

The Gene Pool of Belgorod Oblast Population: The Distribution of Immunological and Biochemical Gene Markers

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Abstract—The frequencies of 33 alleles of 12 loci of immunological and biochemical gene markers (ABO, RH, HP, GC, TF, PI, C³, ACP1, GLO1, PGM1, ESD, and 6-PGD) have been estimated in the indigenous Russian and Ukrainian populations of Belgorod oblast. Differences of the Belgorod population from other populations of Russia with respect to the genetic structure have been determined. It has been found that the frequency distributions of all alleles studied in the Belgorod population are similar to those typical of the genetic structure of Caucasoid populations.

INTRODUCTION

Genetic markers are widely used for describing the genetic structure of modern populations. Classical genetic markers are subdivided into physiological (e.g., taste sensitivity and color blindness), immunological (e.g., blood groups), and biochemical (e.g., erythrocyte and serum proteins) [1, 2]. Analysis of the distributions of the frequencies of immunological and biochemical gene markers is one of the most traditional approaches to the estimation of genetic differentiation of human populations. Data on their distributions in different population groups permit adequate characterization of genetic processes at the population level, which is necessary for studying the population microevolution and estimating the roles of inbreeding, genetic drift, migration, outbreeding, mutation rate, and selection in the evolution [3].

Classical gene markers have been used to study the gene pools of many populations; however, the absence of a unified research program prevents us from performing their correct comparative analysis. Different research groups dealing with the polymorphism of classical genetic markers use different ranges of markers. The gene pools of most populations studied to date can be compared only with respect to five or six biochemical (HP, GC, TF, GLO1, PGM1, and ACP1) and some immunological (ABO, RH, MN, LEW, and KEL) gene markers. The purpose of this study was to characterize the indigenous Russian and Ukrainian populations of Belgorod oblast (region) of Russia with respect to a common wide range of classical genetic markers (12 loci).

MATERIALS AND METHODS

Populations. We studied the Russian populations of Prokhorovka and Krasnoe raions (districts) and the Ukrainian populations of Graivoron and Krasnogvardeiskoe raions of Belgorod oblast (figure).

Prokhorovka raion is located in northern Belgorod oblast and borders on Kursk oblast of Russia. Its population is 22878 people. The raion is divided into 19 rural municipalities. We performed the study in five municipalities geographically remote from one another. Krasnoe raion borders on Voronezh oblast of Russia, to which it administratively belonged until 1954. It is located in northwestern Belgorod oblast. The population of Krasnoe raion is 12737 people. The raion is divided into ten rural municipalities. We performed the study in five municipalities geographically remote from one another.

Graivoron and Krasnogvardeiskoe raions are historically populated by Ukrainians, although they are located in different parts of the oblast (in southwestern and eastern Belgorod oblast, respectively). The population of Graivoron raion is 20606 people; the study was performed in one rural municipality (Kozinka). The population of Krasnogvardeiskoe raion is 35027 people. The study was performed in the Veseloe rural municipality. The first Ukrainian settlements in the area of the modern Graivoron raion appeared in the second half of the 16th century. In 1670, Ukrainians populated free lands in the Vorskla River basin near the mouth of the Graivoronka River. They founded the Graivorony settlement (which was later renamed into the town of Graivoron). In the area of the modern Krasnogvardeiskoe raion, a large cluster of Ukrainian settlements appeared between the late 17th and early 18th centuries. Most migrants were from Right-bank Ukraine



The map of Belgorod oblast. The districts where the samples were collected are shaded.

(Zhabotin, Belaya Tserkov', Gadyach, Korsun', and Uman'). There were also many migrants from the neighboring Sumy, Akhtyrka, Vorozhba, Sudzha, Bogodukhov, and Bakaleya [4].

The total sample from the Belgorod oblast indigenous population was 382 subjects, including 298 Russians from Prokhorovka and Krasnoe raions (146 and 152 subjects, respectively) and 84 Ukrainians from Krasnogvardeiskoe and Graivoron raions (42 subjects from each). The mean age of the subjects was 49.11 years.

Special attention was paid to correct formation of representative samples. Blood was sampled in five geographically separated rural municipalities of each raion populated by Russians. All municipalities were represented by approximately equal numbers of subjects (about 30). This sampling method allowed us to form an entirely representative sample and meets all requirements imposed on population genetic studies.

The samples included only subjects that were not related within the third degree of relationship all of whose ancestors during three generations originated from the given population. Blood was sampled according to international standards, after an informed written consent of the subjects, and under the supervision of the Committee for Ethics of the Medical Genetic Research Center of the Russian Academy of Medical Sciences. The ethnic and population affiliations of the subjects were determined on the basis of the ethnicities and birthplaces of three generations of their ancestors in both parental lines. These data were obtained by interviewing the subjects.

Methods of genotyping genetic biochemical markers. The material for laboratory study was venous blood from each proband's ulnar vein. The blood sample (5–6 ml) was centrifuged at 3000 rpm to separate into the serum and erythrocyte fractions. The obtained material was stored at a temperature of -20°C .

The subjects were typed with respect to ten biochemical polymorphic systems: TF, GC, HP, C'3, PI, ESD, GLO1, ACPI, PGM1, and 6-PGD. We used these gene markers because they met the following requirements: high polymorphisms of their gene loci, independent inheritance and structural and functional differences, and considerable variations of their allele frequencies in the population [5]. In addition, we selected this set of immunological and biochemical gene markers because their distributions are reported in most publications on genetic markers in other Russian populations. Therefore, we could use these genetic markers to correctly compare the genetic characteristics of the Belgorod population and other Russian populations.

The HP, C'3, and 6-PGD biochemical loci were identified by the standard method of vertical electrophoresis in 7.5% polyacrylamide gel (PAAG); the GLO1 locus was identified by the same method in 5% PAAG [5, 6]. We used a Protean II xi 2-D electrophoretic cell (Bio-Rad, United States). The TF, GC, ESD, and PGM1 loci were typed by means of isoelectrofocusing (IEF) in PAAG; the PI and ACPI loci, by means of IEF in agarose [5–9]. A Multiphor device (LKB, Sweden) was used for IEF. The results of the electrophoretic separation of serum proteins were visual-

ized using a Gs-710 densitometer (Bio-Rad, United States). The ESD and ACP1 phenotypes were identified in a dark box with the use of a transilluminator from UVP.

The ABO and RH blood groups were determined under field conditions by means of individual interviews.

Statistical analysis. The phenotypic and gene frequencies were calculated by standard methods [10]. To estimate the correspondence between the observed distribution and that expected on the basis of the Hardy–Weinberg equilibrium, we used the χ^2 [10]:

$$\chi^2 = \frac{(N_1 N_3 - 1/4 N_2^2)^2 N}{n_1 n_2},$$

where N_1 , N_2 , and N_3 are the numbers of genotypes AA, Aa, and aa, respectively, in a sample with a size of N ; n_1 and n_2 are the numbers of alleles A and a, respectively.

