

EEB 2245/ 2245W  
Exam 1 Answer Key:

1A.

1- offspring resemble their parents/ traits are heritable  
2- more offspring are produced than survive/ reproduction is not unlimited  
3- there is variation in the phenotypes of individuals within a population and different phenotypes result in different survival or reproduction. NOTE- full credit was given for answers that only listed variation but it is important to understand that just saying there is variation is not a complete answer. This is because selection does not occur unless the variation in phenotypes results in predictable differences in survival or reproduction.

1B. To have no evolutionary response means the genetic composition of a population is not changing even though something that could cause a change in the genetic composition is occurring in the population (selection, drift, non-random mating, migration or mutation). One way this can occur is if a trait under selection is not heritable. Another way is if natural selection is occurring, but is balanced by another evolutionary process like migration, or sexual selection so that there is no overall genetic change. A third way is if migration is occurring, but equilibrium has already been reached, so the migration does not result in any genetic change.

2.A- population size is large/ infinite

2B- Random mating

2C- All genotypes/phenotypes have equal fitness or equal chance of survival and reproduction

2D- No new genetic input

2E- If all HWE assumptions are met then allele frequencies will stay constant across generations; genotype frequencies may change between the first and second generations, and will remain constant after that..

3- The average fitness of the offspring generation will be greater than or equal to the average fitness of the parent generation.

$$\bar{w}_{\text{offspring}} \geq \bar{w}_{\text{parents}}$$

4A Both result in the loss of heterozygotes, increased frequency of homozygotes and the loss of genetic variation.

4B Allele frequencies change under drift but not inbreeding. (I also gave full credit for the statement that decreased fitness occurs as a result of inbreeding but not drift, because that conclusion was a reasonable one to draw from the discussion of this material in class.

However, it's actually not true. While inbreeding often increases the expression of deleterious recessive alleles (but note that it doesn't change their frequencies) in species in which inbreeding is unusual, in fact many species are obligate inbreeders and do not suffer from inbreeding depression. Additionally, genetic drift can fix alleles that lower fitness.)

4C: Decreased heterozygosity is expected across the entire genome for inbreeding, but only at loci that determine trait used in choosing mates for assortative mating.

4D: Both result in the fixation of one allele and loss of all others.

5A

Probability of mating	
Random mating	Self fertilization
$u^2$	$u$
$2uv$	$0$
$v^2$	$v$

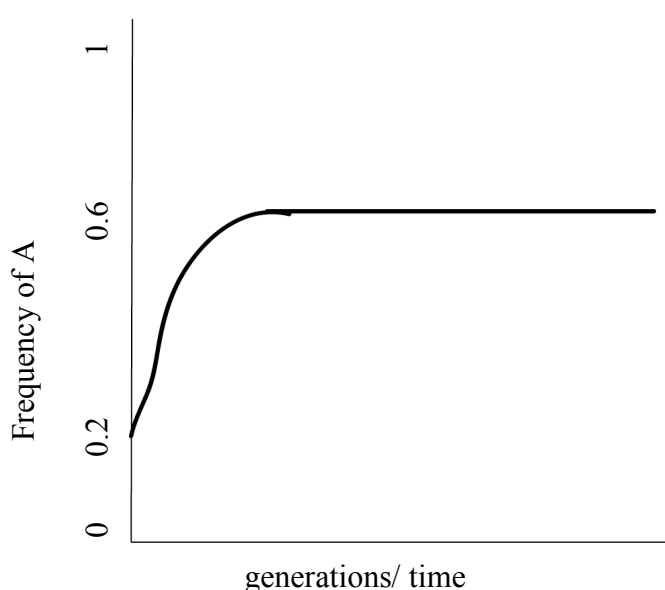
5B:

Initial frequency:  $u$ 

After 1 generation of self fertilization:

frequency  $AA = 1 * u + \frac{1}{4} * v$ Increased in frequency of  $AA = v/4$ 

6A-

6B-  $w_{AA} = 0.5$   $w_{BB} = 0.2$ 

6C- greater than

6D- stabilizing selection

7- Heritability is defined as the proportion of phenotypic variance in a population that is attributed to genetic variation.

$$h^2 = V_G / V_P \text{ or } h^2 = V_G / (V_G + V_E)$$

(Partial credit was given for answers that gave ways to measure heritability, such as looking at the relationship between parent and offspring phenotypes or measuring the response to selection.)

8 A- larger in the greenhouse

8 B-  $R = h^2 S$ , so  $R$  can differ if either  $h^2$  or  $S$  differs between the yard and greenhouse.  $S$ , the selection differential, is the same for both populations because you and your friend selected pumpkins that had an average weight 5 kg greater than the population average. However,  $h^2$  can differ between environments because it depends on the trait's variation due to both genes and the environment. The greenhouse is a more controlled environment than the field and so there will be less phenotypic variation between individuals due to the environment in the

greenhouse. Since  $h^2 = V_G / (V_G + V_E)$ , this leads to a higher  $h^2$  in the greenhouse. Thus, R will be larger in the greenhouse.

