Year 13 Science: Patterns of evolution: divergence, convergence and radiation

Name: _____ Date: _____

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

Practice

1. Sharks and dolphins have similar streamlined bodies. Which pattern of evolution is this?

2. Kea and kākā evolved from one ancestor into an alpine bird and a forest bird. Which pattern is this?

3. A fossil shell grows from 20.0 mm to 26.0 mm in 0.20 million years. Find the rate in mm per million years.

4. Pua o te reinga is pollinated by the short-tailed bat, which feeds on its nectar. Name the pattern.

5. Fossils show a species unchanged for 2 million years, then replaced quickly by a new form. Which model fits?

Exam-style question: the hebes

New Zealand has about a hundred species of hebe, from coastal trees to alpine cushions. DNA differences between species are small. Whipcord hebes of the high mountains have tiny scale-like leaves pressed against the stem, and look so like conifers that one species is named cupressoides, meaning cypress-like.

6. Define adaptive radiation and divergent evolution.

7. Explain two factors that allowed hebes to radiate rapidly in New Zealand.

8. Explain why the likeness of whipcord hebes to conifers is convergent evolution.

9. Discuss whether the hebe radiation better fits gradualism or punctuated equilibrium, using the evidence given.

Fix the mistake

10. Correct this statement: "Dolphins and sharks look alike, so they must share a recent common ancestor."

11. Correct this statement: "Adaptive radiation and divergent evolution are the same thing."

12. Correct this statement: "Co-evolution is when two species evolve at the same time."

13. Correct this statement: "Punctuated equilibrium means evolution happens overnight."

Answer key (for parents and tutors)

1. Sharks and dolphins have similar streamlined bodies. Which pattern of evolution is this?
   Convergent evolution: they are unrelated, and similar selection pressures produced analogous features.
2. Kea and kākā evolved from one ancestor into an alpine bird and a forest bird. Which pattern is this?
   Divergent evolution: one ancestor, different selection pressures in different habitats.
3. A fossil shell grows from 20.0 mm to 26.0 mm in 0.20 million years. Find the rate in mm per million years.
   6.0 ÷ 0.20 = 30 mm per million years.
4. Pua o te reinga is pollinated by the short-tailed bat, which feeds on its nectar. Name the pattern.
   Co-evolution (a mutualism): each species is a selection pressure on the other.
5. Fossils show a species unchanged for 2 million years, then replaced quickly by a new form. Which model fits?
   Punctuated equilibrium: long stasis, then a short burst of change.
6. Define adaptive radiation and divergent evolution.
   Adaptive radiation is the rapid divergent evolution of one ancestral species into many species, each adapted to a different niche; divergent evolution is the process by which related populations become more different as they adapt to different selection pressures (Achieved).
7. Explain two factors that allowed hebes to radiate rapidly in New Zealand.
   The rise of the Southern Alps created many new habitats (alpine scree, bog, cushion field) with few competing plants, so open niches were available; populations on separate ranges and in different habitats had little gene flow, so selection and drift could split them into species quickly (Merit for each factor explained).
8. Explain why the likeness of whipcord hebes to conifers is convergent evolution.
   Whipcord hebes and conifers are not closely related, but both face cold, dry, windy conditions, so selection favoured small, tough leaves with little surface for water loss in both; the scale leaves are analogous structures built independently (Merit, Excellence if linked to the selection pressure and contrasted with homologous features).
9. Discuss whether the hebe radiation better fits gradualism or punctuated equilibrium, using the evidence given.
   Small DNA differences show the species split recently and fast, so the radiation looks like a burst of speciation rather than slow, steady change, which fits punctuated equilibrium at the scale of the group. However, there is little fossil evidence for hebes, so the pattern cannot be checked layer by layer, and each species could still have changed gradually after it formed; the DNA evidence supports a rapid burst but cannot fully rule out gradual change (Excellence: evaluates the evidence for both models).
10. Correct this statement: "Dolphins and sharks look alike, so they must share a recent common ancestor."
    Their similarity is convergent: they are distantly related, and similar selection pressures in water produced analogous body shapes.
11. Correct this statement: "Adaptive radiation and divergent evolution are the same thing."
    Adaptive radiation is divergent evolution that happens rapidly, from one ancestor into many species filling many niches.
12. Correct this statement: "Co-evolution is when two species evolve at the same time."
    Co-evolution needs each species to be a selection pressure on the other, so changes in one cause changes in the other.
13. Correct this statement: "Punctuated equilibrium means evolution happens overnight."
    The bursts take thousands of years, which is quick only compared with the millions of years of stasis around them.