The observed heterozygosity level was calculated by the formula [10] $H_0 = \frac{N_0}{N}$; $N_0 = \sum_{i \neq j} \sum N_{ij}$, where N_{ij} is the number of subjects with genotype $A_i A_j$ for the first locus in the given sample, and N is the sample size.

The expected heterozygosity level was calculated [10] as $H_E = 1 - \sum_i P_i^2$, where P_i is the frequency of the i th allele of the first locus.

The ratio between the observed and expected heterozygosities was estimated by Wright's fixation index (D) [11]: $D = 1 - \frac{\bar{H}_O}{2pq}$, where \bar{H}_O is the mean observed heterozygosity; p and q are the allele frequencies.

RESULTS AND DISCUSSION

The table shows the obtained data on the distributions of phenotypes, gene frequencies, observed and expected heterozygosities, and fixation index for polymorphic blood group systems in the indigenous population of Belgorod oblast.

The ABO system. The frequency distribution of the genes of the ABO system in the Russian population of Belgorod oblast, like those in other Russian populations [1, 2, 12–15], was characterized by the following series: $O > A > B$. The Prokhorovka raion population significantly ($p < 0.001$ – 0.05) differed from the Prokhorovka raion population in the frequencies of alleles ABO^*O (0.61 and 0.51, respectively) and ABO^*A (0.22 and 0.26, respectively). The Ukrainian population of Belgorod oblast significantly ($p < 0.05$) differed from its Russian population in the ABO^*B allele frequency. The frequencies of the ABO blood group genes in the pooled Russian sample from Belgorod oblast were the following: ABO^*O —0.56, ABO^*A —0.24; and ABO^*B —0.20. These values are practically equal to the mean values typical of Russians in general [1]: ABO^*O —0.58, ABO^*A —0.24; and ABO^*B —0.18.

The RH system. The RH^*d allele frequency insignificantly varied in the four districts studied (from 0.38 to 0.42). In Russians from Belgorod oblast, the mean frequency of allele RH^*d (0.40) was almost the same as in Ukrainians from Belgorod oblast (0.41) but was significantly ($p < 0.05$) higher than in the total Russian gene pool (0.30) [1]. The RH^*d allele frequency in Ukrainians from Belgorod oblast (0.41) was somewhat higher than its mean frequency in Ukraine (0.36) [1].

The haptoglobin (HP) system. The HP^*1 allele frequency varied in different districts of Belgorod oblast from 0.31 to 0.34. Its mean frequency was almost the same in Russians and Ukrainians from Belgorod oblast (0.33 and 0.32, respectively). The mean HP^*1 allele frequency in the total Russian gene pool (0.365) is somewhat higher than in Russians and Ukrainians from Belgorod oblast; however, it has been reported [16] that its frequency widely vary in Russians (from 0.17 to 0.51).

The third component of complement (C'3) system. The variation of the $C'3^*F$ allele frequency in different districts of Belgorod oblast was narrow (0.12–0.14); the mean values for Russians and Ukrainians were 0.12 and 0.14, respectively. This variation was the same as in Russian populations of other regions [1, 2, 12, 13].

The group-specific component (GC) system. The distribution of alleles of the GC system considerably varied in different district and ethnic populations of Belgorod oblast. The GC^*2 allele frequency in Russians from Krasnoe raion was significantly decreased at the expense of an increased GC^*1S frequency compared to the Russian population of Prokhorovka raion ($p < 0.001$). The mean frequency of the GC^*1S allele in Russians from Belgorod oblast (0.67) fell at the upper limit of the variation range of its frequency in all Russian populations studied (0.48–0.68) and significantly ($p < 0.001$) differed from the mean frequency for Russians (0.57) [12, 16]. The mean frequency of the GC^*2S allele in Russians from Belgorod oblast was 0.23, which was significantly ($p < 0.001$) lower than the mean value for all Russian populations (0.29) though within the variation range of its frequency in Russians (from 0.14 to 0.38) [16]. The Ukrainian and Russian populations of Belgorod oblast significantly differed from each other in the GC^*2 and GC^*1S allele frequencies ($p < 0.01$ – 0.05).

The transferrin (TF) system. The Belgorod oblast population was characterized by a considerable variation of the frequencies of TF suballeles, the allele frequencies decreasing in the following order: $TF^*C1 > TF^*C2 > TF^*C3 > TF^*B$. The two Russian district populations studied (Krasnoe and Prokhorovka raions) significantly differed in the frequency of allele TF^*C1 ($p < 0.05$). The mean frequencies of the TF alleles in Russians from Belgorod oblast were the following: $TF^*C1 = 0.77$, $TF^*C2 = 0.15$, $TF^*C3 = 0.07$; and $TF^*B = 0.01$. These results entirely agree with data on TF allele variation in other Russian populations, as well as European populations. For example, in Russian populations (in contrast to Asian ones), the

Distribution of the phenotypes, gene frequencies, observed (H_O) and expected (H_E) heterozygosities, and fixation indices (D) of polymorphic blood group systems in the Belgorod oblast population

System and alleles	Russian population												Ukrainian population			Total of Belgorod oblast	
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvardeiskoe raion		Total of Ukrainians
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion					
ABO																	
ΣN	13	22	20	21	13	89	22	19	26	21	27	115	204	21	24	45	249
N_O																	
00(I)	7	7	9	8	6	37	8	3	10	4	8	33	70	7	10	17	87
A(II)	4	5	4	9	3	25	7	8	5	8	9	37	62	8	10	18	80
B(III)	1	6	5	3	3	18	5	4	9	6	6	30	48	5	3	8	56
AB(IV)	1	4	2	1	1	9	2	4	2	3	4	15	24	1	1	2	26
N_E																	
00(I)	6.34	5.05	8.07	8.21	5.67	33.49	7.70	2.22	9.76	4.29	6.72	30.29	63.27	7.79	10.13	17.92	81.33
A(II)	4.62	6.47	4.80	8.81	3.29	28.04	7.26	8.50	5.20	7.79	10.01	39.12	67.55	7.32	9.88	17.18	84.75
B(III)	1.57	7.51	5.81	2.83	3.29	20.93	5.25	4.41	9.21	5.81	6.95	32.05	53.36	4.37	2.89	7.25	60.54
AB(IV)	0.47	2.97	1.32	1.15	0.75	6.54	1.80	3.87	1.83	3.11	3.31	13.53	19.82	1.53	1.10	2.65	22.38
$\chi^2_{(HWE)}$	0.97	1.74	0.70	0.04	0.15	2.03	0.06	0.35	0.03	0.04	0.62	0.65	2.59	0.41	0.02	0.32	1.57
ABO^*O	0.70	0.48	0.64	0.63	0.66	0.61	0.59	0.34	0.61	0.45	0.50	0.51	0.56	0.61	0.65	0.63	0.57
ABO^*A	0.22	0.24	0.17	0.27	0.17	0.22	0.23	0.41	0.15	0.31	0.29	0.26	0.24	0.24	0.26	0.25	0.25
ABO^*B	0.08	0.28	0.20	0.10	0.17	0.17	0.18	0.25	0.24	0.24	0.21	0.22	0.20	0.15	0.09	0.12	0.18
RH																	
ΣN	11	17	19	18	5	68	19	17	23	19	25	103	171	17	24	41	212
RH(+)	9	13	16	16	4	58	16	14	22	13	21	86	144	14	20	34	178
RH(-)	2	4	3	2	1	10	3	3	1	6	4	17	27	3	4	7	34
RH^*D	0.58	0.51	0.60	0.67	0.55	0.62	0.60	0.58	0.79	0.44	0.60	0.59	0.60	0.58	0.59	0.59	0.60
RH^*d	0.42	0.49	0.40	0.33	0.45	0.38	0.40	0.42	0.21	0.56	0.40	0.41	0.40	0.42	0.41	0.41	0.40
HP																	
ΣN	30	30	31	29	26	146	30	30	31	29	27	147	293	42	42	84	377
N_O																	
1-1	0	2	3	3	3	11	3	1	6	3	2	15	26	1	3	4	30
1-2	20	18	18	15	7	78	19	16	11	8	12	66	144	25	20	45	189
2-2	10	10	10	11	16	57	8	13	14	18	13	66	123	16	19	35	158

