Table 10) showed poor fits, but this was attributable to a comparatively large data set in each case which showed a poor fit.

It may be useful in certain circumstances to have frequency estimates for larger and presumably better randomized samples of the population at large than would result from local population studies, according to reasoning which we have discussed elsewhere [*17,18*]. Computation of WMP for systems in which a number of different studies have been done and in which fairly large numbers of people have been typed provides a possible approach to obtaining such an estimate. Some evidence was presented in our previous work [*12*] that this approach may be a useful one.

Acknowledgments

We thank the following for kindly sharing the results of their unpublished population studies for inclusion in the data presented: W. C. Stuver of the Miami/Dade County Metro Police Department Crime Laboratory; Gary Siglar of the Los Angeles Police Department Crime Laboratory; Dr. C. S. Tumosa of the Philadelphia Police Department Crime Laboratory; Barry A. J. Fischer of the Los Angeles County Sheriff's Department Criminalistics Laboratory; Dr. R. C. Briner of the Southeast Missouri Regional Crime Laboratory; John Robertson of the Pennsylvania State Police Crime Laboratory, Erie, PA; and Dr. J. W. Morris, Memorial Hospital Medical Center, Long Beach, CA. In addition, we thank Holly Hammond, now of the Houston Police Department Crime Laboratory, and Matthew Abbott, now of the Maryland State Police Laboratory, for their assistance in modifying programs and management of the extensive data files.

Special Acknowledgments

We take particular pleasure in thanking Dr. Peter Shenkin, Department of Mathematics, John Jay College of Criminal Justice of the City University of New York and Dr. James Uebelacker, Department of Mathematics, University of New Haven, for their many helpful discussions and suggestions.

TABLE 1—*Genotypic and phenotypic frequencies of phosphoglucomutase [Locus 1] (PGM1) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *PGM1*1*	Note	Reference
		CAUCASIAN					
San Francisco, CA	271	169(62.4)	83(30.6)	19(7.0)	0.7768		*T1*
Chicago, IL	101	68(67.3)	30(29.7)	3(3.0)	0.8218		*T2*
Seattle, WA	508				0.752	1	*T3*
New York, NY	164	102(62.2)	51(31.1)	11(6.7)	0.7774		*T4*
Philadelphia, PA	180	(55.9)	(35.1)	(7.9)		2,3	*T5*
Orange County, CA	303	(56.0)	(36.0)	(8.0)		2,4	*T6*
Pittsburgh/Allegheny County, PA	1 253	698(55.7)	487(38.9)	67(5.3)	0.7514	5	*T7*
California and Hawaii	5 972	(58.9)	(35.6)	(5.4)		2,6	*T8*
Bexar County, TX	200	(64.0)	(30.0)	(6.0)			*T9*
Philadelphia, PA including part of NJ	203	114(56.2)	73(36.0)	15(7.4)	0.7414	7,8	*T10*
Greater Detroit, MI	503	288(57.3)	179(35.6)	36(7.2)	0.7505	9	*T11*
Miami/Dade County, FL	367	218(59.4)	123(33.5)	26(7.1)	0.7616	9	*T13*
Los Angeles, CA	386	220(57.0)	149(38.6)	17(4.4)	0.7630	9	*T14*
CA, HI, TX, and Mexico City	1 069	626(58.6)	393(36.8)	48(4.5)	0.7694	10	*T15*
Los Angeles County, CA	487	277(56.9)	191(39.2)	19(3.9)	0.7649	*	*T16*
Minnesota	8 662	5192(59.9)	3000(34.6)	470(5.4)	0.7726	11	*T17*
North Carolina	833	496(59.5)	294(35.3)	41(4.9)	0.7719	12	*T18*
Connecticut	123	63(51.2)	55(44.7)	5(4.1)	0.7358		*T19*
Baltimore, MD	157	(53.5)	(40.7)	(5.7)		2	*T20*
Southeastern MO	372	(56.5)	(39.8)	(3.8)		2	*T21*
Baltimore, MD	205	131(63.9)	61(29.8)	13(6.3)	0.7878	13	*T22*
		TOTAL CAUCASIAN					
Numerical total	14 627	8662(59.2)	5169(35.3)	790(5.4)	0.7689		
WMP		59.1	35.5	5.4			
WSDP		1.760	1.951	0.685			

TABLE 1—*Continued.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *PGM1*1*	Note	Reference
		NEGRO					
San Francisco, CA	284	188(66.2)	77(27.1)	17(6.0)	0.7975	14,*	*T1*
Ann Arbor, MI	202	144(71.3)	52(25.7)	6(3.0)	0.8416		*T23*
Seattle, WA	654				0.809	1,15	*T3*
New York, NY	133	88(66.2)	39(29.3)	6(4.5)	0.8083		*T4*
Philadelphia, PA	180	(59.1)	(35.1)	(3.9)		2	*T6*
Pittsburgh/Allegheny County, PA	714	481(67.4)	209(29.3)	24(3.4)	0.8200		*T7*
California and Hawaii	1 024	(66.2)	(29.5)	(4.0)		2,16	*T8*
Bexar County, TX	200	(64.0)	(32.0)	(4.0)		2	*T9*
Philadelphia, PA including part of NJ	148	80(54.1)	57(38.5)	10(6.8)	0.7331	7,8	*T10*
Greater Detroit, MI	504	310(61.5)	176(34.9)	18(3.6)	0.7897	9	*T11*
Miami/Dade County, FL	344	215(62.5)	113(32.8)	16(4.7)	0.7892	9	*T13*
Los Angeles, CA	171	118(69.0)	46(26.9)	7(4.1)	0.8246	9	*T14*
CA, HI, TX, and Mexico City	802	530(66.1)	238(29.7)	27(3.4)	0.8092	17	*T15*
Los Angeles County, CA	209	149(71.3)	53(25.4)	7(3.3)	0.8397		*T16*
Minnesota	633	408(64.5)	191(30.2)	34(5.4)	0.7954	11	*T17*
North Carolina	777	504(64.9)	242(31.1)	30(3.9)	0.8044	18	*T18*
Connecticut	19	6(31.6)	12(63.2)	1(5.3)	0.6316		*T19*
Baltimore, MD	576	(60.1)	(36.9)	(3.7)		2	*T20*
Southeastern MO	81	(61.7)	(35.8)	(2.5)		2	*T21*
Baltimore, MD	181	110(60.8)	63(34.8)	8(4.4)	0.7818	13	*T22*
		TOTAL NEGRO					
Numerical total	5 222	3393(65.0)	1599(30.6)	219(4.2)	0.8029		
WMP		64.6	31.2	4.1			
WSDP		3.663	3.526	0.939			
		HISPANIC					
New York, NY	129	74(57.4)	43(33.3)	11(8.5)	0.7403	19	*T4*
California and Hawaii	1 586	(58.7)	(34.7)	(6.2)		2,20,21	*T8*
Bexar County, TX	200	(61.0)	(34.0)	(4.0)		2	*T9*

Miami/Dade County, FL	362	204(56.4)	139(38.4)	19(5.2)	0.7555	9	*T13*
Los Angeles, CA	198	117(59.1)	76(38.4)	5(2.5)	0.7828	9	*T14*
Salinas Valley, CA	99	(62.0)	(31.0)	(6.0)		2	*T24*
CA, HI, TX, and Mexico City	1 621	961(59.3)	563(34.7)	87(5.4)	0.7665	22,23	*T15*
Los Angeles County, CA	287	170(59.2)	106(36.9)	11(3.8)	0.7770		*T16*
Connecticut	15	9(60.0)	4(26.7)	2(13.3)	0.7333		*T19*
			TOTAL HISPANIC				
Numerical total	2 612	1535(58.8)	931(35.6)	135(5.2)	0.7659		
WMP		58.9	35.1	5.5			
WSDP		1.038	1.556	1.151			
			CHINESE				
San Francisco, CA	110	64(58.2)	36(32.7)	6(5.5)	0.7455	24	*T25*
New York, NY	156	98(62.8)	51(32.7)	7(4.5)	0.7917		*T4*
			TOTAL CHINESE				
Numerical total	266	162(60.9)	87(32.7)	13(4.9)	0.7726		
WMP		60.9	32.7	4.9			
WSDP		3.891	0.0	0.870			
			ORIENTAL AND ASIAN				
Seattle, WA	212				0.776	1,25	*T3*
California and Hawaii	3 044	(59.0)	(35.0)	(5.6)		2,20	*T8*
CA, HI, TX, and Mexico City	1 500	851(56.7)	557(37.1)	77(5.1)	0.7530	26	*T15*
Los Angeles County, CA	21	10(47.6)	10(47.6)	1(4.8)	0.7143		*T16*
			TOTAL ASIAN				
Numerical total	1 521	861(56.6)	567(37.3)	78(5.1)	0.7525		
WMP		58.2	35.8	5.4			
WSDP		1.284	1.285	0.224			

Notes:

1. Only total number and gene frequencies reported; data not used for calculations.
2. Distributions given in percentages; data not used in calculation of numerical totals.
3. *PGM2* data reported; for 180 Caucasians: 98.5% 1, 0.5% 2−1, 1% "other"; for 180 Negroes: 99.4% 1, 0.6% "other."
4. Population reportedly consisted of approximately 85% Caucasian and 15% Hispanic; data not used for calculations.
5. One was PGM1 6−2.
6. 0.1% were "rare."
7. One was PGM1 7−1.
8. Identical twin study; data for one member of each twin pair tabulated and used in calculations.
9. And see Shaler *[T12]*.
10. Two were "rare."
11. PGM1 subtyping carried out. Among 8662 Minnesota Caucasians, there were 3497 1+, 1516 1+1−, 179 1−, 1838 2+1+, 626 2−1+, 390 2+1−, 146 2−1−, 282 2+, 163 2+2−, and 25 2−; gene frequencies were *PGM1*1+* = 0.633, *PGM1*1−* = 0.139, *PGM1*2+* = 0.171, and *PGM1*2−* = 0.057. Among 633 Minnesota Negroes, there were 269 1+, 125 1+1−, 14 1−, 122 2+1+, 39 2−1+, 24 2+1−, 6 2−1−, 24 2+, 9 2+2−, and 1 2−; gene frequencies were *PGM1*1+* = 0.651, *PGM1*1−* = 0.145, *PGM1*2+* = 0.160, and *PGM1*2−* = 0.044.
12. Two were "other"; PGM1 subtyping carried out. Among 340 North Carolina Caucasians, there were 127 1+, 72 1+1−, 6 1−, 67 2+1+ 27 2−1+, 12 2+1−, 8 2−1−, 11 2+, 9 2+2−, and 1 2−; gene frequencies were *PGM1*1+* = 0.618, *PGM1*1−* = 0.154, *PGM1*2+* = 0.161, and *PGM1*2−* = 0.067.
13. PGM1 subtyping carried out. Among 205 Baltimore Caucasians, there were 91 1+, 35 1+1−, 5 1−, 38 2+1+, 15 2−1+, 5 2+1−, 3 2−1−, 5 2+, 4 2+2−, and 4 2−; gene frequencies were *PGM1*1+* = 0.6585, *PGM1*1−* = 0.1293, *PGM1*2+* = 0.1390, and *PGM1*2−* = 0.0732. Among 181 Baltimore Negroes, there were 82 1+, 26 1+1−, 2 1−, 41 2+1+, 9 2−1+, 11 2+1−, 2 2−1−, 6 2+, and 2 2+2−; gene frequencies were *PGM1*1+* = 0.6630, *PGM1*1−* = 0.1188, *PGM1*2+* = 0.1823, and *PGM1*2−* = 0.0359.
14. Two were reported to be PGM "unusual," and were probably PGM2 2−1.
15. Four were PGM2 2−1 and one was PGM2 3−1.
16. 0.3% were "rare."
17. Seven were "rare."
18. One was "other"; PGM1 subtyping carried out. Among 352 North Carolina Negroes, there were 151 1+, 61 1+1−, 9 1−, 68 2+1+, 25 2−1+, 19 2+1−, 2 2−1−, 12 2+, 2 2+2−, and 1 2−; gene frequencies were *PGM1*1+* = 0.648, *PGM1*1−* = 0.142, *PGM1*2+* = 0.163, and *PGM1*2−* = 0.047.
19. One was a probable PGM1 6−1JAP.
20. 0.4% were "rare."
21. "Chicano-Amerindian."
22. Ten were "rare."
23. Primarily Mexican.
24. Three were PGM1 6−1 and one was PGM1 7−1.
25. "Miscellaneous Oriental."
26. Fifteen were "rare."

* $3.841 < \chi^2 < 6.635$; $0.01 < P < 0.05$.

TABLE 2—*Phenotypic frequencies of PGM1 isoenzyme subtypes in U.S. populations.*

Population	Total	Frequency—Number (Percent)										Reference
		1+	1+1−	1−	2+1+	2−1+	2+1−	2−1−	2+	2+2−	2−	
						CAUCASIAN						
Minnesota	8662	3497	1516	179	1838	626	390	146	282	163	25	
		(40.4)	(17.5)	(2.1)	(21.2)	(7.2)	(4.5)	(1.7)	(3.3)	(1.9)	(0.3)	*T17*
North Carolina	340	127	72	6	67	27	12	8	11	9	1	
		(37.4)	(21.2)	(1.8)	(19.7)	(7.9)	(3.5)	(2.4)	(3.2)	(2.6)	(0.3)	*T18*
Baltimore, MD	205	91	35	5	38	15	5	3	5	4	4	
		(44.4)	(17.1)	(2.4)	(18.5)	(7.3)	(2.4)	(1.5)	(2.4)	(2.0)	(2.0)	*T22*
Numerical total	9207	3715	1623	190	1943	668	407	157	298	176	30	
		(40.3)	(17.6)	(2.1)	(21.1)	(7.3)	(4.4)	(1.7)	(3.2)	(1.9)	(0.3)	
WMP		40.4	17.7	2.1	21.1	7.3	4.4	1.7	3.2	1.9	0.5	
WSDP		0.841	0.761	0.081	0.457	0.141	0.278	0.151	0.105	0.169	0.565	
						NEGRO						
Minnesota	663	269	125	14	122	39	24	6	24	9	1	
		(42.5)	(19.7)	(2.2)	(19.3)	(6.2)	(3.8)	(0.9)	(3.8)	(1.4)	(0.2)	*T17*
North Carolina	352	151	61	9	68	25	19	2	12	4	1	
		(42.9)	(17.3)	(2.6)	(19.3)	(7.1)	(5.4)	(0.6)	(3.4)	(1.1)	(0.3)	*T18*
Baltimore, MD	181	82	26	2	41	9	11	2	6	2	0	
		(45.3)	(14.4)	(1.1)	(22.7)	(5.0)	(6.1)	(1.1)	(3.3)	(1.1)	(0.0)	*T22*
Numerical total	1166	502	212	25	231	73	54	10	42	15	2	
		(43.1)	(18.2)	(2.1)	(19.8)	(6.3)	(4.6)	(0.9)	(3.6)	(1.3)	(0.2)	
WMP		43.1	18.4	2.2	19.9	6.3	4.8	0.9	3.6	1.3	0.2	
WSDP		1.000	1.843	0.374	1.285	0.668	0.954	0.178	0.207	0.145	0.063	

TABLE 3—*Genotypic and phenotypic frequencies of esterase D (ESD) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *ESD*1*	Note	Reference
			CAUCASIAN				
Orange County, CA	181	130(71.8)	44(24.3)	7(3.9)	0.8398	1	*T6*
Minnesota	506	422(83.4)	78(15.4)	6(1.2)	0.9111		*T26*
Pittsburgh/Allegheny County, PA	545	(78.7)	(19.8)	(1.5)		2,3	*T27*
California and Hawaii	5377	(79.5)	(19.3)	(1.2)		2	*T8*
Detroit, MI	503	392(77.9)	106(21.1)	5(1.0)	0.8847	4	*T11*
Miami/Dade County, FL	367	286(77.9)	76(20.7)	7(1.4)	0.8828	4	*T13*
Los Angeles, CA	335	252(75.2)	76(22.7)	7(2.1)	0.8657	4	*T14*
CA, HI, TX, and Mexico City	1025	794(77.5)	225(22.0)	6(0.6)	0.8844	*	*T15*
Pittsburgh/Allegheny County, PA	545	429(78.7)	108(19.8)	8(1.5)	0.8862	3	*T28*
Erie County, PA	300	247(82.3)	51(17.0)	2(0.7)	0.9083		*T29*
Los Angeles County, CA	432	325(75.2)	96(22.2)	11(2.5)	0.8634		*T16*
Minnesota	3147	2443(77.6)	558(17.7)	29(0.9)	0.881	5	*T30*
North Carolina	388	312(80.4)	73(18.8)	3(0.8)	0.8982		*T18*
Connecticut	126	90(71.4)	32(25.4)	4(3.2)	0.8413		*T19*
Southeastern MO	377	(80.1)	(18.3)	(1.6)		2	*T21*
Birmingham, AL	196	148(75.5)	46(23.5)	2(1.0)	0.8724		*T31*
Baltimore, MD	202	146(72.3)	41(20.3)	3(1.5)	0.8490	6	*T22*
			TOTAL CAUCASIAN				
Numerical total	8072	6286(77.9)	1566(19.4)	91(1.1)	0.8757		
WMP		78.6	19.3	1.2			
WSDP		1.942	1.762	0.422			
			NEGRO				
Pittsburgh/Allegheny County, PA	152	(76.3)	(23.7)	(0.0)		2,3	*T27*
California and Hawaii	973	(83.6)	(16.0)	(0.4)		2	*T8*
Detroit, MI	504	424(84.1)	76(15.1)	4(0.8)	0.9167	4	*T11*
Miami/Dade County, FL	343	286(83.4)	54(15.7)	3(0.9)	0.9125	4	*T13*
Los Angeles, CA	146	121(82.9)	23(15.8)	2(1.4)	0.9075	4	*T14*
CA, HI, TX, and Mexico City	770	626(81.3)	140(18.2)	4(0.5)	0.9039		*T15*

Pittsburgh/Allegheny County, PA	152	116(76.3)	36(23.7)	0(0.0)	0.8816	3	*T28*
Los Angeles County, CA	179	151(84.4)	26(14.5)	2(1.1)	0.9162		*T16*
Minnesota	247	206(83.4)	38(15.4)	2(0.8)	0.913	5	*T30*
North Carolina	343	300(87.5)	39(11.4)	4(1.2)	0.9125		*T18*
Connecticut	28	28(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
Southeastern MO	73	(87.7)	(12.3)	(0.0)		2	*T21*
Birmingham, AL	317	254(80.1)	61(19.2)	2(0.6)	0.8975		*T31*
Baltimore, MD	181	159(87.9)	21(11.6)	1(0.6)	0.9365	6	*T22*
			TOTAL NEGRO				
Numerical total	3210	2671(83.2)	514(16.0)	24(0.7)	0.9121		
WMP		83.4	15.9	0.7			
WSDP		2.795	2.905	0.315			
			HISPANIC				
California and Hawaii	1580	(73.9)	(23.8)	(2.3)		2,7	*T8*
Miami/Dade County, FL	360	259(71.9)	89(24.7)	12(3.3)	0.8431	4	*T13*
Los Angeles, CA	156	118(75.6)	35(22.4)	3(1.9)	0.8686	4	*T14*
CA, HI, TX, and Mexico City	1478	1077(72.9)	370(25.0)	31(2.1)	0.8539	8	*T15*
Los Angeles County, CA	256	188(73.4)	59(23.0)	9(3.5)	0.8496		*T16*
Connecticut	15	12(80.0)	3(20.0)	0(0.0)	0.9000		*T19*
			TOTAL HISPANIC				
Numerical total	2265	1654(73.0)	556(24.5)	55(2.4)	0.8530		
WMP		73.4	24.2	2.4			
WSDP		0.886	0.801	0.485			
			ORIENTAL AND ASIAN				
San Francisco, CA	55	17(30.9)	30(54.5)	8(14.5)	0.5818	9	*T32*
San Francisco, CA	111	40(36.0)	56(50.5)	15(13.5)	0.6126	10	*T32*
California and Hawaii	3029	(41.6)	(44.2)	(14.2)		2	*T8*
CA, HI, TX, and Mexico City	1428	561(39.3)	674(47.2)	193(13.5)	0.6289		*T15*
Los Angeles County, CA	18	8(44.4)	5(27.8)	5(27.8)	0.5833		*T16*

Notes:

1. Population reportedly consisted of approximately 85% Caucasian and 15% Hispanic; data not used for calculations.
2. Distributions given in percentages; data not used in calculation of numerical totals.