9A

S = average phenotype of survivors - average phenotype of population before selection

Average phenotype before selection =  $0.8 \times 6 \text{ mm} + 0.2 \times 4 \text{ mm} = 5.6 \text{ mm}$

S =  $4 \text{ mm} - 5.6 \text{ mm} = -1.6 \text{ mm}$

9B 1<sup>st</sup> graph

9C heritability can be estimated as the slope of the line relating parent phenotype to offspring phenotype. The slope of the 1<sup>st</sup> graph is approximately 0.5

9D:  $R = h^2 S = 0.5 \times (-1.6) = -0.8$

phenotype of offspring =  $5.6 + (-0.8) = 4.8 \text{ mm}$

(Note that only answers somewhere between 4 mm and 6 mm are at all plausible)

10- A-  $\bar{w} = w_{11}u + w_{12}v + w_{22}w$  or  $\bar{w} = w_{11}p^2 + w_{12}2pq + w_{22}q^2$

total number of individuals = 200

Freq LL =  $50/200 = 0.25$

Freq LS =  $100/200 = 0.5$

Freq SS =  $50/200 = 0.25$

$\bar{w} = (1 \times 0.25) + (0.2 \times 0.5) + (0.6 \times 0.25) = 0.5$

This could also have been done:

$\bar{w} = [(50 \times 1) + (100 \times 0.2) + (50 \times 0.6)]/200 = 0.5$

10 B- Number of LL individuals after selection = 50

Number of LS individuals after selection = 20

Number of SS individuals after selection = 30

total surviving = 100

Freq of LL =  $50/100 = 0.5$

Freq of LS =  $20/100 = 0.2$

Freq of SS =  $30/100 = 0.3$

Freq of L =  $0.5 + (0.2/2) = 0.6$

Freq of S =  $0.3 + (0.2/2) = 0.4$

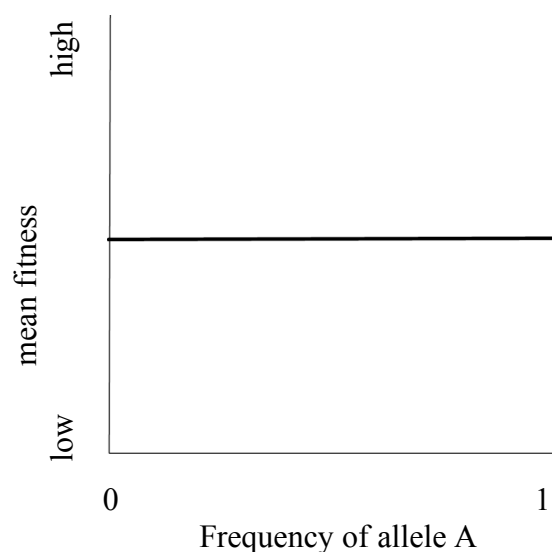
10 C- Freq of LL =  $0.6^2 = 0.36$  long

Freq of LS =  $2 \times 0.6 \times 0.4 = 0.48$  intermediate

Freq of SS =  $0.4^2 = 0.16$  short

10 D- L fixed

Bonus question



11- A-  $30/300 = 0.1$

11 B-  $p(t + 1) = p(t) + m(p_c - p(t))$

$0.25 = 0.2 + 0.1 (p_c - 0.2)$

$0.05 = 0.1(p_c - 0.2)$

$0.5 = p_c - 0.2$

$0.7 = p_c =$  the allele frequency of A1 in the upstream population

11 C- the same as the upstream source population = 0.7

12 A genetic drift

12 B- population 1

12 C- Smaller populations are more influenced by genetic drift. Population 1 has larger differences in allele frequency from generation to generation than population 2 showing that it is more influenced by random chance events and thus is the smaller population.

13A:

field: salamanders in one region of California mimic toxic newt. (credit also given for descriptions of other aspects of geographic variation in color pattern)

experimental: clay salamanders with yellow eyes and warning coloration attacked 50% less frequently than salamanders without yellow eyes; also birds attacked non-warningly colored salamanders much faster than warningly colored ones after prior exposure to the toxic newts. Also accepted evidence that hybrids between different forms had lower fitness than either parental form

13B:

field: pattern of bright spots in headwaters with minor predator and camouflaged/dull pattern near mouth of streams with major pattern repeated in many different streams

experimental evidence: good description of any of the experiments was acceptable here.

13C:

could describe any model of sexual selection. For runaway selection (most frequently chosen), needed to specify that an arbitrary female preference led to a fitness advantage for a particular male trait locus; increase in frequency of this locus was directly selected by female preference. Because offspring with this male trait are more likely to inherit the female preference locus and to have enhanced reproductive success, the female preference locus will also increase in frequency (even though it provides no fitness advantage and is not under selection).

13 D: full credit given for any model name that was consistent with the model described in C. (In addition to runaway/direct benefit/good genes/handicap, also accepted intrasexual or intersexual selection and female choice as models).

14 A: multilocus

14 B: 4 mm. According to Fisher's fundamental theorem, mean fitness of the population will increase (or stay the same) in each generation. Since most of the population has gill raker lengths <8 mm, selection will result in decreasing gill raker length until the local fitness optimum at 4 mm is reached. This is directly analogous to the single gene case of disruptive selection, in which a population is fixed for one allele or the other, depending on the starting point.

NOTE THAT IT IS INCORRECT TO SAY THAT THE POPULATION WILL END UP ON BOTH FITNESS PEAKS—if you took populations that were adapted to the two separate fitness peaks and allowed them to breed, their offspring would have intermediate phenotypes

(because of the multi-locus genetic basis), resulting in a relatively unfit population. Selection would then move the population up one or the other fitness peaks.

14 C: different—because of the different starting point gill raker length would increase from generation to generation as a result of selection, until the population reached the local fitness optimum at 11 mm, which would be the expected average gill raker length in the population at equilibrium.