Table. (Contd.)

System and alleles	Russian population												Ukrainian population			Total of Belgorod oblast		
	Prokhorovka raion						Krasnoe raion						Total of Russians	Giravoron raion	Krasnogvar-detskoe raion		Total of Ukrainians	
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Rashkovets municipality	Gotov'e municipality	Kanyzino municipality	Krasnoe municipality	Total of Krasnoe raion						
N_E																		
1-1	3.33	4.03	4.65	3.80	1.63	17.12	5.21	2.70	4.27	1.69	2.37	15.67	32.78	4.34	4.02	8.36	41.11	
1-2	13.33	13.93	14.71	13.40	9.75	65.75	14.58	12.60	14.47	10.62	11.26	64.65	130.44	18.32	17.95	36.28	166.77	
2-2	13.33	12.03	11.65	11.80	14.63	63.12	10.21	14.70	12.27	16.69	13.37	66.67	129.78	19.34	20.02	39.36	169.11	
$\chi^2_{(HWE)}$	7.50*	2.56	1.55	0.42	2.07	5.06*	2.75	2.18	1.78	1.77	0.12	0.06	3.16	5.58*	0.55	4.85*	6.69**	
H_O	0.67	0.60	0.58	0.52	0.27	0.53	0.63	0.53	0.35	0.28	0.44	0.45	0.49	0.60	0.48	0.54	0.50	
H_E	0.44	0.46	0.47	0.46	0.38	0.45	0.49	0.42	0.47	0.37	0.42	0.44	0.45	0.44	0.43	0.43	0.44	
D	+0.50	+0.29	+0.22	+0.12	-0.28	+0.17	+0.30	+0.27	-0.24	+0.25	+0.07	+0.02	+0.10	+0.37	+0.11	+0.24	+0.13	
t	2.33	1.41	1.14	0.56	1.00	1.87	1.62	1.10	1.22	0.89	0.25	0.20	1.45	1.89	0.57	1.71	2.09	
$HP*1$	0.33	0.37	0.39	0.36	0.25	0.34	0.42	0.30	0.37	0.24	0.30	0.33	0.33	0.32	0.31	0.32	0.33	
$HP*2$	0.67	0.63	0.61	0.64	0.75	0.66	0.58	0.70	0.63	0.76	0.70	0.67	0.67	0.68	0.69	0.68	0.67	
C'3																		
ΣN	30	30	31	29	26	146	30	30	31	29	27	147	293	42	42	84	377	
N_O																		
SS	23	22	25	21	20	111	24	22	25	22	21	114	225	31	32	63	288	
FS	6	7	6	7	6	32	6	8	5	6	6	31	63	10	9	19	82	
FF	1	1	0	1	0	3	0	0	1	1	0	2	5	1	1	2	7	
N_E																		
SS	22.53	21.68	25.29	20.70	20.35	110.47	24.30	22.53	24.40	21.55	21.33	114.08	224.55	30.86	31.72	62.57	287.11	
FS	6.93	7.65	5.42	7.60	5.31	33.05	5.40	6.93	6.21	6.90	5.33	30.83	63.91	10.29	9.56	19.85	83.78	
FF	0.53	0.68	0.29	0.70	0.35	2.47	0.30	0.53	0.40	0.55	0.33	2.08	4.55	0.86	0.72	1.57	6.11	
$\chi^2_{(HWE)}$	0.54	0.21	0.36	0.18	0.44	0.15	0.37	0.71	1.18	0.49	0.42	0.00	0.06	0.03	0.14	0.15	0.17	
H_O	0.20	0.23	0.19	0.24	0.23	0.22	0.20	0.27	0.16	0.21	0.22	0.21	0.22	0.24	0.21	0.23	0.22	
H_E	0.23	0.26	0.17	0.26	0.20	0.23	0.18	0.23	0.20	0.24	0.20	0.21	0.22	0.24	0.23	0.24	0.22	
D	-0.14	-0.09	+0.11	-0.08	+0.13	-0.03	+0.11	+0.15	-0.20	-0.13	+0.13	+0.01	-0.01	-0.03	-0.06	-0.04	-0.02	
t	0.32	0.22	0.20	0.20	0.25	0.16	0.21	0.35	0.43	0.31	0.24	0.03	0.10	0.08	0.16	0.17	0.17	
$C'3*S$	0.87	0.85	0.90	0.84	0.88	0.87	0.90	0.87	0.89	0.86	0.89	0.88	0.88	0.86	0.87	0.86	0.87	
$C'3*F$	0.13	0.15	0.10	0.16	0.12	0.13	0.10	0.13	0.11	0.14	0.11	0.12	0.12	0.14	0.13	0.14	0.13	

Table. (Contd.)