3. Appears to be the same data as given by Smith et al. [*T28*] below; the latter was used in calculations.
4. And see Shaler [*T12*].
5. *ESD**5 types discriminated by the technique employed. Among 3147 Minnesota Caucasians, there were 104 5−1 and 13 5−2; *ESD**5 = 0.019. Among 247 Minnesota Negroes, there was 1 5−1; *ESD**5 = 0.002.
6. *ESD**5 types discriminated by the technique employed. Among 202 Baltimore Caucasians, there were 10 5−1 and 2 5−2; *ESD**5 = 0.0297. Among 181 Baltimore Negroes, there were no *ESD**5 types.
7. "Chicano-Amerindian."
8. Primarily Mexican.
9. Japanese.
10. Chinese.

*$3.841 < \chi^2 < 6.635$; $0.01 < P < 0.05$.

TABLE 4—*Genotypic and phenotypic frequencies of adenylate kinase (AK) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2—1	2	Gene Frequency *AK*1*	Note	Reference
			CAUCASIAN				
Chicago, IL	1315	1193(90.7)	118(9.0)	3(0.2)	0.9521	1	*T33*
Ann Arbor, MI	254	240(94.5)	14(5.5)	0(0.0)	0.9724		*T23*
Seattle, WA	172	163(94.8)	9(5.2)	0(0.0)	0.9738		*T3*
New York, NY	136	127(93.4)	9(6.6)	0(0.0)	0.9669		*T4*
Philadelphia, PA	180	(97.3)	(2.7)	(0.0)		2	*T5*
Washington, DC	364	338(92.9)	25(6.9)	1(0.3)	0.9629		*T34*
California and Hawaii	5969	(92.7)	(7.1)	(0.1)		2,3	*T8*
Philadelphia, PA including part of NJ	220	214(97.3)	6(2.7)	0(0.0)	0.9864	4	*T10*
Detroit, MI	503	474(94.2)	29(5.8)	0(0.0)	0.9712	5	*T11*
Miami/Dade County, FL	366	339(92.6)	26(7.17)	1(0.3)	0.9617	5	*T13*
Los Angeles, CA	115	108(93.9)	7(6.1)	0(0.0)	0.9696	5	*T14*
CA, HI, TX, and Mexico City	1021	944(92.5)	77(7.5)	0(0.0)	0.9623		*T15*
Los Angeles County, CA	224	203(90.6)	20(8.9)	1(0.4)	0.9509		*T16*
North Carolina	442	414(93.7)	26(5.9)	2(0.5)	0.9661		*T18*
Connecticut	51	47(9.2)	4(7.8)	0(0.0)	0.9608		*T19*
Southeastern MO	380	(92.6)	(7.4)	(0.0)			*T21*
			TOTAL CAUCASIAN				
Numerical total	5183	4804(92.7)	370(7.1)	8(0.2)	0.9626		
WMP		92.8	7.1	0.1			
WSDP		1.241	1.178	0.114			
			NEGRO				
Chicago, IL	1063	1049(98.7)	13(1.2)	0(0.0)	0.9929	1	*T33*
Ann Arbor, MI	139	135(97.1)	4(2.9)	0(0.0)	0.9856		*T23*
Seattle, WA	223	220(98.7)	3(1.3)	0(0.0)	0.9933		*T3*
Chicago, IL	101	99(98.0)	2(2.0)	0(0.0)	0.9901		*T2*
New York, NY	134	130(97.0)	3(2.2)	1(0.7)	0.9813		*T4*
Philadelphia, PA	180	(100.0)	(0.0)	(0.0)		2	*T5*

TABLE 4—*Continued.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *AK*1*	Note	Reference
Washington, DC	76	75(98.7)	1(1.3)	0(0.0)	0.9934		*T34*
California and Hawaii	965	(98.4)	(1.6)	(0.0)		2	*T8*
Philadelphia, PA including part of NJ	170	164(96.5)	6(3.5)	0(0.0)	0.9824	4	*T10*
Detroit, MI	504	501(99.4)	3(0.6)	0(0.0)	0.9970	5	*T11*
Miami/Dade County, FL	346	339(98.0)	7(2.0)	0(0.0)	0.9899	5	*T13*
Los Angeles, CA	54	53(98.1)	1(1.9)	0(0.0)	0.9907	5	*T14*
CA, HI, TX, and Mexico City	736	722(98.1)	13(1.8)	0(0.0)	0.9898	6	*T15*
Los Angeles County, CA	91	90(98.9)	1(1.1)	0(0.0)	0.9945		*T16*
North Carolina	400	391(97.7)	9(2.3)	0(0.0)	0.9887		*T18*
Connecticut	21	21(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
Southeastern MO	73	(100.0)	(0.0)	(0.0)		2	*T21*
			TOTAL NEGRO				
Numerical total	4058	3989(98.3)	66(1.6)	1(0.0)	0.9911		
WMP		97.2	1.5	0.0			
WSDP		10.347	0.698	0.117			
			HISPANIC				
New York, NY	136	130(95.6)	6(4.4)	0(0.0)	0.9779	7	*T4*
California and Hawaii	1344	(95.6)	(4.3)	(0.1)		2,8	*T8*
Miami/Dade County, FL	357	339(95.0)	18(5.0)	0(0.0)	0.9748	5	*T13*
Los Angeles, CA	54	53(98.1)	1(1.9)	0(0.0)	0.9907	5	*T14*
CA, HI, TX, and Mexico City	1380	1347(97.6)	31(2.2)	2(0.1)	0.9873	8	*T15*
Los Angeles County, CA	176	167(94.9)	9(5.1)	0(0.0)	0.9744		*T16*
Connecticut	3	3(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
			TOTAL HISPANIC				
Numerical total	2106	2039(96.8)	65(3.1)	2(0.1)	0.9836		
WMP		96.3	3.6	0.1			
WSDP		1.116	1.157	0.054			

ORIENTAL AND ASIAN

Seattle, WA	146	146(100.0)	0(0.0)	0(0.0)	1.0000	10	*T3*
New York, NY	156	156(100.0)	0(0.0)	0(0.0)	1.0000		*T4*
California and Hawaii	2304	(99.8)	(0.2)	(0.0)		2	*T8*
CA, HI, TX, and Mexico City	1410	1406(99.7)	4(0.3)	0(0.0)	0.9986		*T15*
Los Angeles County, CA	13	12(92.3)	1(7.7)	0(0.0)	0.9615		*T16*

Notes:

1. One was AK 3−1.
2. Distributions given in percentages; data not used in calculation of numerical totals.
3. 0.1% were "rare."
4. Identical twin study; data for one member of each twin pair tabulated and used in calculations.
5. And see Shaler [*T12*].
6. One was "rare."
7. Primarily Puerto Rican.
8. "Chicano-Amerindian."
9. Primarily Mexican.
10. "Mixed Oriental."

TABLE 5—*Phenotypic frequencies of acid phosphatase [Locus 1] (ACP1) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) A	BA	B	CA	CB	C	Note	Reference
				CAUCASIAN					
Seattle, WA	193	33(17.1)	76(39.4)	61(31.6)	10(5.2)	13(6.7)	0(0.0)		*T35*
U.S. Naval Personnel in Japan	272	27(9.9)	120(44.1)	107(39.3)	7(2.6)	11(4.0)	0(0.0)		*T36*
Chicago, IL	100	14(14.0)	43(43.0)	38(38.0)	4(4.0)	1(1.0)	0(0.0)		*T2*
Pittsburgh/Allegheny County, PA	1239	145(11.7)	526(42.5)	491(39.6)	20(1.6)	57(4.6)	0(0.0)		*T7*
California and Hawaii	4850	(10.8)	(42.1)	(39.3)	(3.3)	(4.3)	(0.2)	1	*T8*
Bexar County, TX	200	(12.0)	(36.0)	(50.0)	(1.0)	(1.0)	(0.0)	1	*T9*
Greater Philadelphia, PA including part of NJ	215	17(7.9)	83(38.6)	97(45.1)	7(3.3)	11(5.1)	0(0.0)	2	*T10*
Detroit, MI	503	65(12.9)	185(36.8)	193(38.4)	22(4.4)	38(7.6)	0(0.0)	3	*T11*
Miami/Dade County, FL	366	44(12.0)	145(39.6)	156(42.6)	10(2.7)	10(2.7)	1(0.3)	3	*T13*
Los Angeles, CA	357	34(9.5)	150(42.0)	158(44.3)	8(2.2)	7(2.0)	0(0.0)	3	*T14*
Erie, PA	300	33(11.0)	127(42.3)	117(39.0)	9(3.0)	14(4.7)	0(0.0)		*T29*
CA, TX, HI, and Mexico City	1044	106(10.2)	426(40.8)	391(37.5)	45(4.3)	69(6.6)	0(0.0)	4	*T15*
Los Angeles County, CA	499	44(9.9)	178(40.1)	193(43.5)	14(3.2)	15(3.4)	0(0.0)		*T16*
North Carolina	418	49(11.7)	144(34.4)	169(40.4)	20(4.8)	36(8.6)	0(0.0)		*T18*
Connecticut	44	5(11.4)	21(47.7)	16(36.4)	1(2.3)	1(2.3)	0(0.0)		*T19*
Southeastern MO	378	(10.1)	(47.1)	(36.5)	(1.9)	(4.5)	(0.0)	1	*T21*
Baltimore, MD	208	22(10.6)	89(42.8)	77(37.0)	8(3.8)	12(5.8)	0(0.0)		*T22*
				TOTAL CAUCASIAN					
Numerical total	5703	538(11.2)	2313(40.6)	2264(39.7)	185(3.2)	295(5.2)	1(0.0)		
WMP		11.0	41.4	39.6	3.2	4.7	0.1		
WSDP		1.211	2.367	2.515	0.913	1.515	0.103		
				NEGRO					
Seattle, WA	164	12(7.3)	48(29.3)	99(60.4)	2(1.2)	3(1.8)	0(0.0)		*T35*
Ann Arbor, MI	224	12(5.4)	50(22.3)	160(71.4)	0(0.0)	2(0.9)	0(0.0)		*T23*
Austin, TX	63	3(4.8)	16(25.4)	32(50.8)	1(1.6)	8(12.7)	0(0.0)	5	*T37*
Dallas/Houston, TX male patients	294	11(3.7)	100(34.0)	166(56.5)	1(0.3)	7(2.4)	0(0.0)	6	*T37*

