Blood and Serum Groups in Taiwan*

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During 1960 blood samples were collected in Taiwan from 300 male adolescents and adults in the capital town of Taipei and in the small communities of Chi-Chi (centre of Island) and Chung-Li (N.W.) (Motulsky, Lee, and Fraser, 1964). The donors from Taipei originated in all parts of Taiwan. The main object of the study was to investigate the distribution of abnormal haemoglobins and G6PD deficiency but the opportunity was also taken of characterizing blood and serum groups of this population. An attempt was made to restrict this study to the main group of Formosan Chinese who had immigrated from Fukien province on the mainland in the 17th century.

Blood Groups

The blood groups are set out in Table I.

TABLE I

ABO	Taipeh	Chi-Chi	Chung-Li	Total
O	46	61	44	151
A	28	20	31	79
B	19	15	16	50
AB	5	4	11	20
	98	100	102	300

The gene frequencies (Table II) were calculated by the method described by Race and Sanger (1962) and a χ^2 value for one degree of freedom was derived, based on the difference between the observed and expected numbers of AB individuals.

TABLE II

GENE FREQUENCIES

	Taipeh	Chi-Chi	Chung-Li
A	0.18	0.12	0.21
B	0.13	0.09	0.11
O	0.69	0.79	0.68
χ^2	0.03	1.18	4.45

A G test was performed to test heterogeneity between the samples by the method of Woolf (1957). A value of 8.42 was obtained which is not significant at the 5% level if we assume that this value follows the distribution of χ^2 on four degrees of freedom.

It is legitimate, therefore, to pool the sample and calculate gene frequencies for the whole group. The same method was employed and gave the following gene frequencies: A = 0.17; B = 0.11; o = 0.72 ($\chi^2_1 = 5.37$).

These figures do not agree very well with published data for Formosa (Mourant, Kopec, and Domaniewska-Sobczak 1958) in that the frequency of B in most previous samples has been higher.

MNSs Groups. Anti-M, anti-N, and anti-s sera were used, but there were no negative reactors with the last. Only the frequencies of the alleles M and N can, therefore, be considered (Table III).

TABLE III

	Taipeh	Chi-Chi	Chung-Li	Total
MM	25	32	32	89
MN	51	52	52	155
NN	22	15	18	55

The gene frequencies are given in Table IV.

TABLE IV

GENE FREQUENCIES

	Taipeh	Chi-Chi	Chung-Li	Total
M	0.515	0.587	0.569	0.557
N	0.485	0.413	0.431	0.443
χ^2	0.17	0.67	0.16	1.84

The G test for heterogeneity was again performed and gave a value of χ^2_2 of 2.16. The values were, therefore, combined for a pooled estimate of M and N frequencies.

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The MN frequencies in this sample agree well with those from the sample of New York Chinese of Miller, Rosenfield, and Vogel (1951). The frequency of S in this group is low (0.055); it is not surprising, therefore, that SS individuals were not uncovered in our sampling.

Rhesus Groups. Anti-C, D, E, and c sera were used. The calculation of gene frequencies posed a considerable problem. While the persons in Taipeh came from all parts of Formosa and could perhaps be regarded as a representative sample, Chi-Chi and Chung-Li are small communities. Furthermore, the G test tables of Woolf (1957) revealed a considerable heterogeneity ($\chi^2_4 = 11.63$, $0.05 > p > 0.01$). Frequencies have therefore been calculated both on the pooled data and on each group separately (Table V).

As mentioned above, the Taipeh frequencies may be considered as the most representative of Taiwan as a whole. They agree well with those for New York Chinese as reported by Wiener, Sonn, and Belkin (1943, 1945) except that these authors did not use anti-c sera and were not able to identify the R_z chromosome. χ^2 values for fits to the observations may be calculated. For two degrees of freedom they are 5.98 for Taipeh, 2.88 for Chung-Li, and 0.38 for Chi-Chi.

No positive reactions were observed in 221 tests with anti-V serum in this group. Giblett, Chase, and Motulsky (1957) found the V or ce^s complex to be very rare in groups other than Negroes.