System and alleles	Russian population														Ukrainian population			
	Prokhorovka raion							Krasnoe raion							Graivoron raion	Krasnogvardeiskoe raion	Total of Ukrainians	Total of Belgorod oblast
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion	Total of Russians					
GC	30	30	31	29	26	146	30	30	30	29	32	151	297	40	39	79	376	
ΣN																		
N_0	4	4	4	4	4	20	2	3	0	0	1	6	26	6	2	8	34	
2-2	5	12	11	14	7	49	4	7	6	2	4	23	72	19	16	35	107	
2-1S	1	2	1	1	2	7	2	0	1	1	1	5	12	1	1	2	14	
2-1F	14	6	9	8	10	47	18	19	20	25	19	101	148	5	17	22	170	
1S-1S	5	3	6	2	3	19	4	1	2	1	5	13	32	9	2	11	43	
1S-1F	1	3	0	0	0	4	0	0	1	0	2	3	7	0	1	1	8	
1F-1F																		
N_E	1.63	4.03	3.23	4.56	2.78	15.78	0.83	1.41	0.41	0.08	0.38	2.65	15.57	6.40	2.83	8.89	23.75	
2-2	8.87	9.90	11.29	12.69	9.81	53.26	7.33	9.97	5.60	2.74	5.14	31.52	91.58	15.20	14.00	30.19	123.15	
2-1S	1.87	4.03	2.26	1.19	1.63	11.18	1.00	0.22	0.58	0.10	1.09	3.18	13.28	4.00	1.35	5.03	18.35	
2-1F	12.03	6.07	9.88	8.83	8.65	44.94	16.13	17.63	19.20	24.22	17.26	93.78	134.68	9.02	17.33	25.63	159.64	
1S-1S	5.07	4.95	3.95	1.66	2.88	18.96	4.40	0.77	4.00	1.83	7.34	18.91	39.06	4.75	3.33	8.54	47.57	
1S-1F	0.53	1.01	0.40	0.08	0.24	1.98	0.30	0.01	0.21	0.03	0.78	0.95	2.83	0.63	0.16	0.71	3.54	
1F-1F																		
$\chi^2_{(HW/E)}$	6.25	6.17	2.43	0.46	1.88	5.19	4.70	3.08	4.78	8.48	4.08	14.38**	20.03***	9.45*	5.56	4.02	14.29***	
H_0	0.37	0.57	0.58	0.59	0.46	0.51	0.33	0.27	0.30	0.14	0.31	0.27	0.39	0.73	0.49	0.61	0.44	
H_E	0.53	0.63	0.56	0.54	0.55	0.57	0.42	0.37	0.34	0.16	0.42	0.36	0.48	0.60	0.48	0.55	0.50	
D	-0.30	-0.10	+0.03	+0.09	-0.16	-0.10	-0.22	-0.27	-0.12	-0.14	-0.26	-0.24	-0.19	+0.21	+0.02	+0.10	-0.13	
t	1.54	0.67	0.17	0.52	0.83	1.26	0.84	0.97	0.36	0.26	1.07	1.74	2.77	1.68	0.09	0.89	2.22	
$GC*2$	0.23	0.37	0.33	0.40	0.33	0.33	0.17	0.22	0.12	0.05	0.11	0.13	0.23	0.40	0.27	0.34	0.25	
$GC*1S$	0.63	0.45	0.56	0.55	0.58	0.55	0.73	0.77	0.80	0.91	0.73	0.79	0.67	0.48	0.67	0.57	0.65	
$GC*1F$	0.14	0.18	0.11	0.05	0.09	0.12	0.10	0.01	0.08	0.04	0.16	0.08	0.10	0.12	0.06	0.09	0.10	

Table. (Contd.)

System and alleles	Russian population													Ukrainian population			Total of Belgorod oblast	
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvardeiskoe raion	Total of Ukrainians		
	Kholodnoe municipality	Kolomyitsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion						
TF																		
ΣN	30	30	31	29	26	146	30	30	31	29	32	152	298	42	39	81	376	
N_O																		
C1C1	14	22	21	25	12	94	14	13	13	17	22	79	173	15	26	41	214	
C1C2	10	5	8	1	8	32	11	6	10	6	8	41	73	18	5	23	96	
C1C3	4	2	1	1	3	11	4	7	5	5	0	21	32	3	2	5	37	
C1B	1	0	1	2	0	4	0	2	2	0	1	5	9	3	1	4	13	
C1D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	
C2C2	0	0	0	0	1	1	1	1	0	1	0	3	4	2	0	2	6	
C2C3	1	1	0	0	1	3	0	1	1	0	1	3	6	1	1	2	8	
C3C3	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	1	2	
N_E																		
C1C1	15.41	21.68	21.81	25.14	11.78	97.56	15.41	14.01	14.91	17.46	21.95	83.26	177.52	17.36	25.44	42.25	219.61	
C1C2	7.88	5.10	6.71	0.93	7.40	29.78	9.32	6.15	7.63	6.21	7.45	37.01	67.15	14.79	4.85	20.94	88.30	
C1C3	3.58	2.55	0.84	0.93	4.01	12.88	2.87	5.47	4.16	3.88	0.83	17.76	30.87	2.57	4.04	6.50	37.30	
C1B	0.72	0	0.84	1.86	0	3.22	0	1.37	1.39	0	0.83	3.70	6.95	1.93	0.81	2.89	9.90	
C1D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.42	2.17	2.28	
C2C2	1.01	0.30	0.52	0.01	1.16	2.34	1.41	0.68	0.98	0.55	0.63	4.11	6.35	3.15	0.23	2.60	8.88	
C2C3	0.92	0.30	0.13	0.02	1.27	2.03	0.87	1.20	1.06	0.69	0.14	3.95	5.84	1.10	0.38	1.61	7.50	
C3C3	0.21	0.08	0.01	0.01	0.35	0.44	0.13	0.53	0.29	0.22	0.01	0.95	1.34	0.10	0.16	0.25	1.58	
$\chi^2_{(HWE)}$	2.36	2.13	1.15	0.16	1.63	3.34	1.99	2.12	3.27	1.61	6.96	4.43	4.22	3.23	7.51	5.61	6.74	
H_O	0.53	0.27	0.33	0.14	0.46	0.34	0.50	0.53	0.58	0.38	0.31	0.46	0.40	0.60	0.31	0.46	0.41	
H_E	0.45	0.27	0.28	0.13	0.49	0.33	0.44	0.49	0.48	0.37	0.29	0.42	0.38	0.51	0.34	0.44	0.39	
D	+0.20	+0.01	+0.16	+0.05	-0.06	+0.03	+0.15	+0.09	+0.22	+0.02	+0.06	+0.10	+0.07	+0.17	-0.08	+0.03	+0.06	
t	0.78	0.02	0.40	0.08	0.23	0.18	0.59	0.37	0.94	0.07	0.18	0.82	0.67	0.98	0.29	0.21	0.67	
$TF*C1$	0.72	0.85	0.84	0.93	0.67	0.80	0.72	0.69	0.69	0.77	0.83	0.74	0.77	0.64	0.81	0.72	0.76	
$TF*C2$	0.18	0.10	0.13	0.02	0.21	0.13	0.22	0.15	0.18	0.14	0.14	0.16	0.15	0.27	0.08	0.18	0.15	
$TF*C3$	0.08	0.05	0.02	0.02	0.12	0.06	0.06	0.13	0.10	0.09	0.02	0.08	0.07	0.05	0.06	0.06	0.06	
$TF*B$	0.02	0	0.01	0.03	0	0.01	0	0.03	0.03	0	0.01	0.02	0.01	0.04	0.01	0.02	0.02	
$TF*D$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0.02	0.01	

Table. (Contd.)