Seattle, WA	429	30(7.0)	150(35.0)	222(51.7)	2(0.5)	10(2.3)	0(0.0)	7	*T3,T38*
Chicago, IL	101	8(7.9)	19(18.8)	66(65.3)	1(1.0)	2(2.0)	0(0.0)	8	*T2,T38*
Pittsburgh/Allegheny County, PA	718	39(5.4)	239(33.3)	426(59.3)	2(0.3)	11(1.5)	0(0.0)	9	*T7*
California and Hawaii	875	(5.6)	(31.4)	(60.2)	(0.2)	(1.3)	(0.1)	1,10	*T8*
Bexar County, TX	200	(7.0)	(27.0)	(66.0)	(0.0)	(0.0)	(0.0)	1	*T9*
Greater Philadelphia, PA including part of NJ	167	15(9.0)	40(24.0)	111(66.5)	0(0.0)	0(0.0)	0(0.0)	2,11	*T10*
Detroit, MI	504	30(6.0)	171(33.9)	280(55.6)	4(0.8)	6(1.2)	0(0.0)	3,12	*T11*
Miami/Dade County, FL	345	24(7.0)	110(31.9)	201(58.3)	1(0.3)	6(1.7)	0(0.0)	3,13	*T13*
Los Angeles, CA	161	5(3.1)	66(41.0)	89(55.3)	0(0.0)	1(0.6)	0(0.0)	3	*T14*
CA, TX, HI, and Mexico City	845	31(3.7)	305(36.1)	481(56.9)	2(0.2)	8(0.9)	0(0.0)	14	*T15*
Los Angeles County, CA	197	9(4.6)	71(36.0)	116(58.9)	0(0.0)	1(0.5)	0(0.0)		*T16*
North Carolina	366	16(4.4)	106(29.0)	220(60.1)	2(0.5)	4(1.1)	0(0.0)	15	*T18*
Connecticut	13	0(0.0)	7(53.8)	6(46.2)	0(0.0)	0(0.0)	0(0.0)		*T19*
Southeastern MO	81	(6.2)	(28.4)	(64.2)	(0.0)	(1.2)	(0.0)	1	*T21*
Baltimore, MD	181	9(5.0)	50(27.6)	114(63.0)	2(1.1)	3(1.7)	0(0.0)	16	*T22*
				TOTAL NEGRO					
Numerical total	4772	254(5.3)	1548(32.4)	2789(58.4)	20(0.4)	72(1.5)	0(0.0)		
WMP		5.4	32.0	59.0	0.4	1.4	0.0		
WSDP		1.375	4.331	4.265	0.330	1.307	0.035		
				MIXED CAUCASIAN AND NEGRO					
Washington, DC	137	14(10.2)	52(38.0)	61(44.5)	4(2.9)	6(4.4)	0(0.0)		*T39*
				HISPANIC					
California and Hawaii	1360	(6.7)	(35.8)	(53.5)	(1.6)	(2.2)	(0.0)	17,18	*T8*
Bexar County, TX	200	(9.0)	(31.0)	(60.0)	(2.0)	(0.0)	(0.0)	1	*T9*
Miami/Dade County, FL	362	27(7.5)	123(34.0)	184(50.8)	7(1.9)	20(5.5)	1(0.3)	3	*T13*
Los Angeles, CA	179	6(3.4)	69(38.5)	99(55.3)	2(1.1)	3(1.7)	0(0.0)	3	*T14*
CA, TX, HI, and Mexico City	1797	109(6.1)	640(35.6)	986(54.9)	19(1.1)	40(2.2)	0(0.0)	19,20	*T15*
Los Angeles County, CA	275	14(5.1)	102(37.1)	151(54.9)	4(1.5)	4(1.5)	0(0.0)		*T16*
Connecticut	4	0(0.0)	1(25.0)	3(75.0)	0(0.0)	0(0.0)	0(0.0)		*T19*
				TOTAL HISPANIC					
Numerical total	2617	156(6.0)	935(35.7)	1423(54.4)	32(1.2)	67(2.6)	1(0.0)		
WMP		6.3	35.5	54.4	1.4	2.3	0.0		
WSDP		1.023	1.369	1.850	0.330	1.108	0.078		

TABLE 5—*Continued.*

Population	Total	Frequency—Number (Percent)						Note	Reference
		A	BA	B	CA	CB	C		
				ORIENTAL AND ASIAN					
Seattle, WA	77	4(5.2)	22(28.6)	51(66.2)	0(0.0)	0(0.0)	0(0.0)	22	*T35*
Seattle, WA	221	8(3.6)	70(31.7)	142(64.3)	0(0.0)	1(0.5)	0(0.0)		*T3, T38*
California and Hawaii	2462	(5.2)	(35.6)	(59.2)	(0.0)	(0.0)	(0.0)	1	*T8*
CA, TX, HI, and Mexico City	1542	67(4.3)	502(32.6)	972(63.0)	0(0.0)	1(0.1)	0(0.0)		*T15*
Los Angeles County, CA	18	0(0.0)	9(50.0)	9(50.0)	0(0.0)	0(0.0)	0(0.0)		*T16*

Notes:

1. Distributions given in percentages; data not used in calculating numerical totals.
2. Identical twin study; data for one member of each twin pair tabulated and used in calculations.
3. And see Shaler [*T12*].
4. 7 were "rare."
5. 1 RA, 2 RB.
6. 1 RA, 5 RB, 1 RC, 2 BD.
7. 3 RA, 11 RB, 1 BD.
8. 5 RB.
9. 1 RA.
10. 1.1% were "rare."
11. 1 AD.
12. 1 RA, 11 RB, 1 RC.
13. 1 RA, 1 RB, 1 BD.
14. 18 were "rare."
15. 4 RA, 13 RB, 1 R.
16. 2 RB, 1 BE.
17. "Chicano/Amerindian."
18. 0.2% were "rare."
19. Primarily Mexican.
20. 3 were "rare."
21. "Mixed Oriental."

TABLE 6—*Gene frequencies for the ACP1 system in U.S. populations.*

Population	Total Number Typed	Gene Frequency				Note	Reference to Population Study
		*ACP*A*	*ACP*B*	*ACP*C*	Other		
			CAUCASIAN				
Seattle, WA	193	0.3938	0.5466	0.0596			*T35*
U.S. Naval personnel in Japan	272	0.3327	0.6342	0.0331			*T36*
Chicago, IL	100	0.3750	0.6000	0.0250			*T2*
Pittsburgh/Allegheny County, PA	1239	0.3394	0.6316	0.0311			*T7*
Greater Philadelphia, PA including part of NJ	215	0.2884	0.6698	0.0419			*T10*
Detroit, MI	503	0.3350	0.6054	0.0596			*T11*
Miami/Dade County, FL	366	0.3320	0.6380	0.0301			*T13*
Los Angeles, CA	357	0.3165	0.6625	0.0210			*T14*
Erie, PA	300	0.3367	0.6250	0.0383			*T29*
CA, TX, HI, and Mexico City	1044	0.3271	0.6116	0.0546			*T15*
Los Angeles County, CA	444	0.3153	0.6250	0.0327			*T16*
North Carolina	418	0.3134	0.6196	0.0670			*T18*
Connecticut	44	0.3636	0.6136	0.0227			*T19*
Baltimore, MD	208	0.3389	0.6130	0.0481			*T22*
Total caucasian	5703	0.3309	0.6256	0.0423			
			NEGRO				
Seattle, WA	164	0.2256	0.7591	0.0152			*T35*
Ann Arbor, MI	224	0.1652	0.8304	0.0045			*T23*
Austin, TX	63	0.1905	0.7143	0.0714	*ACP*R* = 0.0238		*T37*
Dallas/Houston, TX male patients	294	0.2109	0.7585	0.0153	*ACP*R* = 0.0119 *ACP*D* = 0.0034		*T37*
Seattle, WA	429	0.2506	0.7180	0.0134	*ACP*R* = 0.0163 *ACP*D* = 0.0012		*T3, T38*
Chicago, IL	101	0.1782	0.7822	0.0149	*ACP*R* = 0.0248	*	*T2, T38*
Pittsburgh/Allegheny County, PA	718	0.2228	0.7674	0.0091	*ACP*R* = 0.0007		*T7*
Greater Philadelphia, PA including part of NJ	167	0.2126	0.7844	0.0000	*ACP*D* = 0.0030	*	*T10*

