

BIOL*2400 Evolution
W16
Assignment 2

Due: February 26, 2016

NOTE: This assignment is to be completed individually.

Questions:

1. In the following table calculate the frequency of each of the three genotypes at Hardy-Weinberg Equilibrium for each of the five allele frequencies for the A_1 allele. [1.5 points]

Freq of A_1	A_1A_1	A_1A_2	A_2A_2
0.1	0.01	0.18	0.81
0.3	0.09	0.42	0.49
0.5	0.25	0.5	0.25
0.7	0.49	0.42	0.09
0.9	0.81	0.18	0.01

2. Suppose the relative fitnesses of the genotypes B_1B_1 , B_1B_2 , and B_2B_2 are 0.8, 0.95 and 1.0, respectively. If the current frequency of the B_1 allele is 0.8, what is its average excess of fitness? Show your work. Given its average excess of fitness, do you expect the B_1 allele to increase in frequency? Why? [1 point]

$$\begin{aligned}\bar{w} &= p^2 w_{B_1B_1} + 2pq w_{B_1B_2} + q^2 w_{B_2B_2} \\ &= (0.8)^2 (0.8) + (2)(0.8)(0.2)(0.95) + (0.2)^2 (1.0) \\ &= 0.856\end{aligned}$$

$$\begin{aligned}a_{B_1} &= [p (w_{11} - \bar{w})] + [q (w_{12} - \bar{w})] \\ &= 0.8(0.8 - 0.856) + 0.2(0.95 - 0.856) \\ &= -0.026\end{aligned}$$

3. In an exam I could possibly provide you with the following three equations and ask you to calculate the average excess of fitness as above. Use algebra to get the fourth equation based on the first three equations. Show your work. [1 point]

$$1) \Delta p = p' - p$$

$$2) p = p^2 + \frac{1}{2}2pq$$

$$3) p' = p^2 \frac{W_{B_1 B_1}}{\bar{w}} + \frac{1}{2}2pq \frac{W_{B_1 B_2}}{\bar{w}}$$

$$4) \Delta p = \frac{p}{\bar{w}} [p(W_{B_1 B_1} - \bar{w}) + q(W_{B_1 B_2} - \bar{w})]$$

$$\Delta p = p' - p$$

Sub equation ② and ③ into ①:

$$\Delta p = p^2 \frac{W_{B_1 B_1}}{\bar{w}} + \frac{1}{2} \cdot 2pq \frac{W_{B_1 B_2}}{\bar{w}} - (p^2 + \frac{1}{2} \cdot 2pq)$$

$$\Delta p = p^2 \frac{W_{B_1 B_1}}{\bar{w}} - p^2 + pq \frac{W_{B_1 B_2}}{\bar{w}} - pq$$

$$\Delta p = \frac{p}{\bar{w}} [p(W_{B_1 B_1} - \bar{w}) + q(W_{B_1 B_2} - \bar{w})]$$

4. Suppose the relative fitnesses of the genotypes B_1B_1 , B_1B_2 , and B_2B_2 are 0.8, 0.8 and 1.0, respectively. The frequency of the B_1 allele is 0.9. Calculate the average excess of fitness of the B_1 allele. What will the frequency of the B_1 allele be in four generations? [1 point]

Generation 1:

$$\begin{aligned}\bar{w}' &= p^2 w_{B_1B_1} + 2pq w_{B_1B_2} + q^2 w_{B_2B_2} \\ &= (0.9)^2 (0.8) + 2(0.9)(0.1)(0.8) + (0.1)^2 (1.0) \\ \bar{w}' &= 0.802\end{aligned}$$

$$\begin{aligned}p' &= p^2 \left(\frac{w_{11}}{\bar{w}} \right) + \frac{1}{2} \cdot 2pq \left(\frac{w_{12}}{\bar{w}} \right) \\ &= (0.9)^2 \left(\frac{0.8}{0.802} \right) + (0.9)(0.1) \left(\frac{0.8}{0.802} \right)\end{aligned}$$

$$p' = 0.8977$$

$$\begin{aligned}q' &= 1 - 0.8977 \\ &= 0.1023\end{aligned}$$

Generation 2:

$$\begin{aligned}\bar{w}'' &= p'^2 w_{B_1B_1} + 2p'q' w_{B_1B_2} + q'^2 w_{B_2B_2} \\ &= (0.8977)^2 (0.8) + 2(0.8977)(0.1023)(0.8) + (0.1023)^2 (1.0) \\ &= 0.801\end{aligned}$$

$$\begin{aligned}p'' &= p'^2 \left(\frac{w_{11}}{\bar{w}''} \right) + \frac{1}{2} \cdot 2p'q' \left(\frac{w_{12}}{\bar{w}''} \right); q'' = 0.105 \\ &= 0.8948\end{aligned}$$

Generation 3:

$$\begin{aligned}\bar{w}''' &= p''^2 w_{B_1B_1} + 2p''q'' w_{B_1B_2} + q''^2 w_{B_2B_2} \\ &= (0.8948)^2 (0.8) + 2(0.8948)(0.105)(0.8) + (0.105)^2 (1.0) \\ \bar{w}''' &= 0.797\end{aligned}$$

$$\begin{aligned}p''' &= p''^2 \left(\frac{w_{11}}{\bar{w}'''} \right) + \frac{1}{2} \cdot 2p''q'' \left(\frac{w_{12}}{\bar{w}'''} \right); q''' = 0.1046 \\ &= 0.8954\end{aligned}$$

Generation 4:

$$\begin{aligned}\bar{w}'''' &= p'''^2 w_{B_1B_1} + 2p'''q''' w_{B_1B_2} + q'''^2 w_{B_2B_2} \\ &= (0.8954)^2 (0.8) + 2(0.8954)(0.1046)(0.8) + (0.1046)^2 (1.0) \\ &= 0.8023\end{aligned}$$

$$\begin{aligned}p'''' &= p'''^2 \left(\frac{w_{11}}{\bar{w}''''} \right) + \frac{1}{2} \cdot 2p'''q''' \left(\frac{w_{12}}{\bar{w}''''} \right) \\ &= (0.8954)^2 \left(\frac{0.8}{0.8023} \right) + \frac{1}{2} (2) (0.8954)(0.1046) \left(\frac{0.8}{0.8023} \right)\end{aligned}$$

$$p'''' = 0.894$$

$$\begin{aligned}q'''' &= 1 - 0.894 \\ &= 0.106\end{aligned}$$

5. Suppose the relative fitnesses of the genotypes B_1B_1 , and B_2B_2 are 0.8 and 1.0, respectively. The frequency of the B_1 allele is 0.9. Use the watersnakePQ.xls spreadsheet (available on Courselink) to determine how many generations it will take for either the B_1 or B_2 allele to go to fixation i) when B_1 is dominant, and ii) when B_1 is recessive (it is ok to round allele frequency to 4 decimal places here). Be sure to start with a frequency of the B_1 allele of 0.9. [0.5 points]

B_1 dominant:

It will take 93 generations to go to fixation

B_1 recessive:

It will not go to fixation

Instructions. Submit your individual answers in PDF format through Dropbox on CourseLink by midnight on February 26, 2016.