System and alleles	Russian population													Ukrainian population			Total of Belgorod oblast	
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvar-deiskoe raion	Total of Ukrainians		
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion						
PI																		
ΣN	26	30	31	27	13	127	22	25	31	28	14	120	247	33	42	75	322	
N_O																		
M1M1	17	25	26	24	9	101	16	15	16	20	7	74	175	25	29	54	229	
M1M2	6	4	4	2	3	19	4	3	6	4	4	21	40	4	6	10	50	
M1M3	1	0	1	0	1	3	2	3	7	3	3	18	21	3	3	6	27	
M1R	0	1	0	1	0	2	0	0	0	1	0	1	3	0	1	1	4	
M2M2	2	0	0	0	0	2	0	1	2	0	0	3	5	1	2	3	8	
M2M3	0	0	0	0	0	0	0	2	0	0	0	2	2	0	0	0	2	
M2R	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	
M3M3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
RR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	
N_E																		
M1M1	16.16	25.21	26.20	24.08	9.31	100.54	16.41	12.96	16.33	20.57	7.88	73.63	173.48	24.61	27.52	52.08	225.56	
M1M2	7.88	3.67	3.68	1.89	2.54	20.46	3.45	5.76	7.26	3.43	3.00	23.50	44.42	5.18	8.10	13.33	57.75	
M1M3	0.79	0	0.92	0	0.85	2.67	1.73	3.60	5.08	2.57	2.25	15.67	19.28	2.59	2.43	5.00	24.27	
M1R	0	0.92	0	0.94	0	1.78	0	0.72	0	0.86	0	1.57	3.35	0	2.43	2.50	5.86	
M2M2	0.96	0.13	0.13	0.04	0.17	1.04	0.18	0.64	0.81	0.14	0.29	1.88	2.84	0.27	0.60	0.85	3.70	
M2M3	0.19	0	0.06	0	0.12	0.27	0.18	0.80	1.13	0.21	0.43	2.50	2.47	0.27	0.36	0.64	3.11	
M2R	0	0.03	0	0.04	0	0.18	0	0.16	0	0.07	0	0.25	0.43	0	0.36	0.32	0.75	
M3M3	0.01	0	0.01	0	0.02	0.02	0.05	0.25	0.40	0.08	0.16	0.83	0.54	0.07	0.05	0.12	0.65	
RR	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0.02	0	0.05	0.03	0.04	
$\chi^2_{(HWE)}$	1.87	0.25	0.24	0.09	0.43	1.56	0.55	9.24	4.24	0.78	1.56	4.85	3.87	2.62	22.51*	39.97**	32.77**	
H_O	0.27	0.17	0.16	0.11	0.31	0.19	0.27	0.36	0.42	0.29	0.50	0.36	0.27	0.21	0.24	0.23	0.26	
H_E	0.34	0.16	0.15	0.10	0.27	0.20	0.24	0.45	0.43	0.26	0.41	0.36	0.28	0.24	0.33	0.29	0.29	
D	-0.21	+0.08	+0.07	+0.05	+0.14	-0.06	+0.12	-0.19	-0.05	+0.11	+0.23	-0.02	-0.05	-0.13	-0.27	-0.22	-0.09	
t	0.65	0.13	0.12	0.06	0.23	0.23	0.23	0.70	0.14	0.25	0.57	0.10	0.34	0.33	0.10	0.99	0.76	
$PI*MI$	0.79	0.92	0.92	0.94	0.85	0.89	0.86	0.72	0.73	0.86	0.75	0.78	0.84	0.86	0.81	0.83	0.84	
$PI*M2$	0.19	0.07	0.06	0.04	0.12	0.09	0.09	0.16	0.16	0.07	0.14	0.13	0.11	0.09	0.12	0.11	0.11	
$PI*M3$	0.02	0	0.02	0	0.03	0.01	0.05	0.10	0.11	0.05	0.11	0.08	0.04	0.05	0.04	0.04	0.04	
$PI*R$	0	0.01	0	0.02	0	0.01	0	0.02	0	0.02	0	0.01	0.01	0	0.03	0.02	0.01	

Table. (Contd.)

System and alleles	Russian population												Ukrainian population			Total of Belgorod oblast		
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvardeiskoe raion		Total of Ukrainians	
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskiï municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion						
GLO1																		
ΣN	30	30	31	29	26	146	30	30	31	29	32	152	298	42	42	84	382	
N_O																		
1-1	3	3	3	4	3	16	6	4	0	6	6	22	38	7	4	11	49	
1-2	13	12	11	10	8	54	10	9	18	11	8	56	110	15	18	33	143	
2-2	14	15	17	15	15	76	14	17	13	12	18	74	150	20	20	40	190	
N_E																		
1-1	3.01	2.70	2.33	2.79	1.88	12.66	4.03	2.41	2.61	4.56	3.13	16.45	29.02	5.01	4.02	9.00	38.01	
1-2	12.98	12.60	12.34	12.41	10.23	60.67	13.93	12.18	12.77	13.88	13.75	67.11	127.95	18.99	17.95	36.99	164.98	
2-2	14.01	14.70	16.33	13.79	13.86	72.66	12.03	15.41	15.61	10.56	15.13	68.45	141.02	18.01	20.02	38.00	179.01	
$\chi^2_{(HWE)}$	0	0.07	0.36	1.09	1.24	1.77	2.39	2.05	5.19*	1.25	5.59*	4.16*	5.87*	1.85	0.00	0.98	6.78**	
H_O	0.43	0.40	0.35	0.35	0.31	0.37	0.33	0.30	0.58	0.38	0.25	0.37	0.37	0.36	0.43	0.39	0.37	
H_E	0.43	0.42	0.38	0.43	0.39	0.42	0.46	0.41	0.41	0.48	0.43	0.44	0.43	0.45	0.43	0.44	0.43	
D	+0.00	-0.05	-0.11	-0.19	-0.22	-0.11	-0.28	-0.26	+0.41	-0.21	-0.42	-0.17	-0.14	-0.21	+0.00	-0.11	-0.13	
t	0.01	0.20	0.43	0.83	0.80	1.00	1.41	1.09	1.67	1.05	2.04	1.69	1.92	1.18	0.01	0.81	2.08	
GLO1*1	0.32	0.30	0.27	0.31	0.27	0.29	0.37	0.28	0.29	0.40	0.31	0.33	0.31	0.35	0.31	0.33	0.32	
GLO1*2	0.68	0.70	0.73	0.69	0.73	0.71	0.63	0.72	0.71	0.60	0.69	0.67	0.69	0.65	0.69	0.67	0.68	
ESD																		
ΣN	30	30	31	29	26	146	29	30	31	27	32	149	295	42	42	84	379	
N_O																		
1-1	25	25	27	28	25	130	25	27	27	23	30	132	262	36	40	76	338	
1-2	3	5	2	1	1	12	3	3	4	4	1	15	27	4	2	6	33	
2-2	2	0	2	0	0	4	1	0	0	0	1	2	6	2	0	2	8	
N_E																		
1-1	23.41	25.21	25.29	28.01	25.01	126.68	24.22	27.07	27.13	23.15	29.07	130.61	257.29	34.38	40.02	74.30	331.58	
1-2	6.18	4.58	5.42	0.98	0.98	18.63	4.57	2.85	3.74	3.70	2.86	17.79	36.42	7.24	1.95	9.40	45.83	
2-2	0.41	0.21	0.29	0.01	0.01	0.68	0.22	0.08	0.13	0.15	0.07	0.61	1.29	0.38	0.02	0.30	1.58	

Table. (Contd.)

