Part B

Case 1

Testing an Ideal Population

Initial Class Frequencies: AA: 0.25 Aa: 0.5 aa: 0.25

My Initial Genotype: Aa

F_1 Genotype: aa

F_2 Genotype: Aa

F_3 Genotype: AA

F_4 Genotype: Aa

F_5 Genotype: AA

$p^2 + 2pq + q^2 = 1$

Final Class Frequencies: AA: 0.2 Aa: 0.5 aa: 0.3

p: 0.45 q: 0.55

Number of A alleles present at the fifth generation

Number of offspring with genotype AA 3 X2 = 6 A alleles

Number of offspring with genotype Aa 4 X1 = 4 A alleles

Total = 10 A alleles

$p = \frac{\text{TOTAL number of A alleles}}{\text{TOTAL number of alleles in the population}} = \frac{10}{22} = 0.45\ (p)$

Number of a alleles present at the fifth generation

Number of offspring with genotype aa 4 X2 = 8 a alleles

Number of offspring with genotype Aa 4 X1 = 4 a alleles

Total = 12 a alleles

$q = \frac{\text{TOTAL number of a alleles}}{\text{TOTAL number of alleles in the population}} = \frac{12}{22} = 0.55\ (q)$

Case 2

may not live as aa

Selection

Initial Class Frequencies: AA: 0.25 Aa: 0.5 aa: 0.25

My Initial Genotype: Aa

F_1 Genotype: AA

F_2 Genotype: Aa

F_3 Genotype: Aa

F_4 Genotype: AA

F_5 Genotype: AA

AA – 8 ×2 = 16

Aa – 3 ×1 = 3

Final Class Frequencies: AA: 0.73 Aa: 0.24 aa: 0.02

p: 0.86 q: 0.14

Case 3

Heterozygote Advantage

Initial Class Frequencies: AA: 0.25 Aa: 0.5 aa: 0.25

My Initial Genotype: Aa

F_1 Genotype: Aa

F_2 Genotype: Aa

F_3 Genotype: Aa

F_4 Genotype: Aa

F_5 Genotype: Aa

AA – 7

Aa – 4

aa – 0

Final Class Frequencies: (After five generations) AA: 0.67 Aa: 0.3 aa: 0.03

p: 0.82 q: 0.18

F_6 Genotype: AA

F_7 Genotype: AA

F_8 Genotype: AA

F_9 Genotype: AA

F_{10} Genotype: Aa

AA – 7

Aa – 4

aa – 0

Final Class Frequencies: (After ten generations) AA: 0.67 Aa: 0.3 aa: 0.03

p: 0.82 q: 0.18

Case 4
Genetic Drift

Initial Class Frequencies: AA: 0.25 Aa: 0.5 aa: 0.25

p: 0.45 q: 0.55

My Initial Genotype: Aa

F_1 Genotype: Aa

F_2 Genotype: Aa

F_3 Genotype: Aa

F_4 Genotype: AA

F_5 Genotype: AA

all end as AA

Final Class Frequencies: AA: 1 Aa: 0 aa: 0

p: 1 q: 0

(1) AA - 0
Aa - 2
aa - 1

(2) AA - 2
Aa - 0
aa - 0

(3) AA - 3
Aa - 0
aa - 0

(4) AA - 0
Aa - 3
aa - 0

Name: ______
Group: ______
Date: ______

ASSESSMENT

1. Using the PTC tasting results for the entire class, how close were the frequencies of each phenotype (taster vs. non-taster) to those found in the North American population (approximately 70% tasters)? If there was variation, what could have accounted for this?

2. In the first exercise in Part B, 'Testing an Ideal Population', what would be the expected values of p and q after the five generations?

   The expected values would most likely be the same as the initial p and q values, or very close to them.

3. How close were your class results to an ideal population?

   The class results were quite close to an ideal population; only off by 0.05.

4. What do you think would happen if you carried this simulation out for ten more generations?

   After ten more generations, the allele frequencies would probably get even closer to the ideal.

5. How do the frequencies of p and q compare after the factor of selection was added to the simulation?

   After the selection factor was added, the p value went way up to 80%, because aa was selected against.

6. What do you think would happen if you carried this simulation out for another ten generations?

   Slowly but surely, the allele for q (little a) would be almost completely eradicated. However, since heterozygotes live, there may still be some a alleles.

7. Do you think that the a allele would ever be totally eliminated from the population? Why or why not?

~~I do~~ The a allele would not be totally eliminated because heterozygotes could still pass on the a allele and have heterozygote offspring who could do the same.

8. Suppose there was a medical advance that allowed most individuals with the double recessive condition to survive and reach reproductive age. How would this affect the allele frequencies?

This would mean that the frequencies would even out again over time. The a frequency would go up again and the A allele frequency would decrease some.

9. Explain the difference in the results of the simulation showing selection to the simulation favoring heterozygotes.

The results for case 2 and case 3 were surprisingly similar. Both cases showed around 80% frequency for the A allele. The frequencies for case 3 would have been expected to be more equal.

10. Why is the heterozygous condition important in maintaining genetic variation within a population?

Heterozygotes are important for genetic variation because they may produce a variety of phenotypes for offspring. They also make sure that not all members of the population can be affected by changes in the same way.

11. In the simulation demonstrating genetic drift, what do the resulting allele frequencies suggest about population size as an evolutionary force?

Population size can be very important for the variation of genes in a gene pool. If the population is small, there are less potential mates and may be less opportunity for new gene combinations. There will be less genetic variation among the population.

12. You are a population geneticist and you have recently visited a remote Pacific island where you have discovered a race of giant purple-skinned, seven-toed, three-horned dragons. In examining the new race you have discovered that a small number of the dragons have only six toes as opposed to seven and it seems to be a genetically inherited trait. After a population survey, you have found that in a population of 1,378 dragons, 174 of them have only six toes. Assuming the six-toed organisms are carrying a recessive trait, calculate the gene frequencies and the percentage of homozygous dominant, heterozygous, and recessive individuals on the island.

174/1378 = 0.126 (12.6% are aa)

$q^2 = 0.126$ | $\sqrt{}$

$q = 0.35$

$p = 0.65$

$p^2 = 0.42$

$2pq = 0.455$

$0.42 + 0.455 + 0.126 = 1.001$

homo dom: 42%

hetero: 45.5%

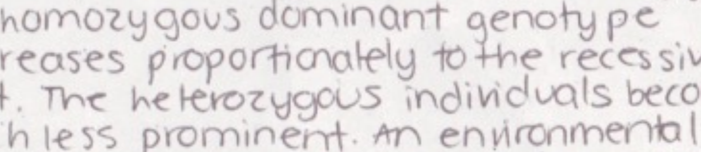
homo rec: 12.6%

13. Below are four pie charts representing the percentage of homozygous dominant, heterozygous, and recessive individuals within a population over a period of 400 years. Examine the charts and explain below what you believe is happening within the population.

homo dom — steady decrease

homo rec — steady increase

hetero: getting smaller



☐ Homozygous dominant ▩ Heterozygous ■ Homozygous recessive

Over the 400 years, homozygous recessive genotype is being selected for strongly. The homozygous dominant genotype decreases proportionately to the recessive trait. The heterozygous individuals become much less prominent. An environmental change may have caused the homozygous recessive trait to become more advantageous. The dominant allele is being selected against and the heterozygotes ~~are~~ survive much less efficiently over time. An outside factor most likely caused the recessive (homozygous) genotype to be favored.