TABLE 6—*Continued.*

Population	Total Number Typed	Gene Frequency				Note	Reference to Population Study
		*ACP*A*	*ACP*B*	*ACP*C*	Other		
Detroit, MI	504	0.2341	0.7421	0.0109	*ACP*R* = 0.0129		*T11*
Miami/Dade County, FL	345	0.2319	0.7536	0.0101	*ACP*R* = 0.0029		
					*ACP*D* = 0.0015		*T13*
Los Angeles, CA	161	0.2360	0.7609	0.0031			*T14*
CA, TX, HI, and Mexico City	845	0.223	0.771	0.006		1	*T15*
Los Angeles County, CA	197	0.2259	0.7716	0.0025			*T16*
North Carolina	366	0.1967	0.7691	0.0082	*ACP*R* = 0.0260		*T18*
Baltimore, MD	181	0.1934	0.7845	0.0138	*ACP*R* = 0.0055		
					*ACP*E* = 0.0028		*T22*
Total Negro	3927	0.2190	0.7611	0.0107	*ACP*R* = 0.0084		
					*ACP*D* = 0.0006		
					*ACP*E* = 0.0001	2,*	
			HISPANIC				
Miami/Dade County, FL	362	0.2541	0.7058	0.0401			*T13*
Los Angeles, CA	179	0.2318	0.7542	0.0140			*T14*
CA, TX, HI, and Mexico City	1797	0.2440	0.7379	0.0164			*T15*
Los Angeles County, CA	275	0.2436	0.7418	0.0145			*T16*
Total Hispanic	2617	0.2444	0.7352	0.0193			
			ORIENTAL AND ASIAN				
Seattle, WA	77	0.1948	0.8052	0.0000			*T35*
Seattle, WA	221	0.1946	0.8032	0.0023			*T3. T38*
CA, HI, TX, and Mexico City	1542	0.2062	0.7935	0.0003			*T15*
Los Angeles County, CA	18	0.2500	0.7500	0.0000			*T16*

Notes:

1. Author gene frequencies for 827 people (excludes rare types).
2. Total Negro values and calculations exclude the CA, TX, HI, and Mexico City data.

*$\chi^2 > 9.210$; $P < 0.01$.

TABLE 7—*Genotypic and phenotypic frequencies of adenosine deaminase (ADA) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *ADA*1*	Note	Reference
			CAUCASIAN				
Seattle, WA	168	152(90.5)	16(9.5)	0(0.0)	0.9524		*T40*
Philadelphia, PA	180	(88.1)	(11.9)	(0.0)		1	*T5*
California and Hawaii	5883	(90.0)	(9.8)	(0.2)		1	*T8*
Philadelphia, PA including part of NJ	220	194(88.2)	26(11.8)	0(0.0)	0.9409	2	*T10*
Detroit, MI	503	446(88.7)	56(11.1)	1(0.2)	0.9423	3	*T11*
Miami/Dade County, FL	360	323(89.7)	36(10.0)	1(0.3)	0.9472	3	*T13*
Los Angeles, CA	135	123(91.1)	12(8.9)	0(0.0)	0.9556	3	*T14*
CA, HI, TX, and Mexico City	1005	910(90.5)	91(9.1)	3(0.3)	0.9507	4	*T15*
Los Angeles County, CA	211	192(91.0)	19(9.0)	0(0.0)	0.9550		*T16*
North Carolina	436	389(89.2)	47(10.8)	0(0.0)	0.9461		*T18*
Connecticut	37	34(91.9)	3(8.1)	0(0.0)	0.9595		*T19*
Southeastern, MO	374	(90.1)	(9.9)	(0.0)		1	*T21*
			TOTAL CAUCASIAN				
Numerical total	3075	2763(89.9)	306(10.0)	5(0.2)	0.9483		
WMP		89.9	9.9	0.2			
WSDP		0.593	0.637	0.090			
			NEGRO				
Seattle, WA	186	178(95.7)	6(3.2)	0(0.0)	0.9731	5	*T40*
Philadelphia, PA	180	(97.2)	(2.8)	(0.0)		1	*T5*
California and Hawaii	927	(97.8)	(2.2)	(0.0)		1	*T8*
Philadelphia, PA including part of NJ	171	168(98.2)	3(1.8)	0(0.0)	0.9912	2	*T10*
Detroit, MI	504	496(98.4)	8(1.6)	0(0.0)	0.9921	3	*T11*
Miami/Dade County, FL	344	333(96.8)	11(3.2)	0(0.0)	0.9840	3	*T13*
Los Angeles, CA	56	54(96.4)	2(3.6)	0(0.0)	0.9821	3	*T14*
CA, HI, TX, and Mexico City	726	701(96.6)	24(3.3)	1(0.1)	0.9821		*T15*
Los Angeles County, CA	85	83(97.6)	2(2.4)	0(0.0)	0.9882		*T16*

TABLE 7—*Continued.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *ADA*1*	Note	Reference
North Carolina	399	395(99.0)	4(1.0)	0(0.0)	0.9950		*T18*
Connecticut	3	3(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
Southeastern, MO	73	(100.0)	(0.0)	(0.0)	1.0000	1	*T21*
		TOTAL NEGRO					
Numerical total	2474	2411(97.5)	60(2.4)	1(0.0)	0.9867		
WMP		97.6	2.3	0.0			
WSDP		0.970	0.858	0.055			
		HISPANIC					
California and Hawaii	1260	(93.8)	(5.9)	(0.3)		1,6	*T8*
Miami/Dade County, FL	355	329(92.7)	24(6.8)	2(0.6)	0.9606	3	*T13*
Los Angeles, CA	81	77(95.1)	4(4.9)	0(0.0)	0.9753	3	*T14*
CA, HI, TX, and Mexico City	1329	1284(96.6)	44(3.3)	1(0.1)	0.9827	7	*T15*
Los Angeles County, CA	169	156(92.3)	13(7.7)	0(0.0)	0.9615		*T16*
Connecticut	4	4(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
		TOTAL HISPANIC					
Numerical total	1938	1850(95.5)	85(4.4)	3(0.2)	0.9765		
WMP		94.8	5.0	0.2			
WSDP		1.621	1.504	0.168			
		ORIENTAL AND ASIAN					
Seattle, WA	118	113(95.8)	5(4.2)	0(0.0)	0.9788	8	*T40*
California and Hawaii	1821	(95.2)	(4.6)	(0.2)		1	*T8*
CA, HI, TX, and Mexico City	1391	1317(94.7)	73(5.2)	1(0.1)	0.9730		*T15*
Los Angeles County, CA	11	11(100.0)	0(0.0)	0(0.0)	1.0000		*T16*

Notes:

1. Distributions given in percentages; data not used in calculating numerical totals.
2. Identical twin study; data for one member of each twin pair tabulated and used in calculations.
3. And see Shaler [*TI2*].
4. One was "rare."
5. Two were ADA 5−1; $ADA*5 = 0.0054$.
6. "Chicano/Amerindian."
7. Primarily Mexican.
8. "Mixed Oriental."

TABLE 8—*Genotypic and phenotypic frequencies of glyoxalase I (GLO) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *GLO*1*	Note	Reference
			CAUCASIAN				
Rochester, NY	101	21(20.8)	42(41.6)	38(37.6)	0.4158		*T41*
Detroit, MI	503	100(19.9)	260(51.7)	143(28.4)	0.4573	1	*T11*
CA, HI, TX, and Mexico City	313	54(17.3)	165(52.7)	94(30.0)	0.4361		*T15*
Los Angeles County, CA	186	37(19.9)	99(53.2)	50(26.9)	0.4651		*T16*
North Carolina	309	53(17.2)	160(51.8)	96(31.1)	0.4304		*T18*
Southeastern, MO	372	(11.0)	(59.4)	(29.6)		2	*T21*
Birmingham, AL	196	40(20.4)	90(45.9)	66(33.7)	0.4337		*T31*
Baltimore, MD	204	38(18.6)	98(48.0)	68(33.3)	0.4265		*T22*
			TOTAL CAUCASIAN				
Numerical total	1812	343(18.9)	914(50.4)	555(30.6)	0.4415		
WMP		17.6	52.0	30.5			
WSDP		3.223	4.400	2.513			
			NEGRO				
Rochester, NY	108	10(9.3)	40(37.0)	58(53.7)	0.2778		*T41*
Detroit, MI	504	75(14.9)	212(42.1)	217(43.1)	0.3591	1	*T11*
CA, HI, TX, and Mexico City	310	39(12.6)	125(40.3)	146(47.1)	0.3274		*T15*
Minnesota	75				0.28	3	*T42*
Michigan (not including Detroit)	370				0.339	3	*T43*
Milwaukee, WI	62				0.35	3	*T44*

Houston and southeastern TX, and southwestern LA	100				0.35	3	*T45*
Chicago, IL	322				0.303	3	*T46*
Los Angeles County, CA	77	8(10.4)	39(50.6)	30(39.0)	0.3571		*T16*
North Carolina	327	31(9.5)	132(40.4)	164(50.2)	0.2966		*T18*
Southeastern, MO	73	(2.7)	(43.8)	(53.4)		2	*T21*
Birmingham, AL	320	19(5.9)	136(42.5)	165(51.6)	0.2719		*T31*
Baltimore, MD	179	23(12.8)	70(39.1)	86(48.0)	0.3240		*T22*
			TOTAL NEGRO				
Numerical total	1825	205(11.2)	754(41.3)	866(47.5)	0.3189	*	
WMP		10.9	41.4	47.7			
WSDP		3.504	2.443	3.969			
			HISPANIC				
CA, HI, TX, and Mexico City	1080	111(10.3)	444(41.1)	525(48.6)	0.3083		*T15*
Los Angeles County, CA	153	17(11.1)	81(52.9)	55(35.9)	0.3758		*T16*
			ASIAN				
CA, HI, TX, and Mexico City	884	4(0.5)	125(14.1)	755(85.4)	0.0752		*T15*
Los Angeles County, CA	13	1(7.7)	4(30.8)	8(61.5)	0.2308		*T16*

Notes:

1. And see Shaler [*T12*].
2. Distributions given in percentages; data not used in calculating numerical totals.
3. Data included only total number tested and *GLO*1* frequency.