System and alleles	Russian population												Ukrainian population			Total of Belgorod oblast	
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvar-deitskoe raion		Total of Ukrainians
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion					
$\chi^2_{(HWE)}$	7.95*	0.25	12.34**	0.01	0.01	18.49***	3.42	0.08	0.15	0.17	13.53**	3.66	19.74**	8.41**	0.03	11.01**	29.71***
H_O	0.10	0.17	0.06	0.04	0.04	0.08	0.10	0.01	0.13	0.15	0.03	0.10	0.09	0.10	0.05	0.07	0.09
H_E	0.21	0.15	0.17	0.03	0.03	0.13	0.16	0.10	0.12	0.14	0.09	0.12	0.12	0.17	0.04	0.11	0.12
D	-0.52	+0.09	-0.63	+0.02	+0.02	-0.36	-0.34	+0.05	+0.07	+0.08	-0.65	-0.16	-0.26	-0.45	+0.02	-0.36	-0.28
t	1.27	0.15	1.49	0.01	0.01	1.33	0.66	0.07	0.10	0.12	1.03	0.54	1.31	1.13	0.03	0.95	1.59
$ESD*1$	0.88	0.92	0.90	0.98	0.98	0.93	0.91	0.95	0.94	0.93	0.95	0.94	0.93	0.90	0.98	0.94	0.94
$ESD*2$	0.12	0.08	0.10	0.02	0.02	0.07	0.09	0.05	0.06	0.07	0.05	0.06	0.07	0.10	0.02	0.06	0.06
6-PGD																	
ΣN	30	30	31	29	26	146	30	30	31	29	32	152	298	42	42	84	382
N_O																	
AA	27	27	28	27	24	133	26	28	28	28	30	140	273	39	39	78	351
AC	3	3	3	2	2	13	4	2	3	1	1	11	24	3	2	5	29
CC	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	2
N_E																	
AA	27.07	27.07	28.07	27.03	24.04	133.29	26.13	28.03	28.07	28.01	29.07	139.28	272.57	39.05	38.10	77.15	349.71
AC	2.85	2.85	2.85	1.93	1.92	12.42	3.73	1.93	2.85	0.98	2.86	12.44	24.87	2.89	3.81	6.71	31.57
CC	0	0	0.07	0.03	0.04	0.29	0.13	0.03	0.07	0.01	0.07	0.28	0.57	0.05	0.10	0.15	0.71
$\chi^2_{(HWE)}$	0.08	0.08	0.08	0.04	0.04	0.31	0.15	0.04	0.08	0.01	13.53**	2.05	0.36	0.06	9.48*	5.45*	2.54
H_O	0.10	0.10	0.10	0.07	0.08	0.09	0.13	0.07	0.10	0.04	0.03	0.07	0.08	0.07	0.05	0.06	0.06
H_E	0.09	0.09	0.09	0.06	0.07	0.08	0.12	0.06	0.09	0.03	0.09	0.08	0.08	0.06	0.09	0.08	0.08
D	+0.05	+0.05	+0.05	+0.04	+0.04	+0.05	+0.07	+0.05	+0.05	+0.02	-0.65	-0.12	-0.14	+0.04	-0.48	-0.08	-0.26
t	0.07	0.07	0.07	0.04	0.04	0.12	0.11	0.04	0.07	0.01	1.03	0.32	0.13	0.05	0.81	0.53	0.35
6-PGD*A	0.95	0.95	0.95	0.97	0.96	0.96	0.93	0.97	0.95	0.98	0.95	0.96	0.96	0.96	0.95	0.96	0.96
6-PGD*C	0.05	0.05	0.05	0.03	0.04	0.04	0.07	0.03	0.05	0.02	0.05	0.04	0.04	0.04	0.05	0.04	0.04

Table. (Contd.)

System and alleles	Russian population												Ukrainian population			Total of Belgorod oblast	
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvar-deiskoe raion		Total of Ukrainians
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelestnoe municipality	Total of Prokhorovka raion	Gorki municipality	Raskhovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion					
ACPI																	
ΣN	29	27	30	29	24	139	30	29	29	12	21	121	260	39	41	80	340
N_O																	
AA	3	1	5	3	5	17	3	3	0	1	1	8	25	2	3	5	30
AB	8	12	11	7	4	42	14	13	14	3	10	54	96	15	18	33	129
AC	4	0	2	1	0	7	6	0	0	0	1	7	14	1	2	3	17
BB	9	11	9	15	13	57	5	11	12	6	8	42	99	15	13	28	127
BC	2	2	2	3	0	9	1	2	1	1	1	6	15	6	5	11	26
CC	3	1	1	0	2	7	1	0	2	1	0	4	11	0	0	0	11
N_E																	
AA	2.79	1.81	4.41	1.69	2.04	12.39	5.63	3.11	1.69	0.52	2.01	12.25	24.62	2.56	4.12	6.61	31.20
AB	8.69	9.33	11.88	9.66	8.50	49.26	10.83	12.12	9.41	3.33	8.36	45.82	192.08	13.08	15.54	28.75	123.90
AC	3.72	1.04	2.30	0.97	1.17	8.96	3.90	0.66	1.21	0.63	0.62	6.68	15.69	1.79	2.22	4.02	19.69
BB	6.76	12.00	8.01	13.79	9.38	48.97	5.21	11.80	13.11	5.33	8.68	42.84	91.81	16.67	14.64	31.25	123.00
BC	5.79	2.67	3.10	2.76	2.50	17.81	3.75	1.28	3.36	2.00	1.29	12.50	30.31	4.58	4.18	8.75	39.10
CC	1.24	0.15	0.30	0.14	0.17	1.62	0.68	0.03	0.22	0.19	0.05	0.91	2.50	0.31	0.30	0.61	3.11
$\chi^2_{(HWE)}$	5.81	7.31	2.33	2.01	32.10***	26.77***	5.47	1.22	21.66***	5.20	1.23	16.82**	37.37***	1.68	1.36	2.81	25.19***
H_O	0.48	0.52	0.50	0.38	0.17	0.42	0.70	0.52	0.52	0.33	0.57	0.55	0.48	0.56	0.61	0.59	0.51
H_E	0.63	0.48	0.58	0.46	0.51	0.55	0.62	0.48	0.48	0.50	0.49	0.54	0.54	0.50	0.54	0.52	0.54
D	-0.23	+0.07	-0.13	-0.18	-0.68	-0.24	+0.14	+0.07	+0.07	-0.33	+0.17	+0.03	-0.11	+0.13	+0.14	+0.13	-0.06
t	1.48	0.32	0.78	0.76	3.73	2.76	0.95	0.32	0.32	0.99	0.68	0.33	1.79	0.70	0.88	1.09	1.03
$ACPI^*A$	0.31	0.26	0.38	0.24	0.29	0.30	0.43	0.33	0.24	0.21	0.31	0.32	0.31	0.26	0.32	0.29	0.30
$ACPI^*B$	0.48	0.67	0.52	0.69	0.63	0.59	0.42	0.64	0.67	0.67	0.64	0.60	0.59	0.65	0.60	0.62	0.60
$ACPI^*C$	0.21	0.07	0.10	0.07	0.08	0.11	0.15	0.03	0.09	0.13	0.05	0.08	0.10	0.09	0.08	0.09	0.10
PGMI																	
ΣN	30	29	31	29	26	145	29	30	31	29	32	151	296	40	42	82	378
N_O																	
1S1S	15	14	13	11	8	61	11	12	8	11	12	54	115	20	16	36	151
1S1F	1	1	4	2	2	10	4	3	2	2	3	14	24	5	4	9	33
1S2S	12	8	9	8	11	48	8	8	11	8	8	43	91	9	12	21	112