Kell Groups. No positive reactions with anti-K serum were found in 300 tests. This indicates a very low gene frequency of K. The K

TABLE V

Phenotypes				Genotypes	Taipeh	Chung-Li	Chi-Chi	Total
Anti-C	c	D	E					
+	—	+	—	CDe/CDe	47	52	54	153
+	+	+	—	CDe/cde, CDe/cDe	7	6	9	22
—	+	+	+	cDe/cde, cDe/cDe,	11	3	5	19
				cDe/cDE				
+	+	+	+	CDe/cDE, CDe/cde				
+	—	+	+	CDE/cDE, CDE/cDe	21	35	27	83
—	+	—	—	CDE/CDE, CDE/CDe	9	1	7	17
—	+	+	—	cde/cde	0	1	0	1
				cDe/cDe, cDe/cde	1	0	0	1
					96	98	102	296

The chromosome frequencies were calculated by the method of Race and Sanger (1962) for the entire group: $r = 0.0571$; $R_0 = 0.0237$; $R_1 = 0.7190$; $R_z = 0.0388$; $R_2 = 0.1614$.

χ^2_1 values of 4.47, 0.56, 1.02 were obtained for fit in the three phenotypic classes (+ + + —), (— + + +), and (+ + + +). Owing to the small numbers in the phenotypic classes (— + — —) and (— + + —), it is not possible to obtain realistic estimates of r and R_0 for the groups separately. Combined estimates can, however, be made by the method of Mourant (1954) (Table VI).

TABLE VI

	Taipeh	Chung-Li	Chi-Chi
$R_0 + r$	0.0917	0.0329	0.0571
R_1	0.6652	0.7430	0.7288
R_z	0.0640	0.0070	0.0457
R_2	0.1791	0.2171	0.1684

gene is rare or non-existent also in the Chinese (Miller *et al.*, 1951), the Marshallese (Simmons Graydon, Semple, Birdsell, Milbourne, and Lee, 1952), and the Malaysians (Polunin and Sneath, 1953).

Duffy Groups. Anti Fy^a serum was used in 299 tests and only 8 were negative. This suggests a gene frequency of 0.836 of the Fy^a allele. This is a little lower than for New York Chinese (Miller *et al.*, 1951).

Diego Groups. Anti Di^a was used and 18 of 300 samples gave a positive reaction. This suggests a gene frequency of about 0.015 for the Di^a allele. This is similar to the frequency in the Chinese (Layrisse and Arends, 1956).

Serum Groups

Haptoglobins (Table VII).

TABLE VII

	Taipeh	Chi-Chi	Chung-Li	Total
Hp 1-1	10	15	11	36
Hp 2-1	51	55	54	160
Hp 2-2	37	25	33	95
Hp 0	0	5	3	8
	98	100	101	299

From this, the following gene frequencies may be derived (Table VIII).

TABLE VIII

	Taipeh	Chi-Chi	Chung-Li	Total
Hp 1	0.359	0.447	0.388	0.397
Hp 2	0.641	0.553	0.612	0.603

The G tables of Woolf (1957) gave no hint of heterogeneity in these results ($\chi^2_2 = 3.66$). The last figures, therefore, may be taken as representative of haptoglobin gene frequencies in Taiwan. Of the 8 persons with ahaptoglobinaemia, one was thalassaemic but none had G6PD deficiency. One person in addition to those in the table showed a haptoglobin pattern which resembled the 'Johnson' phenotype (Giblett, 1961) except for a decreased concentration of the slowest moving bands.

These frequencies are rather different from those obtained by Blackwell, Lin, and Shiao (1962). These investigators found a Hp 1 gene frequency of 0.282 in 172 Taiwanese.

Transferrins. 13 of 300 persons showed a CD₁ transferrin pattern suggesting a frequency of the gene D₁ of about 0.021. The D₁ transferrin may, in fact, have been the variant D_{Chi} described by Parker and Bearn (1961).

Summary

ABO, Rh, MNS, Kell, Duffy, and Diego blood groups were determined on 300 individuals in

Taiwan. Gene and chromosome frequencies in the Rh system were calculated. Haptoglobin and transferrin types were also studied. A few cases with ahaptoglobinaemia and one variant resembling the Johnson type of haptoglobin were found. D₁ transferrin (D_{Chi}?) variant was found in 2.1% of the population. In general, gene frequencies resembled those in New York Chinese. Taiwanese populations originated in the Fukien province of South East China and have lived in Taiwan for 100-300 years. The New York Chinese population originated for the most part in the Kwangtung Province which adjoins Fukien.

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