

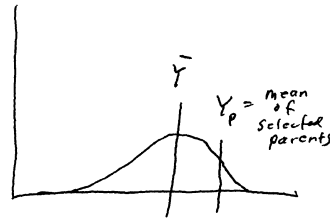
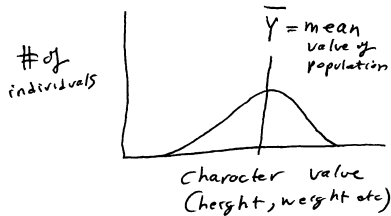
NAME: _____ KEY _____

SCORE: _____/100

Notes:

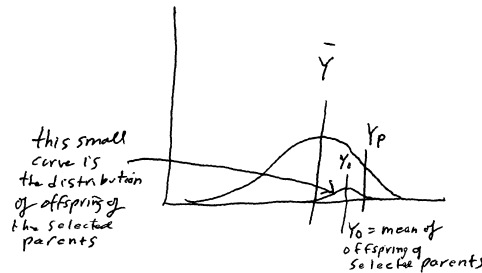
1. Make sure you have your name on the test.
2. Make sure you have the correct number of pages — check now!
3. Be sure to show ALL your work on problems — credit is given for correct steps in solving the problem. The correct answer without a clear showing of the derivation of the answer will receive little or no credit. If you run out of room in the space given, continue on the back of the page.
4. Maintain silence throughout the test.
5. For multiple choice questions, put the letter of the correct answer in the blank to the left of the question number. Multiple choice questions are worth 3 points each.
6. DO NOT GET UP — if you have a question, raise your hand and the instructor will come to you.
7. Read the questions carefully — misreading is a primary cause of point loss. Also be sure to answer the question that was asked.

1. (13) Using graphs of the population and the offspring of selected parents, graphically and algebraically derive the equation for heritability as done in class. Use words to explain all terms, equations, and graphs.

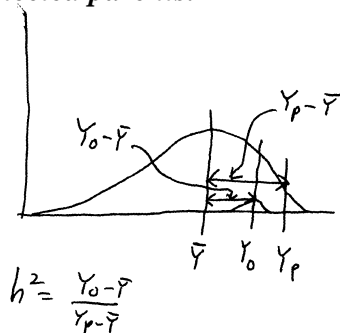


In the graph above left, the distribution of some character trait is shown for some population. The mean value of the population is denoted by \bar{Y} . We select parents who have a higher than average value for the trait; the mean value of the trait for these selected parents is called Y_P .

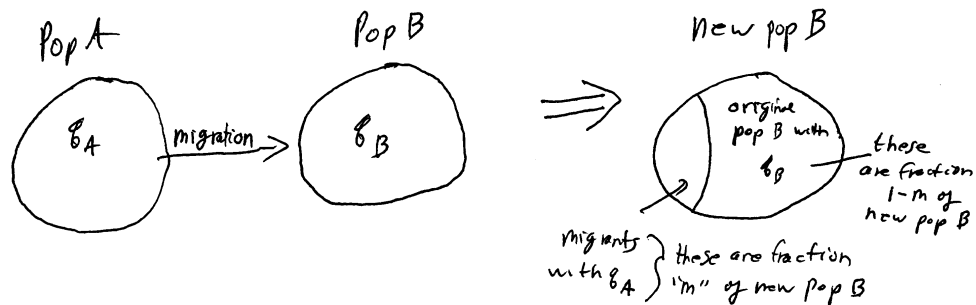
Now we breed the parents together, and look at their offspring. The offspring will vary among themselves, of course, but their mean value we denote Y_O . This is shown below:



Heritability is the proportionate distance that the mean of the offspring is from the population mean to the mean of the selected parents.



2. (13) Using graphs and equations, derive the recurrence and Δq equations for migration. Be sure to use words to explain all graphs, symbols, and equations.



Some of population A migrate into population B, forming new population B

In new population B, a proportion "m" come from population A, and a proportion "1-m" come from the old population B

The gene frequency of the A_2 allele in new population B is the weighted average of the gene frequencies of the A_2 allele in populations A and B, weighted by their proportions in new population B

q_A = frequency of A_2 in population A

q_B = frequency of A_2 in old population B

thus, q'_B , the frequency of the A_2 allele in new population B is: $q'_B = mq_A + (1-m)q_B$

Δq is always $q'_B - q_B$, so $\Delta q = mq_A + (1-m)q_B - q_B \equiv mq_A + q_B - mq_B - q_B \equiv mq_A - mq_B$

Thus,

$$\Delta q \equiv m(q_A - q_B)$$

3. (13) Test the following population for agreement with Hardy-Weinberg genotypic frequencies:
35 A_1A_1 , 45 A_1A_2 , 55 A_2A_2 .

$$35+45+55=135=N \quad p = \frac{35+\frac{45}{2}}{135} = 0.4259 \quad q = 1-p = 0.5741$$

$$p^2N=(.4259)^2 \times 135=24.49 \quad 2pqN=2 \times 0.4259 \times 0.5741 \times 135= 66.02 \quad q^2N=.5741^2 \times 135=44.49$$

	A_1A_1	A_1A_2	A_2A_2
<i>observed</i>	35	45	55
<i>expected</i>	24.49	66.02	44.49
<i>obs-exp</i>	10.51	-21.02	10.51
<i>(obs-exp)²</i>	110.46	441.84	110.46
$\frac{(o-e)^2}{e}$	4.51	6.69	2.48

$$\chi^2 = 13.68 \gg 3.84 \text{ so NOT in H-W}$$

1 df, so ~3 (actually 3.84) is critical value.

4. (13) Set up and solve a problem which demonstrates the Wahlund effect.