Table. (Contd.)

System and alleles	Russian population												Ukrainian population			Total of Belgorod oblast	
	Prokhorovka raion						Krasnoe raion						Total of Russians	Graivoron raion	Krasnogvardeiskoe raion		Total of Ukrainians
	Kholodnoe municipality	Kolomytsevo municipality	Podolezhenskii municipality	Plota municipality	Prelesnoe municipality	Total of Prokhorovka raion	Gorki municipality	Rashovets municipality	Gotov'e municipality	Kamyzino municipality	Krasnoe municipality	Total of Krasnoe raion					
1S2F	1	3	2	3	0	9	3	4	4	4	6	21	30	3	3	6	36
1F1F	0	0	1	0	1	2	1	0	2	1	1	5	7	0	2	2	9
1F2S	0	0	0	0	0	0	0	2	1	2	0	5	5	1	0	1	6
1F2F	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1
2S2S	1	2	2	1	3	9	0	0	2	1	2	5	14	1	5	6	20
2S2F	0	1	0	4	0	5	1	0	1	0	0	2	7	1	0	1	8
2F2F	0	0	0	0	1	1	0	1	0	0	0	1	2	0	0	0	2
N_E																	
1S1S	16.13	13.79	13.56	10.56	8.09	61.59	11.80	12.67	8.78	11.17	13.13	57.28	118.77	20.31	15.48	35.56	154.29
1S1F	0.73	0.69	3.97	1.21	2.23	9.12	4.47	3.25	3.73	3.72	3.20	18.48	27.87	4.28	4.86	9.22	37.06
1S2S	10.27	8.97	8.60	8.45	9.48	46.27	5.74	6.50	9.05	7.45	7.69	36.95	82.98	9.26	13.36	23.05	106.06
1S2F	0.73	2.76	1.32	4.22	1.12	10.43	3.19	3.90	2.66	2.48	3.84	16.01	26.60	2.85	1.82	4.61	31.31
1F1F	0.01	0.01	0.29	0.03	0.15	0.34	0.42	0.21	0.40	0.31	0.20	1.49	1.64	0.23	0.38	0.60	2.22
1F2S	0.23	0.22	1.26	0.48	1.31	3.43	1.09	0.83	1.92	1.24	0.94	5.96	9.74	0.98	2.10	2.99	12.74
1F2F	0.02	0.07	0.19	0.24	0.15	0.77	0.60	0.50	0.56	0.41	0.47	2.58	3.12	0.30	0.29	0.60	3.76
2S2S	1.63	1.46	1.36	1.69	2.78	8.69	0.70	0.83	2.33	1.24	1.13	5.96	14.49	1.06	2.88	3.73	18.22
2S2F	0.23	0.90	0.42	1.69	0.65	3.92	0.78	1.00	1.37	0.83	1.13	5.17	9.29	0.65	0.79	1.49	10.76
2F2F	0.01	0.14	0.03	0.42	0.04	0.44	0.22	0.30	0.20	0.14	0.28	1.12	1.49	0.10	0.05	0.15	1.59
$\chi^2_{(HWE)}$	1.31	0.92	4.32	5.54	32.21**	13.74	4.12	6.21	9.83	5.19	8.14	15.31*	23.97***	0.96	12.73	7.51	28.76***
H_O	0.47	0.45	0.48	0.59	0.50	0.50	0.59	0.57	0.61	0.55	0.53	0.57	0.53	0.48	0.45	0.46	0.52
H_E	0.41	0.47	0.51	0.56	0.58	0.51	0.55	0.53	0.62	0.56	0.54	0.56	0.54	0.46	0.55	0.51	0.53
D	+0.15	-0.04	-0.05	+0.04	-0.13	-0.03	+0.07	+0.06	-0.02	-0.01	-0.02	+0.01	-0.01	+0.04	-0.18	-0.09	-0.03
t	0.54	0.19	0.23	0.23	0.69	0.27	0.35	0.31	0.10	0.04	0.08	0.12	0.16	0.17	1.12	0.73	0.49
$PGMI*1S$	0.73	0.69	0.66	0.60	0.56	0.65	0.64	0.65	0.53	0.62	0.64	0.62	0.63	0.71	0.61	0.66	0.64
$PGMI*1F$	0.02	0.02	0.10	0.04	0.08	0.05	0.12	0.08	0.11	0.10	0.08	0.10	0.08	0.08	0.09	0.09	0.08
$PGMI*2S$	0.23	0.22	0.21	0.24	0.32	0.24	0.15	0.17	0.28	0.21	0.19	0.20	0.22	0.16	0.26	0.21	0.22
$PGMI*2F$	0.02	0.07	0.03	0.12	0.04	0.06	0.09	0.10	0.08	0.07	0.09	0.08	0.07	0.05	0.04	0.04	0.06

Note: ΣN , the size of the population studied; N_O , the observed number of genotypes; N_E , the expected number of genotypes; H_O , the observed heterozygosity; H_E , the expected heterozygosity; D , the coefficient of deviation of the observed heterozygosity from the expected one.; 24. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

*TF*C2* gene frequency is never higher than 20% [12]; in 20 Russian populations studied in this respect, it varied between 0.06 and 0.21, the mean value being 0.15 [16]. The mean *TF*C1* allele frequency in Russians from Belgorod oblast fell within the variation range for the total Russian gene pool (74–87%) [12]. In Ukrainians from Belgorod oblast, the distribution of TF alleles was practically the same as in Russians (*TF*C1* = 0.72, *TF*C2* = 0.18, *TF*C3* = 0.06, *TF*B* = 0.02; and *TF*D* = 0.02).

