Year 13 Science: Mutation, gene flow, natural selection and genetic drift

Name: _____ Date: _____

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

Practice

1. A mutation happens in a skin cell of a gecko. Can its offspring inherit the new allele?

2. A population of 50 breeding animals has p = 0.5. Find the typical chance change in p in one generation, $\sqrt{(p(1 - p) \div 2N)}$.

3. Very light and very heavy newborn lambs die more often than average ones. Which type of selection is this?

4. 100 snails are 36 AA, 48 Aa and 16 aa. A thrush eats half of the AA snails. Find f(A) among the survivors, to 2 decimal places.

5. DOC moves a few kiwi from one population to another every few years. Which process is this, and what does it do to the two gene pools?

Exam-style question: tauhou on the islands

Tauhou (silvereyes) crossed the Tasman from Australia on their own and became common in New Zealand from the 1850s. From the mainland, small groups later reached offshore islands such as the Chathams. Genetic studies find that each population founded in this chain carries fewer alleles than the one it came from, and some island birds are now larger than mainland birds.

6. Describe gene flow and genetic drift.

7. Explain why each new island population has fewer alleles than its source.

8. Explain why mutation will only slowly restore the lost diversity.

9. Discuss how drift, natural selection and the lack of gene flow could together make an island population of tauhou diverge from the mainland population.

Fix the mistake

10. Correct this statement: "The bacteria mutated to become resistant because they were exposed to the antibiotic."

11. Correct this statement: "Genetic drift means the population moved to a new place."

12. Correct this statement: "Natural selection gives organisms what they need to survive."

13. Correct this statement: "A bottleneck only lowers the number of individuals, so diversity returns when numbers recover."

Answer key (for parents and tutors)

1. A mutation happens in a skin cell of a gecko. Can its offspring inherit the new allele?
   No: a skin cell is a body (somatic) cell, and only mutations in the germ line reach eggs or sperm.
2. A population of 50 breeding animals has p = 0.5. Find the typical chance change in p in one generation, $\sqrt{(p(1 - p) \div 2N)}$.
   $\sqrt{(0.5 \times 0.5 \div 100)} = \sqrt{0.0025} = 0.05$.
3. Very light and very heavy newborn lambs die more often than average ones. Which type of selection is this?
   Stabilising selection: both extremes are selected against, so the average is kept and variation narrows.
4. 100 snails are 36 AA, 48 Aa and 16 aa. A thrush eats half of the AA snails. Find f(A) among the survivors, to 2 decimal places.
   18 AA, 48 Aa and 16 aa survive = 82 snails = 164 alleles; A = (2 × 18) + 48 = 84, so f(A) = 84 ÷ 164 = 0.51 (it was 0.60).
5. DOC moves a few kiwi from one population to another every few years. Which process is this, and what does it do to the two gene pools?
   Gene flow: it adds alleles to each population and makes the two gene pools more alike.
6. Describe gene flow and genetic drift.
   Gene flow is the movement of alleles between populations when individuals migrate and breed; genetic drift is a random change in allele frequencies from one generation to the next (Achieved).
7. Explain why each new island population has fewer alleles than its source.
   Each island was colonised by a few founders, who carried only a sample of their source population's alleles, with rare alleles likely to be missed; this founder effect is a form of drift, and further drift in the small new population loses more alleles (Merit).
8. Explain why mutation will only slowly restore the lost diversity.
   Mutation is the only source of brand new alleles, but the rate per gene is very low, most new mutations are harmful or neutral, and a new allele starts as a single copy that drift can easily lose in a small population (Merit).
9. Discuss how drift, natural selection and the lack of gene flow could together make an island population of tauhou diverge from the mainland population.
   The founder effect gave each island a different, smaller gene pool by chance, and drift kept changing it strongly while numbers were low. The sea limits gene flow, so mainland alleles rarely arrive to undo those differences. Island conditions, such as different food and fewer predators, select for different phenotypes, so larger body size may have been favoured by directional selection. Selection and drift both change the isolated island gene pool and gene flow does not oppose them, so the island population diverges further each generation, which could in time lead to reproductive isolation (Excellence: links all three processes to the evidence).
10. Correct this statement: "The bacteria mutated to become resistant because they were exposed to the antibiotic."
    Resistance alleles arose by random mutation before exposure; the antibiotic only selected for them by killing the rest.
11. Correct this statement: "Genetic drift means the population moved to a new place."
    Drift is a random change in allele frequencies; moving between populations is gene flow.
12. Correct this statement: "Natural selection gives organisms what they need to survive."
    Selection can only act on variation already present; it changes how common existing alleles are.
13. Correct this statement: "A bottleneck only lowers the number of individuals, so diversity returns when numbers recover."
    Lost alleles do not come back when numbers rise; only new mutation or gene flow can restore diversity, and both are slow.