Take two populations, "A" and "B". Population "A" has $p_A = f(A_1) = 0.3$; in population B, $p_B = 0.6$. So, in population A, we would have, say in a population of 100 individuals, 9 A_1A_1 , 42 A_1A_2 , and 49 A_2A_2 individuals, that is, the Hardy-Weinberg proportions. In population B, the Hardy-Weinberg proportions for a population of, say, 200 individuals, would be 72 A_1A_1 , 96 A_1A_2 , and 32 A_2A_2 individuals. Each population is separately in Hardy-Weinberg.

Now, look at the combined population: it would contain $9 + 72 = 81$ A_1A_1 , $42 + 96 = 138$ A_1A_2 , and $49 + 32 = 81$ A_2A_2 individuals. Now, look at the observed and expected values for genotypic frequencies in this population:

$$81 + 138 + 81 = 300 = N \quad p = \frac{81 + \frac{138}{2}}{300} = 0.5 \quad q = 1 - p = 0.5$$

$$p^2N = (.5)^2 \times 300 = 75 \quad 2pqN = 2 \times 0.5 \times 0.5 \times 300 = 150 \quad q^2N = .5^2 \times 300 = 75$$

	A_1A_1	A_1A_2	A_2A_2
<i>observed</i>	81	138	81
<i>expected</i>	75	150	75

Note that although each population separately is in perfect H-W frequencies (they were made up that way), in the combined population there are more (observed) homozygotes of each type than expected, and fewer (observed) heterozygotes than expected. This is a demonstration of the Wahlund effect.

- a** 5. [Ch. 4.2] If any entity has heritable variation in reproduction, and these entities produce more offspring than can survive in the environment, which of the following must occur? **a.** selection **b.** migration **c.** mutation **d.** genetic drift **e.** non-random mating
f. none of the preceding
6. [Ch. 4.4] If “directional” is one of the three major modes (or types) of selection, list the other two: **disruptive** and **stabilizing** .
- a** 7. [Ch. 4.8] Which of the following forces is the only one that causes adaptation as a direct consequence of its action? **a.** selection **b.** migration **c.** mutation **d.** genetic drift
e. non-random mating
8. [Ch. 5.1] In the absence of any forces acting upon them, allele and genotype frequencies will remain constant. This is one way of stating the: **HARDY-WEINBERG LAW** .
- b** 9. [Ch. 5.8] Selection-mutation balance occurs when: **a.** selection is equal to but opposite in direction from, the force of mutation **b.** a mutation is selected against, but continues to arise, and thus settles at a low frequency in the population **c.** selection and mutation together balance genetic drift, so there is no net change in gene frequencies
d. selection and mutation together balance migration, so there is no net change in gene frequencies **e.** selection and mutation together balance any or all of the other forces, so there is no net change in gene frequencies
- d** 10. [Ch. 5.11] Subdivided populations have a higher proportion of which of the following than an equivalent large, fused population? **a.** heterozygotes **b.** alleles **c.** gametes
d. homozygotes **e.** translocations **f.** mutations
- b** 11. [Ch. 5.12] If a population is subdivided, which force can (most easily) maintain an allele that is selected against in just one of the subpopulations? **a.** selection **b.** migration
c. mutation **d.** genetic drift **e.** non-random mating
- d** 12. [Ch. 6.2] Which of the forces has a greater effect in a small population than a large population, simply due to the population size? **a.** selection **b.** migration **c.** mutation
d. genetic drift **e.** non-random mating

- c 13. [Ch. 6.5] The fate of any given allele in a small population is to: **a.** become fixed **b.** become lost **c.** either become fixed or become lost **d.** rise or fall to an allele frequency of 0.50 **e.** none of the preceding
- b 14. [Ch. 7.9] The higher evolutionary rate of less important (your book says “functionally less constrained”) regions of proteins can be explained by: **a.** selection **b.** the neutral theory **c.** the Hardy-Weinberg Law **d.** Wright’s shifting balance theory **e.** Fisher’s model of adaptive evolution
- e 15. [Ch. 9.5] A character’s evolutionary response to selection is determined by its: **a.** level of genetic variation **b.** mutation rate **c.** two-locus combinatorial diffusion model frequency **d.** quantitative epistatic interactions **e.** heritability
- c 16. [Ch. 10.1] A lot of the non-coding DNA in our genome is composed of: **a.** enzyme genes **b.** structural protein genes **c.** repetitive DNA **d.** transcribed DNA **e.** translated DNA
- b 17. [Ch. 11.5] Which of the following is suggested by the taxonomic distribution of asexually reproducing species? **a.** sexual species have a higher extinction rate than asexual species **b.** asexual species have a higher extinction rate than sexual species **c.** asexual species have more offspring than sexual species **d.** sexual species have more offspring than asexual species **e.** a coevolutionary “arms race”
- d 18. [Ch. 11.8] In Darwin’s theory of sexual selection, strange secondary sexual characters: **a.** decrease their bearer’s survival and reproduction **b.** increase their bearer’s survival and reproduction **c.** increase their bearer’s survival, but decrease their success in reproduction **d.** decrease their bearer’s survival, but increase their success in reproduction **e.** are an example of the “changing adaptive peaks” part of the theory
- a 19. [Ch. 12.10] Natural selection fundamentally adjusts the frequencies of: **a.** small genetic units (replicators) **b.** chromosomes **c.** whole populations **d.** species **e.** genera and higher taxa
- d 20. [Ch. 13.7] A species may be adapted to a past environment, if environmental change is rapid; thus, the species may not look adapted. This is an example of: **a.** orthogenesis **b.** panselectionism **c.** preadaptation **d.** a time lag **e.** a genetic constraint