The $\alpha 1$ antitrypsin (PI) system. The frequencies of the main genotypes in both Russians and Ukrainians decreased in the order M1M1 > M1M2 > M1M3. The Russian population of Belgorod oblast was considerably heterogeneous with respect to the distribution of PI alleles. For example, the frequency of allele *PI*M1* in Russians varied from 72 to 94%. The proportion of the *PI*M2* allele varied from 0.04 to 0.19. These results agree with the data on the total Russian gene pool, where the *PI*M2* frequency varies from 0.04 to 0.23 (the mean value was 0.145) and the population of Europe, where it frequency varies within the range 0.09–0.18 [16]. The populations of Prokhorovka and Krasnoe raions significantly differed from each other ($p < 0.001$) in the frequencies of alleles *PI*M1* (0.89 and 0.78, respectively) and *PI*M3* (0.01 and 0.08, respectively). The mean allele frequencies in the pooled sample from these two populations were the following: *PI*M1* = 0.84, *PI*M2* = 0.11, *PI*M3* = 0.04; and *PI*R* = 0.01. Thus, Russians from Belgorod oblast were characterized by an increased *PI*M1* and a decreased *PI*M3* frequencies compared to European populations (*PI*M1*, 0.63–0.79; *PI*M2*, 0.09–0.18; and *PI*M3*, 0.06–0.12) [16]. The frequencies of PI alleles in Ukrainians from Belgorod oblast were almost the same as in Russians.

The glyoxalase 1 (GLO1) system. The *GLO1*1* allele frequency in Russians from Belgorod oblast (0.31) was significantly ($p < 0.001$) lower than the mean value for Russians (0.37) but considerably higher than its frequencies in Central Asian and Far Eastern ethnic groups, where it is never higher than 20% [12]. The variation of the *GLO1*1* allele frequency in Ukrainians from Belgorod oblast was about the same as in Russians (from 30 to 34%); the mean value was 0.32.

The erythrocyte esterase D system. The mean *ESD*1* allele frequency in the Russian population of Belgorod oblast was 93%, which is close to literature data on Belgorod oblast (95.5%) [2]. The *ESD*1* allele frequency in Russians from Belgorod oblast significantly ($p < 0.05$) differed from the mean frequency for the total Russian population, although it fell within the range its variation in the total Russian gene pool (from 0.79 to 0.96; the mean value is 0.903) [2, 17]. Note that, in both Russian and Ukrainian populations of Belgorod oblast, the frequency of the “Asian” *ESD*2* allele (0.05–0.12) was substantially lower than in indigenous Far Eastern and Central Asian populations, in some of which its frequency is as high as 30%, i.e., higher than

the upper limit of the variation of this allele frequency in European populations (11–15%) [12, 17].

The erythrocyte 6-phosphogluconate dehydrogenase (6-PGD) system. The frequency of the rare allele (*PGD*C*) in the district populations of Belgorod oblast varied from 3 to 4%. The mean frequency of the *PGD*C* allele was the same in Russian and Ukrainians (0.04) and fell within its variation range in the total Russian gene pool (2–8%; the mean frequency is 0.039) [1, 2, 12].

The phosphoglucomutase (PGMI) system. The PGM1 allele frequencies in the population of Belgorod oblast followed the distribution pattern typical of both Russian and European populations [12]. The allele frequencies decreased in the order *PGMI*1S* > *PGMI*2S* > *PGMI*1F* > *PGMI*2F*. The mean frequency of allele *PGMI*1S* in Russians from Belgorod oblast was 0.63, which was significantly ($p < 0.05$) higher than both its frequency in the total Russian gene pool (0.604; the variation range is 0.475–0.700) [2, 12–15] and published data on its frequency in Belgorod oblast (0.55) [2]. The *PGMI*2S* allele frequency in Russians from Belgorod oblast was 0.22, which was almost equal to its mean frequency in Russians (0.232; the variation range is 0.14–0.38) estimated in [2, 17]. Russians and Ukrainians from Belgorod oblast were similar with respect to *PGMI*1S* and *PGMI*2S* allele frequencies. According to published data [2, 17], the *PGMI*1F* frequency in 27 Russian populations varies from 0 to 0.18, the mean frequency being 0.107; and the *PGMI*2F* frequency varies from 0 to 0.16 (the mean value is 0.057). Our results agree with these data: the proportions of both the *PGMI*1F* and the *PGMI*2F* alleles in Russians from Belgorod oblast were 7%. Note significant ($p < 0.01$) differences between Russians from Prokhorovka and Krasnoe raions in the frequency of *PGMI*1F*.

The erythrocyte acid phosphatase (ACPI) system. The *ACPI*A* allele frequency in the Russian population of Belgorod oblast varied from 0.30 to 0.32 (the mean frequency was 0.31), which agreed with the estimates for the total Russian gene pool (variation from 0.18 to 0.41 and a mean value of 0.312) [2, 17]. However, the mean frequency of this allele was lower than that earlier reported for the Belgorod oblast population (0.373) [2]. The frequency of the “European” allele *ACPI*C* in Russians from Belgorod oblast (0.10) was significantly ($p < 0.05$) higher than the mean value for Russians (0.04; the variation range is 0–0.07) [2, 17]. In Ukrainians from Belgorod oblast, the *ACPI*A* and *ACPI*B* allele frequencies (0.29 and 0.62, respectively) were similar to those in Russians from Belgorod oblast and in the total Russian gene pool.

Thus, two Russian district populations (Prokhorovka and Krasnoe raions of Belgorod oblast) significantly differed from each other in the frequencies of eight alleles of five loci: *ABO*0*, *ABO*A*, *GC*2*, *GC*1S*, *TF*C1*, *PI*M1*, *PI*M3*, and *PGMI*1F*. The mean frequencies of the *RH*D*, *GC*2*, and *GLO1*1*

alleles in Russians from Belgorod oblast were significantly lower than the mean values for all Russian populations ($p < 0.001$). The frequencies of the *GC*1S*, *ESD*1*, *PGM1*1S*, and *ACPI*C* alleles were at the upper limit of the variation ranges of their frequencies in the total Russian gene pool and were significantly higher than the respective mean frequencies for all Russian populations ($p < 0.001-0.05$). However, the frequencies of all alleles studied fell within the ranges of their variation in the total Russian gene pool.

Ukrainians from Belgorod oblast significantly ($p < 0.01-0.05$) differed from Russians living in the same region in the frequencies of alleles of only two loci (ABO and GC). In general, the genetic structure of the Belgorod population corresponded to those of European populations.

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