Year 12 Science: Gene pools and how they change

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. A population of 50 snails has 18 AA, 24 Aa and 8 aa. Find the frequency of A and of a.

2. The frequency of allele B in a population is 0.35. What is the frequency of its only other allele, b?

3. A storm kills most of a small island population of skinks, and which ones die is down to luck. Which process has changed the gene pool?

4. Six birds are blown to a new island and start a population there. What is this called?

5. In 1989, 18 of 35 black robin females laid rim eggs. What percentage is that, to one decimal place?

6. Which process adds alleles to a gene pool from another population of the same species?

Exam-style question: the black robin

In 1980 only five black robins survived, with one breeding pair. Some females lay eggs on the rim of the nest, a trait that fits a single dominant allele (R). Rim eggs never hatch unless people move them into the nest. Staff did this until 1990: in 1989, 51.4% of females were rim layers, and in 2007 to 2011, after it stopped, 9% were.

7. Describe what is meant by a gene pool and allele frequency.

8. Explain why the 1980 bottleneck reduced the genetic diversity of the black robin.

9. Suppose a sample of 40 robins contained 2 RR, 12 Rr and 26 rr birds (practice numbers, not real counts). Calculate the frequency of R and of r.

10. Discuss how human management and natural selection changed the frequency of the rim-laying allele between 1980 and 2011.

Fix the mistake

11. Correct this statement: "Individuals evolve when they adapt to their environment."

12. Correct this statement: "After a bottleneck, once the population grows back, its genetic diversity comes back too."

13. Correct this statement: "Genetic drift means the best adapted alleles become more common."

14. Correct this statement: "With 98 BB, 84 Bb and 18 bb, the frequency of b is 18 ÷ 200."

Answer key (for parents and tutors)

1. A population of 50 snails has 18 AA, 24 Aa and 8 aa. Find the frequency of A and of a.
   Total alleles = 50 × 2 = 100. A = (2 × 18) + 24 = 60, so f(A) = 0.60; a = (2 × 8) + 24 = 40, so f(a) = 0.40.
2. The frequency of allele B in a population is 0.35. What is the frequency of its only other allele, b?
   1 – 0.35 = 0.65.
3. A storm kills most of a small island population of skinks, and which ones die is down to luck. Which process has changed the gene pool?
   Genetic drift, as a bottleneck: survival was by chance, not by phenotype.
4. Six birds are blown to a new island and start a population there. What is this called?
   The founder effect, a kind of genetic drift: the new gene pool holds only the six founders' alleles.
5. In 1989, 18 of 35 black robin females laid rim eggs. What percentage is that, to one decimal place?
   18 ÷ 35 × 100 = 51.4%.
6. Which process adds alleles to a gene pool from another population of the same species?
   Migration (immigration), also called gene flow.
7. Describe what is meant by a gene pool and allele frequency.
   A gene pool is all the alleles of all the individuals in a population; allele frequency is the proportion of the copies of one gene that are a particular allele (Achieved).
8. Explain why the 1980 bottleneck reduced the genetic diversity of the black robin.
   Only the five survivors' alleles could be passed on, so all other alleles were lost; with so few birds, which alleles survived and how common they became was down to chance (drift), so some alleles were fixed and diversity fell (Merit).
9. Suppose a sample of 40 robins contained 2 RR, 12 Rr and 26 rr birds (practice numbers, not real counts). Calculate the frequency of R and of r.
   Total alleles = 40 × 2 = 80; R = (2 × 2) + 12 = 16, so f(R) = 16 ÷ 80 = 0.20; f(r) = 1 – 0.20 = 0.80 (check: (2 × 26) + 12 = 64, and 64 ÷ 80 = 0.80) (Achieved for the method, Merit with full working).
10. Discuss how human management and natural selection changed the frequency of the rim-laying allele between 1980 and 2011.
    Normally the R allele is selected against, because rim eggs fail and rim-laying females leave fewer offspring. Moving the eggs removed that selection pressure, so R-carrying females raised as many chicks as others; in a population descended from so few founders, chance (drift) let R spread until over half the females (51.4%) laid rim eggs by 1989. Once staff stopped in 1990, rim eggs failed again: rim layers laid smaller clutches and raised fewer chicks, so fewer copies of R were passed on each generation and natural selection cut the share of rim layers to 9% by 2007 to 2011. R is dominant, so every carrier shows the trait and is exposed to selection, which is why it fell quickly, though in a small population drift can keep it from being lost entirely (Excellence: links the removal and return of the selection pressure, drift in the small population, and the data).
11. Correct this statement: "Individuals evolve when they adapt to their environment."
    Populations evolve: allele frequencies in the gene pool change over generations, while each individual keeps the alleles it was born with.
12. Correct this statement: "After a bottleneck, once the population grows back, its genetic diversity comes back too."
    The alleles lost in the bottleneck are gone; growth only makes more copies of the survivors' alleles, unless mutation or migration adds new ones.
13. Correct this statement: "Genetic drift means the best adapted alleles become more common."
    That is natural selection; drift is a change by chance, and it can even fix a harmful allele in a small population.
14. Correct this statement: "With 98 BB, 84 Bb and 18 bb, the frequency of b is 18 ÷ 200."
    Count alleles, not individuals: b = (2 × 18) + 84 = 120 out of 400, so f(b) = 0.30.