*$\chi^2 > 3.841$; $0.02 < P < 0.05$.

TABLE 9—*Genotypic and phenotypic frequencies of 6-phosphogluconate dehydrogenase (PGD) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) A	AC	C	Gene Frequency *PGD*A*	Note	Reference
			CAUCASIAN				
Unspecified locale	58	57(98.3)	1(1.7)	0(0.0)	0.9914		*T47*
Chicago and Joliet, IL	600	554(92.3)	45(7.5)	1(0.2)	0.9608		*T48*
Buffalo, NY	1377	1313(95.4)	62(4.5)	2(0.1)	0.9760		*T49*
Chicago, IL	101	97(96.0)	4(4.0)	0(0.0)	0.9802		*T2*
Seattle, WA	647	624(96.4)	22(3.4)	1(0.2)	0.9815		*T3*
California and Hawaii	4472	(96.2)	(3.7)	(0.0)		1	*T8*
Philadelphia, PA including part of NJ	220	207(94.1)	12(5.5)	1(0.5)	0.9682	2	*T10*
Detroit, MI	503	482(95.8)	20(4.0)	1(0.2)	0.9781	3	*T11*
CA, TX, HI, and Mexico City	951	918(96.5)	31(3.3)	0(0.0)	0.9816	4	*T15*
North Carolina	317	305(96.2)	10(3.2)	1(0.3)	0.9779	5	*T18*
Connecticut	15	15(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
			TOTAL CAUCASIAN				
Numerical total	4785	4572(95.5)	207(4.3)	7(0.1)	0.9763	*	
WMP		95.8	4.0	0.1			
WSDP		1.053	1.043	0.107			
			NEGRO				
Unspecified locale	296	278(93.9)	18(6.1)	0(0.0)	0.9696		*T47*
Chicago and Joliet, IL	416	385(92.5)	31(7.5)	0(0.0)	0.9627		*T48*
Buffalo, NY	1226	1141(93.1)	83(6.8)	2(0.2)	0.9645		*T49*
Chicago, IL	101	93(92.1)	8(7.9)	0(0.0)	0.9604		*T2*
Seattle, WA	506	452(89.3)	52(10.3)	2(0.4)	0.9447		*T3*
California and Hawaii	787	(92.6)	(7.2)	(0.4)		6	*T8*
Philadelphia, PA including part of NJ	170	163(95.9)	7(4.1)	0(0.0)	0.9794	2	*T10*

Detroit, MI	503	462(91.8)	39(7.8)	2(0.4)	0.8857	3	*T11*
CA, TX, HI, and Mexico City	828	752(90.8)	73(8.8)	0(0.0)	0.9523	7	*T15*
North Carolina	309	281(90.9)	27(8.7)	0(0.0)	0.9531	5	*T18*
Connecticut	15	15(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
			TOTAL NEGRO				
Numerical total	4370	4022(92.0)	338(7.7)	6(0.1)	0.9590		
WMP		92.1	7.7	0.2			
WSDP		1.492	1.382	0.173			
			HISPANIC				
California and Hawaii	1494	(94.6)	(5.2)	(0.0)		8,9	*T8*
CA, HI, TX, and Mexico City	1806	1719(95.2)	85(4.7)	0(0.0)	0.9754	4,10	*T15*
			ASIAN				
California and Hawaii	2894	(86.8)	(12.6)	(0.0)		11	*T8*
CA, HI, TX, and Mexico City	1541	1257(81.6)	276(17.9)	0(0.0)	0.9053	12	*T15*

Notes:

1. Distributions given in percentages; data not used in calculating numerical totals.
2. Identical twin study; data for one member of each twin pair tabulated and used in calculations.
3. And see Shaler [*T12*].
4. Two were "rare."
5. One was "other."
6. 0.4% were "rare."
7. Three were "rare."
8. 0.1% were "rare."
9. "Chicano/Amerindian."
10. Primarily Mexican.
11. 0.6% were "rare."
12. Eight were "rare."

*$\chi^2 > 6.635$; $P < 0.01$.

TABLE 10—*Genotypic and phenotypic frequencies of glutamic-pyruvic transaminase (GPT) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *GPT*1*	Note	Reference
		CAUCASIAN					
Seattle, WA	253	59(23.3)	133(52.6)	61(24.1)	0.4960		*T50*
Seattle, WA	528	145(27.5)	261(49.4)	117(22.2)	0.5218	1	*T51*
New York, NY	294	84(28.6)	144(49.0)	64(21.8)	0.5909	2	*T52*
CA, HI, TX, and Mexico City	517	198(38.3)	189(36.6)	127(24.6)	0.5658	3,**	*T15*
		TOTAL CAUCASIAN					
Numerical total	1592	486(30.5)	727(45.7)	369(23.2)	0.5336	**,#	
WMP		30.5	45.7	23.2			
WSDP		5.629	6.423	1.214			
		NEGRO					
Seattle, WA	220	146(66.4)	66(30.0)	8(3.6)	0.8136		*T50*
Seattle, WA	220	146(66.4)	63(28.6)	8(3.6)	0.8068	4	*T51*
New York, NY	258	171(66.3)	76(29.5)	11(4.3)	0.8101		*T52*
CA, HI, TX, and Mexico City	560	359(64.3)	148(26.5)	53(9.5)	0.7760	**	*T15*
		TOTAL NEGRO					
Numerical total	1256	822(65.4)	353(28.1)	80(6.4)	0.7950	**,##	
WMP		65.4	28.1	6.4			
WSDP		0.992	1.471	2.807			

			HISPANIC				
New York, NY	310	85(27.4)	154(49.7)	71(22.9)	0.5226		*T52*
CA, HI, TX, and Mexico City	1021	180(17.6)	438(42.9)	401(39.3)	0.3908	5,6,**	*T15*
			ORIENTAL				
Seattle, WA	215	71(33.0)	115(53.5)	29(13.5)	0.5977		*T50*
New York, NY	151	35(23.2)	76(50.3)	40(26.5)	0.4834	7	*T52*
			ASIAN				
Seattle, WA	247	77(31.2)	138(55.9)	32(13.0)	0.5911	*	*T51*
CA, HI, TX, and Mexico City	1076	400(37.2)	454(42.2)	220(20.4)	0.5827	**	*T15*
			TOTAL ASIAN				
Numerical total	1323	477(36.1)	592(44.7)	252(19.0)	0.5846	**	
WMP		36.1	44.7	19.0			
WSDP		2.338	5.330	2.919			

Notes:

1. Two were 3−1 and 3 were 3−2.
2. Two were 3−2.
3. Three were "rare."
4. Three were 3−1.
5. Two were "rare."
6. Primarily Mexican.
7. Chinese.

*$3.841 < \chi^2 < 6.635$; $0.01 < P < 0.05$.
**$\chi^2 > 6.635$; $P < 0.01$.
*#GPT*1* = 0.5181 for 1075 Caucasians if data from Ref *T15* is excluded; $\chi^2 < 3.841$, $P > 0.05$.
*##GPT*1* = 0.8102 for 698 Negroes if data from Ref *T15* is excluded; $\chi^2 < 3.841$, $P > 0.05$.

TABLE 11—*Genotypic and phenotypic frequencies of carbonic anhydrase II (CA2) isoenzyme groups in U.S. populations.*

Population	Total	Frequency—Number (Percent) 1	2−1	2	Gene Frequency *CA2*1*	Note	Reference
		CAUCASIAN					
Philadelphia, PA	108	102(94.4)	6(5.6)	0(0.0)	0.9722		*T53*
North Carolina	335	334(99.7)	1(0.3)	0(0.0)	0.9985		*T18*
Connecticut	6	6(100.0)	0(0.0)	0(0.0)	1.0000		*T19*
Birmingham, AL	196	196(100.0)	0(0.0)	0(0.0)	1.0000		*T31*
		TOTAL CAUCASIAN					
Numerical total	645	638(98.9)	7(1.1)	0(0.0)	0.9946		
WMP		98.9	1.1	0.0			
WSDP		2.009	2.009	0.000			
		NEGRO					
Chicago IL, Detroit MI, New York, NY, and Milwaukee and Madison, WI	222	180(81.1)	39(17.6)	3(1.4)	0.8986		*T54*
Unspecified locale	128	103(80.5)	23(18.0)	2(1.6)	0.8945		*T55*
Detroit, MI	504	423(83.9)	75(14.9)	6(1.2)	0.9137	1	*T11*
Pittsburgh/Allegheny County, PA	646	526(81.4)	114(17.6)	6(0.9)	0.9025		*T27*
Philadelphia, PA	409	339(82.9)	68(16.6)	2(0.5)	0.9120		*T53*
North Carolina	395	313(79.2)	76(19.2)	6(1.5)	0.8886		*T18*
Connecticut	22	17(77.3)	5(18.9)	0(0.0)	0.8864		*T19*
Birmingham, AL	333	268(80.5)	63(18.9)	2(0.6)	0.8994		*T31*
		TOTAL NEGRO					
Numerical total	2659	2169(81.6)	463(17.4)	27(1.0)	0.9028		
WMP		81.6	17.4	1.0			
WSDP		1.584	1.534	0.377			

Note: 1. And see Shaler [*T12*].

