Population Genetics Problem Set

1 The allele for brown eyes is dominant to the allele for blue (B>b). For each population, calculate the frequencies of B and b and estimate the number of brown-eyed individuals who are homozygous and heterozygous:

Phenotype	Pop1	Pop 2	Pop 3	Pop 4	Pop 5
Brown	450	225	365	580	860
blue	550	575	275	320	340
Tot Population	1000	800	640	900	1200

Allele Frequencies

	Pop1	Pop 2	Pop 3	Pop 4	Pop 5
b					
B					

Phenotype Numbers

Blue (bb)					
Brown (BB)					
Brown (Bb)					

Solutions:

Phenotypes		Pop 1	Pop 2	Pop 3	Pop 4	Pop 5
Freq Brown:	Brown/Total	0.45	0.28	0.57	0.64	0.72
Freq Blue:	Blue/Total	0.55	0.72	0.43	0.36	0.28
b:	√Freq Blue	0.74	0.85	0.66	0.60	0.53
B:	1 - Freq Blue	0.26	0.15	0.34	0.40	0.47
#Blue (bb):	b x b x total	550	575	275	320	340
#Brown (BB):	B x B x total	67	19	76	147	263
#Brown (Bb)	2 x B x b x total	383	323	314	412	487
Total Brown:	BB + Bb	450	342	390	559	750

2 Calculate the frequencies of I^A, I^B, and i alleles for each population:

Phenotype	Pop1	Pop 2	Pop 3	Pop 4	Pop 5
A	198	295	148	384	449
B	340	135	410	120	332
AB	152	89	165	288	361
O	110	131	76	8	58
Tot Population	800.00	650.00	800.00	800.00	1200.00

Allele Frequencies

	Pop1	Pop 2	Pop 3	Pop 4	Pop 5
I^A					
I^B					
i					

Solutions:

Phenotype Frequencies	Pop1	Pop 2	Pop 3	Pop 4	Pop 5
Freq type A	0.248	0.454	0.185	0.480	0.374
Freq type B	0.426	0.207	0.512	0.150	0.277
Freq type AB	0.190	0.137	0.207	0.360	0.301
Freq type O	0.137	0.203	0.096	0.010	0.048
Tot Frequency	1.00	1.00	1.00	1.00	1.00
Tot Population	800	650	800	800	1200
Calculate Allele Frequencies					
i = square root type O	**0.370**	**0.450**	**0.310**	**0.100**	**0.220**
By Calculating I^A First					
$(I^A + i) \times (I^A + i)$ = type A + type O	0.384	0.656	0.281	0.490	0.423
$I^A + i$ = square root types (A+O)	0.620	0.810	0.530	0.700	0.650
I^A = square root (A + O) - i	**0.250**	**0.360**	**0.220**	**0.600**	**0.430**
$I^B = 1 - I^A - i$	**0.380**	**0.190**	**0.470**	**0.300**	**0.350**
By Calculating I^B First					
$(I^B + i) \times (I^B + i)$ = type B + type O	0.563	0.410	0.608	0.160	0.325
$I^B + i$ = square root types (B+O)	0.750	0.640	0.780	0.400	0.570
I^B = square root (B + O) - i	**0.380**	**0.190**	**0.470**	**0.300**	**0.350**
$I^A = 1 - I^B - i$	**0.250**	**0.360**	**0.220**	**0.600**	**0.430**

3 Calculate the number of individuals of each blood type for each population:

Allele Frequencies	**Pop 1**	**Pop 2**	**Pop 3**	**Pop 4**	**Pop 5**	**Pop 6**
I^A	0.210	0.320	0.170	0.340	0.25	0.33
I^B	0.640	0.320	0.480	0.280	0.19	0.38
i	0.150	0.360	0.350	0.380	0.56	0.29
Population Size	950	850	900	700	800	800

Phenotype Numbers

	Pop 1	**Pop 2**	**Pop 3**	**Pop 4**	**Pop 5**	**Pop 6**
Type A						
Type B						
Type AB						
Type O						

Solutions:

Phenotypes		**Pop 1**	**Pop 2**	**Pop 3**	**Pop 4**	**Pop 5**	**Pop 6**
Freq Type A:	$(I^A \times I^A) + 2(I^A)(i)$	0.107	0.333	0.148	0.374	0.343	0.300
# Type A:	Freq Type A x Pop size	102	283	133	262	274	240
Freq Type B:	$(I^B \times I^B) + 2(I^B)(i)$	0.602	0.333	0.566	0.291	0.249	0.365
#Type B	Freq Type B x Pop size	572	283	510	204	199	292
Freq Type AB:	$2(I^A)(I^B)$	0.269	0.205	0.163	0.190	0.095	0.251
#Type AB:	Freq Type AB x Pop size	255	174	147	133	76	201
Freq Type O:	i x i	0.023	0.130	0.123	0.144	0.314	0.084
#Type O:	Freq Type O x Pop size	21	110	110	101	250	67
Tot Frequency:		1.00	1.00	1.00	1.00	1.00	1.00
Tot Population:		950	850	900	700	800	800