TABLE 12—*Genotypic and phenotypic frequencies of glucose-6-phosphate dehydrogenase (G6PD) isoenzyme groups in U.S. negro populations.*

Population	Total	Frequency—Number (Percent) B	BA	A	Gene Frequency *G6PD*B*	Note	Reference
		MALES					
Baltimore, MD	311	206(66.2)	. . .	105(33.8)	0.6624		*T56*
Oklahoma	135	88(65.2)	. . .	47(34.8)	0.6519		*T57*
Chicago, IL	35	28(80.0)	. . .	7(20.0)	0.8000		*T2*
California and Hawaii	896	(73.0)	. . .	(26.7)		1	*T8*
Detroit, MI	252	173(68.7)	. . .	78(31.0)	0.6865	2,3	*T11*
		TOTAL MALES					
Numerical total	733	495(67.5)	. . .	237(32.2)	0.6753		
WMP		70.5		32.3			
WSDP		3.422		3.510			
		FEMALES					
Baltimore, MD	100	52(52.0)	35(35.0)	13(13.0)	0.6950		*T56*
Oklahoma	39	23(59.0)	13(33.3)	3(7.7)	0.7564		*T57*
Chicago, IL	65	45(69.2)	11(16.9)	9(13.8)	0.7769	*	*T2*
California and Hawaii	111	(63.1)	(23.4)	(9.9)		1	*T8*
Detroit, MI	248	159(64.1)	57(23.0)	30(12.1)	0.7560	2,3,*	*T11*
		TOTAL FEMALES					
Numerical total	452	279(61.7)	116(25.7)	55(12.2)	0.7456	*	
WMP		62.0	25.2	11.7			
WSDP		5.161	5.688	1.629			

Notes:

1. Distributions given in percentages; data not used in calculation of numerical totals.
2. One "rare" among males; two "rare" among females.
3. And see Shaler [*T12*].

*$\chi^2 > 6.635$, $P < 0.01$.

References

[1] Gaensslen, R. E. and Camp, F. R., "Forensic Serology: Parentage Testing," in *Forensic Sciences*, C. H. Wecht, Ed., Matthew Bender, New York, 1986, Vol. 2, Chap. 30 (originally as Camp, F. R. and Gaensslen, R. E., "Forensic Serology: Paternity Testing (and Transfusion Reactions)," same title, 1981).

[2] Silver, H., Ed., *Probability of Inclusion in Paternity Testing*, American Association of Blood Banks, Arlington, VA, 1982.

[3] Walker, R. H., Ed., *Inclusion Probabilities in Parentage Testing*, American Association of Blood Banks, Arlington, VA, 1983.

[4] Culliford, B. J., *The Examination and Typing of Bloodstains in the Crime Laboratory*, U.S. Government Printing Office, Washington, DC, 1971.

[5] Metropolitan Police Forensic Science Laboratory, *Biology Methods Manual*, Commissioner of Police of the Metropolis, London, 1978.

[6] Gaensslen, R. E. and Camp, F. R., "Forensic Serology: Analysis of Bloodstains and Body Fluid Stains," in *Forensic Sciences*, Vol. 2, C. H. Wecht, Ed., Matthew Bender, New York, 1984, Chap. 29.

[7] Lee, H. C., "Identification and Grouping of Bloodstains," in *Forensic Science Handbook*, R. Saferstein, Ed., Prentice Hall, Englewood Cliffs, NJ, 1982, pp. 267-337.

[8] Sensabaugh, G. F., "Isozymes in Forensic Science," in *Isozymes, Current Topics in Biological and Medical Research*, Vol. 6, M. C. Rattazzi, J. G. Scandalios, and G. S. Whitt, Eds., Alan R. Liss, New York, 1982, pp. 247-282.

[9] Sensabaugh, G. F., "The Utilization of Polymorphic Enzymes in Forensic Science," in *Isozymes. Current Topics in Biological and Medical Research*, Vol. 11, M. C. Rattazzi, J. G. Scandalios, and G. S. Whitt, Eds., Alan R. Liss, New York, 1983, pp. 137-154.

[10] Gaensslen, R. E., *Sourcebook in Forensic Serology, Immunology and Biochemistry*, U.S. Government Printing Office, Washington, DC, 1983.

[11] Mourant, A. E., Kopeć, A. C., and Domaniewska-Sobczak, K., *The Distribution of the Human Blood Groups and Other Polymorphisms*, Oxford University Press, London, 1976.

[12] Gaensslen, R. E., Bell, S. C., and Lee, H. C., "Distributions of Genetic Markers in United States Populations: I. Blood Group and Secretor Systems," *Journal of Forensic Sciences*, Vol. 32, No. 4, July 1987, pp. 1016-1058.

[13] Levitan, M. and Montagu, A., *Textbook of Human Genetics*, Oxford University Press, New York, London, Toronto, 1971.

[14] Fisher, R. A., *Statistical Methods for Research Workers*, 14th ed., Hafner Division of Macmillan, New York, 1970.

[15] Shows, T. B., Alper, C. A., Bootsma, D., Dorf, M., Douglas, T., et al., "International System for Human Gene Nomenclature (1979). ISGN (1979)," *Cytogenetics and Cell Genetics*, Vol. 25, 1979, pp. 96-116.

[16] Paar, C. W. and Fitch, L. I., "Inherited Quantitative Variations in Human Phosphogluconate Dehydrogenase," *Annals of Human Genetics*, Vol. 30, 1967, pp. 339-353.

[17] Gaensslen, R. E., Lee, H. C., Ehart, S., Abbott, M., and Hammond, H., "Use and Interpretation of Phenotypic Frequencies for Genetic Markers in Populations in Forensic Serology," in *Proceedings of the International Symposium on the Forensic Applications of Electrophoresis*, FBI Academy, Quantico, VA, 1984.

[18] Gaensslen, R. E., "When Blood is Their Argument: Use and Interpretation of Population Genetic Marker Frequency Data in Forensic Serology," *FBI Crime Laboratory Digest*, Vol. 12, No. 4, Oct. 1985, pp. 75-81.

Table References

[T1] Lie-Injo, L. E., "Phosphoglucomutase Polymorphism: An Unusual Type in Negroes," *Nature*, Vol. 210, 1966, pp. 1183-1184.

[T2] Shih, L.-Y. and Hsia, D. Y.-Y., "The Distribution of Genetic Polymorphisms among Chinese in Taiwan," *Human Heredity*, Vol. 19, 1969, pp. 227-233.

[T3] Giblett, E. and Scott, N. M., unpublished, cited in Giblett, E. R., *Genetic Markers in Human Blood*, Blackwell Scientific Publications, Oxford, 1969.

[T4] Mondovano, J. A. and Gaensslen, R. E., "Distribution of Adenylate Kinase and Phosphoglucomutase Isoenzymes in the Population of the City of New York," *Human Heredity*, Vol. 25, No. 6, 1975, pp. 488-492.

[*T5*] Polesky, H. F., Dykes, D. D., Scarr-Salapatek, S., and Katz, S. H., unpublished, cited in Sussman, L. N., *Paternity Testing by Blood Grouping*, 2nd ed., Charles C Thomas, Springfield, IL, 1976.

[*T6*] Fitzpatrick, F. A., Graves, M. H., and White, J. M., "The Distribution of EsD Phenotypes in a Selected California Population," *Forensic Serology News*, Vol. 2, No. 6, 1976.

[*T7*] Hagins, A. M., Shaler, R. C., Mortimer, C. E., Stuver, W. C., and Neilson, D. M., "Population Frequencies of Forensically Important Genetic Markers: Phosphoglucomutase, Erythrocyte Acid Phosphatase, and Haptoglobin," *Journal of Forensic Sciences*, Vol. 23, No. 3, July 1978, pp. 563-569.

[*T8*] Grunbaum, B. W., Selvin, S., Pace, N., and Black, D. M., "Frequency Distribution and Discrimination Probability of Twelve Protein Genetic Variants in Human Blood as Functions of Race, Sex and Age," *Journal of Forensic Sciences*, Vol. 23, No. 3, July 1978, pp. 577-587.

[*T9*] Ganaway, R. L. and Lux, P., "ABO, PGM, EAP and Hp Distributions in Three Ethnic Groups in Bexar County, Texas," *Forensic Serology News*, Vol. 4, No. 1, 1978.

[*T10*] Pakstis, A. J., Polesky, H. F., Scarr, S., and Katz, S. H., "Gene Frequency Estimates for Samples of Black and White Twins from the Philadelphia Metropolitan Area," *Human Genetics*, Vol. 43, 1978, pp. 159-177.

[*T11*] Stolorow, M. D., Housel, D. L., Schaefer, J. R., Schoonover, J. L., Hauncher, J. D., et al., "Blood Genetic Marker Study—Greater Detroit Metropolitan Area," presented at the 31st Annual Meeting of the American Academy of Forensic Sciences, Atlanta, GA, Feb. 1979.

[*T12*] Shaler, R. C., *Forensic Implications of Genetic Population Data Collected in Different Geographical Regions*, Final Report, Report ATR-79(7910)-1, Contract J-LEAA-025-73 for Law Enforcement Assistance Administration, Eastern Technical Division, Aerospace Corp., 1978.

[*T13*] Stuver, W. C., unpublished personal communication, 1979.

[*T14*] Siglar, G., unpublished personal communication, 1979.

[*T15*] Grunbaum, B. W., Selvin, S., Myhre, B. A., and Pace, N., "Distribution of Gene Frequencies and Discrimination Probabilities for 22 Human Blood Genetic Systems in Four Racial Groups," *Journal of Forensic Sciences*, Vol. 25, No. 2, April 1980, pp. 428-444.

[*T16*] Fischer, B., unpublished personal communication, 1982.

[*T17*] Dykes, D. D., Crawford, M. H., and Polesky, H. F., "Population Distribution in North and Central America of PGM_1 and Gc Subtypes as Determined by Isoelectric Focusing (IEF)," *American Journal of Physical Anthropology*, Vol. 62, 1983, pp. 137-145.

[*T18*] Nelson, M. S., "A Computer-Assisted Population Frequency Study of 14 Polymorphic Blood Group Systems in North Carolina," *Journal of Forensic Sciences*, Vol. 29, No. 3, July 1984, pp. 762-773.

[*T19*] Lee, H. C., Gaensslen, R. E., Pagliaro, E. M., and Lord, C., unpublished, 1984.

[*T20*] Hurley, R. J. and Profili, M., "Phosphoglucomutase Isoenzyme Distributions in the Baltimore, Maryland Metropolitan Area," *Forensic Serology News*, Vol. 10, No. 4, 1984.

[*T21*] Briner, R. C. and Compas, T., unpublished personal communication, 1985.

[*T22*] Budowle, B., Sundaram, S., and Wenk, R. E., "Population Data on the Forensic Genetic Markers: Phosphoglucomutase-1, Esterase D, Erythrocyte Acid Phosphatase and Glyoxalase I," *Forensic Science International*, Vol. 28, No. 2, June/July 1985, pp. 77-81.

[*T23*] Brewer, G. J., Bowbeer, D. R., and Tashian, R. E., "The Electrophoretic Phenotypes of Red Cell Phosphoglucomutase, Adenylate Kinase and Acid Phosphatase in the American Negro," *Acta Genetica et Statistica Medica*, Vol. 17, 1967, pp. 97-103.

[*T24*] Malaga, E., "The Distribution of PGM Phenotypes among the Spanish-Surnamed Population of the Salinas Valley, California," *Forensic Serology News*, Vol. 3, No. 3, 1979.

[*T25*] Lie-Injo, L. E., Lopez, C. G., and Poey-Oey, H. G., "Erythrocyte and Leucocyte Phosphoglucomutase in Chinese," *American Journal of Human Genetics*, Vol. 20, 1968, pp. 101-106.

[*T26*] Dykes, D. D. and Polesky, H. F., "Paternity Testing by Using Erythrocyte Enzyme Esterase D," *Journal of Forensic Sciences*, Vol. 22, No. 1, Jan. 1977, pp. 173-177.

[*T27*] Mortimer, C., Berk, L., Smith, F., and Hagins, A. M., "Population Frequencies of Esterase-D and Carbonic Anhydrase II Isoenzymes," presented at the 30th Annual Meeting of the American Academy of Forensic Sciences, St. Louis, MO, Feb. 1978.

[*T28*] Smith, F. P., Mortimer, C. E., Shaler, R. C., and Berk, L. B., "Population Frequencies of Carbonic Anhydrase II and Esterase D in the Pittsburgh Metropolitan Area," *Journal of Forensic Sciences*, Vol. 25, No. 4, Oct. 1980, pp. 866-869.

[*T29*] Robertson, J. A., "Comparison of Forensic Blood Group Population Frequency Studies Using Chi-square," presented at the 33rd Annual Meeting of the American Academy of Forensic Sciences, Los Angeles, CA, Feb. 1981.

[*T30*] Dykes, D. D., Polesky, H. F., and Miller, S., "Frequency of the ESD*5 Allele in Three Ethnic Groups in Minnesota," *Human Genetics*, Vol. 62, 1982, pp. 162-163.

[*T31*] Meighen, G. and Smith, F. P., "Population Frequencies of Carbonic Anhydrase II (CAII) and Glyoxalase I (GLO) in the Metropolitan Birmingham, Alabama Area," presented at the 37th Annual Meeting of the American Academy of Forensic Sciences, Las Vegas, NV, Feb. 1985.

[*T32*] Sensabaugh, G. F. and Golden, V. L., "Esterase-D Polymorphism in Chinese and Japanese," *Human Genetics,* Vol. 35, 1976, pp. 103-105.

[*T33*] Bowman, J. E., Frischer, H., Ajmar, F., Carson, P. E., and Gower, M. K., "Population, Family and Biochemical Investigation of Human Adenylate Kinase Polymorphism," *Nature,* Vol. 214, 1967, pp. 1156-1158.

[*T34*] Stombaugh, P. M. and Kearney, J. J., "Determination of Adenylate Kinase Variants in Two Washington, D.C., Population Samples: A Micro Cellulose Acetate Procedure," *Journal of Forensic Sciences,* Vol. 22, No. 3, July 1977, pp. 590-595.

[*T35*] Giblett, E. R. and Scott, N. M., "Red Cell Acid Phosphatase: Racial Distribution and Report of a New Phenotype," *American Journal of Human Genetics,* Vol. 17, 1965, pp. 425-432.

[*T36*] Omoto, K. and Harada, S., "Red Cell and Serum Protein Types in the Ainu Population of Shizunai, Hokkaido," in 8th Int. Congr. Anthropol. Ethnol. Sci., Vol. 1, 1968, pp. 206-209, cited by Mourant, A. E., Kopeć, A. C., and Domaniewska-Sobczak, K., *The Distribution of the Human Blood Groups and Other Polymorphisms,* Oxford University Press, London, 1976.

[*T37*] Karp, G. W. and Sutton, H. E., "Some New Phenotypes of Human Red Cell Acid Phosphatase," *American Journal of Human Genetics,* Vol. 19, 1967, pp. 54-62.

[*T38*] Mourant, A. E., Kopeć, A. C., and Domaniewska-Sobczak, K., *The Distribution of the Human Blood Groups and Other Polymorphisms,* Oxford University Press, London, 1976.

[*T39*] McWright, C. G., Kearney, J. J., and Mudd, J. L., "Effect of Environmental Factors on Starch Gel Electrophoretic Patterns of Human Erthrocyte Acid Phosphatase," in *Forensic Science,* 1st ed., G. Davies, Ed., American Chemical Society Symposium Series No. 13, American Chemical Society, Washington, DC, 1975, pp. 151-161.

[*T40*] Detter, J. C., Stamatoyannopoulos, G., and Giblett, E. R., "Adenosine Deaminase: Racial Distribution and Report of a New Phenotype," *Journal of Medical Genetics,* Vol. 7, 1970, pp. 356-357.

[*T41*] Weitkamp, J. R., "Linkage of GLO with HLA and Bf. Effect of Population and Sex on Recombination Frequency," *Tissue Antigens,* Vol. 7, 1976, pp. 273-279.

[*T42*] Polesky, H. F. and Dykes, D. D., personal communication to Dr. J. W. Morris, Long Beach, CA, 1981.

[*T43*] Gershowitz, H., personal communication to Dr. J. W. Morris, Long Beach, CA, 1981.

[*T44*] Morris, J. W., personal communication, Long Beach, CA, 1981.

[*T45*] Ferrell, R., personal communication to Dr. J. W. Morris, Long Beach, CA, 1981.

[*T46*] Lee, C., personal communication to Dr. J. W. Morris, Long Beach, CA, 1981.

[*T47*] Dern, R. J., Brewer, G. J., Tashian, R. E., and Shows, T. B., "Hereditary Variation of Erythrocyte 6-Phosphoglucose Dehydrogenase," *Journal of Laboratory and Clinical Medicine,* Vol. 67, 1966, pp. 255-264.

[*T48*] Bowman, J. E., Carson, P. E., Frischer, H., and deGaray, A. L., "Genetics of Starch Gel Electrophoretic Variants of Human 6-Phosphogluconate Dehydrogenase: Population and Family Studies in the United States and in Mexico," *Nature,* Vol. 210, 1966, pp. 811-813.

[*T49*] Davidson, R. G., "Electrophoretic Variants of Human 6-Phosphogluconate Dehydrogenase: Population and Family Studies and Description of a New Variant," *Annals of Human Genetics,* Vol. 30, 1967, pp. 355-361.

[*T50*] Chen, S.-H. and Giblett, E. R., "Polymorphism of Soluble Glutamic-Pyruvic Transaminase: A New Genetic Marker in Man," *Science,* Vol. 173, 1971, pp. 148-149.

[*T51*] Chen, S.-H., Giblett, E. R., Anderson, J. E., and Fossum, B. L. G., "Genetics of Glutamic-Pyruvic Transaminase: Its Inheritance, Common and Rare Variants, Population Distribution, and Differences in Catalytic Activity," *Annals of Human Genetics,* Vol. 35, 1972, pp. 401-409.

[*T52*] Welch, S. G., Mills, P. R., and Gaensslen, R. E., "Phenotypic Distributions of Red Cell Glutamate-Pyruvate Transaminase (E.C.2.6.1.2) Isoenzymes in British and New York Populations," *Humangenetik,* Vol. 27, 1975, pp. 59-62.

[*T53*] Tumosa, C. S., unpublished personal communication, 1981.

[*T54*] Moore, M. J., Funakoshi, S., and Deutsch, H. F., "Human Carbonic Anhydrases. VII. A New C Type Isozyme in Erythrocytes of American Negroes," *Biochemical Genetics,* Vol. 5, 1971, pp. 497-504.

[*T55*] Tashian, R. E. and Carter, N. D., "Biochemical Genetics of Carbonic Anhydrase," in *Advances in Human Genetics,* Vol. 7, H. Harris and K. Hirschhorn, Eds., Plenum, New York and London, 1976, pp. 1-56.

[*T56*] Boyer, S. H., Porter, I. H., and Weilbacher, R. G., "Electrophoretic Heterogeneity of Glucose-6-phosphate Dehydrogenase and Its Relation to Enzyme Deficiency in Man," *Proceedings of the National Academy of Sciences* (U.S.A.), Vol. 48, 1962, pp. 1868-1876.

[*T57*] Kirkman, H. N. and Hendrickson, E. M., "Sex-Linked Electrophoretic Difference in Glucose-6-Phosphate Dehydrogenase," *American Journal of Human Genetics,* Vol. 15, 1963, pp. 241–258.

Address requests for reprints or additional information to
R. E. Gaensslen
Forensic Sciences Program and Laboratories
University of New Haven
300 Orange Ave.
West Haven, CT 06516