4 ***A*** **is a sex-linked gene in** ***Drosophila*****. The frequency of** ***A*** **in each population is set in generation 0. Calculate the frequency of the** ***A*** **allele in each subsequent generation for each population. Calculate the mean values for** ***A*** **and** ***a*** **at equilibrium.**

	Population 1		Population 2		Population 3	
generation	**males**	**females**	**males**	**females**	**males**	**females**
0	0.500	0.300	0.500	0.600	0.250	0.750
1						
2						
3						
4						
5						
6						
7						
8						
9						
A mean						
a mean						

	Population 4		Population 5		Population 6	
generation	**males**	**females**	**males**	**females**	**males**	**females**
0	0.800	0.500	0.350	0.660	0.450	0.260
1						
2						
3						
4						
5						
6						
7						
8						
9						
A mean						
a mean						

Solutions:

			Population 1		Population 2	
generation	**males**	**females**	**males**	**females**	**males**	**females**
0			0.500	0.300	0.500	0.600
1	F(n0)	[F(n0) + M(n0)]/2	0.300	0.400	0.600	0.550
2	F(n1)	[F(n1) + M(n1)]/2	0.400	0.350	0.550	0.575
3	F(n2)	[F(n2) + M(n2)]/2	0.350	0.375	0.575	0.563
4	F(n3)	[F(n3) + M(n3)]/2	0.375	0.363	0.563	0.569
5	F(n4)	[F(n4) + M(n4)]/2	0.363	0.369	0.569	0.566
6	F(n5)	[F(n5) + M(n5)]/2	0.369	0.366	0.566	0.567
7	F(n6)	[F(n6) + M(n6)]/2	0.366	0.367	0.567	0.566
8	F(n7)	[F(n7) + M(n7)]/2	0.367	0.366	0.566	0.567
9	F(n8)	[F(n8) + M(n8)]/2	0.366	0.367	0.567	0.567
A mean	[2 F(n0) + M(n0)] / 3		0.367		0.567	
a mean	1 - A		0.633		0.433	

			Population 3		Population 4	
generation	**males**	**females**	**males**	**females**	**males**	**females**
0			0.250	0.750	0.800	0.500
1	F(n0)	[F(n0) + M(n0)]/2	0.750	0.500	0.500	0.650
2	F(n1)	[F(n1) + M(n1)]/2	0.500	0.625	0.650	0.575
3	F(n2)	[F(n2) + M(n2)]/2	0.625	0.563	0.575	0.613
4	F(n3)	[F(n3) + M(n3)]/2	0.563	0.594	0.613	0.594
5	F(n4)	[F(n4) + M(n4)]/2	0.594	0.578	0.594	0.603
6	F(n5)	[F(n5) + M(n5)]/2	0.578	0.586	0.603	0.598
7	F(n6)	[F(n6) + M(n6)]/2	0.586	0.582	0.598	0.601
8	F(n7)	[F(n7) + M(n7)]/2	0.582	0.584	0.601	0.600
9	F(n8)	[F(n8) + M(n8)]/2	0.584	0.583	0.600	0.600
A mean	[2 F(n0) + M(n0)] / 3		0.583		0.600	
a mean	1 - A		0.417		0.400	

			Population 5		Population 6	
generation	**males**	**females**	**males**	**females**	**males**	**females**
0			0.350	0.660	0.450	0.260
1	F(n0)	[F(n0) + M(n0)]/2	0.660	0.505	0.260	0.355
2	F(n1)	[F(n1) + M(n1)]/2	0.505	0.583	0.355	0.308
3	F(n2)	[F(n2) + M(n2)]/2	0.583	0.544	0.308	0.331
4	F(n3)	[F(n3) + M(n3)]/2	0.544	0.563	0.331	0.319
5	F(n4)	[F(n4) + M(n4)]/2	0.563	0.553	0.319	0.325
6	F(n5)	[F(n5) + M(n5)]/2	0.553	0.558	0.325	0.322
7	F(n6)	[F(n6) + M(n6)]/2	0.558	0.556	0.322	0.324
8	F(n7)	[F(n7) + M(n7)]/2	0.556	0.557	0.324	0.323
9	F(n8)	[F(n8) + M(n8)]/2	0.557	0.556	0.323	0.323
A mean	[2 F(n0) + M(n0)] / 3		0.557		0.323	
a mean	1 - A		0.443		0.677	