RLP-BIOB · RLP Biology B — Ecosystems, Evolution and Human Impact

Unit 3: Evolution: Evidence and Mechanisms

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 3.1 — Phenomenon: Pale Fish in Missouri's Caves

FLUENCY

1. State the biological species concept in one sentence.

2. Why are grotto sculpins found only where Perry County's sinkhole plain drains into cave streams?

3. Put these stages of speciation in order: reproductive isolation; populations separated; populations change independently.

APPLICATION

4. Assume (for illustration) that a Missouri cavefish has a generation time of about 5 years. How many generations pass in 1 million years?

5. Grotto sculpins from several Perry County caves share one nuclear DNA haplotype; banded sculpins from Greasy Creek (Madison County) and the Current River (Ripley County) each carry a different one, and no other sculpin species lives within the grotto sculpin's range. Can the biological species concept be tested directly on grotto and banded sculpins in nature? How did scientists decide they are separate species?

6. Give two examples of barriers in Missouri that can separate populations and start speciation.

CHALLENGE

7. Scientists keep revising how many cavefish species live in Missouri: the Salem Plateau cavefish was split from the southern cavefish, and the Shawnee Hills cavefish from the spring cavefish. Explain why these revisions do not cast doubt on the conclusion that the populations evolved.

REVIEW

8. In a trait where A (dominant) masks a (recessive), cross Aa × aa. Give the genotype ratio and the probability of the dominant phenotype.

Lesson 3.2 — Hunting the Dots: A Natural Selection Investigation

FLUENCY

1. A population has 33 green and 67 brown dots. What proportion is brown?
2. After predation, 8 green and 64 brown dots survive. Scale back to 100 and give the new proportion of brown.
3. List the four factors of natural selection in HS-LS4-2.

APPLICATION

4. Start with 50 green and 50 brown dots. Predators remove 60% of green and 20% of brown each round, and the population is scaled back to 100. Find the proportion of brown after one round.

5. A trait starts at 10% of a population. Carriers leave offspring at full rate and non-carriers at 80% of that rate. Find the trait's frequency after one, two and three generations.

6. In eight repeated runs, the brown proportion rose in all eight on the patterned fabric, but rose in four and fell in four on white paper. What do these results show?

CHALLENGE

7. A trait starts at 5% of a population and carriers leave twice as many offspring as non-carriers. Find its frequency after each of five generations, and explain why the increase is slow at first and then fast.

REVIEW

8. For the data 3, 8, 11, 13, 27, 28, 30, 34: find the mean, median, range and interquartile range. (Find the quartiles as the medians of the lower and upper halves, leaving out the overall median when the count is odd.)

Lesson 3.3 — Many Lines, One Conclusion: The Evidence for Common Ancestry

FLUENCY

1. Two 20-base sequences differ at 3 positions. What percentage identical are they?

2. Two 40-base sequences differ at 7 positions. What percentage identical are they?

3. Two 50-base sequences differ at 12 positions. What percentage identical are they?

APPLICATION

4. Classify each pair as homologous or analogous: (a) human arm and whale flipper; (b) bird wing and butterfly wing; (c) bat wing and cat foreleg; (d) the streamlined body shape of a shark and of a dolphin.

5. Compared with species A (illustrative sequences), species B differs at 1 of 20 bases, C at 2 and D at 5. Draw or describe the simplest tree and explain your reasoning.

6. Arrange the early whale fossils from oldest to youngest and describe the trend: Basilosaurus (about 40 million years), Pakicetus (about 50), Ambulocetus (about 49), Rodhocetus (about 47).

CHALLENGE

7. Humans and other primates share the same broken copy of the GULO gene, which other mammals use to make vitamin C. Explain why shared mistakes in DNA are especially strong evidence of common ancestry.

REVIEW

8. (Biology A) Translate the mRNA AUG GCU UGG AAA UAG.

Lesson 3.4 — Adaptation in Action: Modeling Selection and Resistance

FLUENCY

1. Out of 1,000 bacteria, 10 are resistant. An antibiotic kills 90% of the susceptible bacteria and none of the resistant ones. What percentage of the survivors are resistant?

2. Bacteria divide every 30 minutes. How many generations can they pass through in a day?

3. Name the three possible outcomes for species when environmental conditions change, as listed in HS-LS4-5.

APPLICATION

4. Out of 1,000 bacteria, 2% are resistant. An antibiotic kills 95% of susceptible bacteria and no resistant ones. Find the resistant percentage after one treatment, and after a second treatment of the regrown survivors.

5. The CDC reports that its 2019 report showed more than 2.6 million antimicrobial-resistant infections and nearly 44,000 deaths each year in the United States. Explain how prescribing antibiotics for viral colds contributes to this problem.

6. In the PhET Natural Selection sim, brown fur spreads in the arctic when wolves are on, but not when wolves are off. Which of the four factors does this demonstrate most directly?

CHALLENGE

7. A species of salamander has a generation time of 5 years and little genetic variation; a species of fruit fly has a generation time of 2 weeks and much variation. A rapid warming event lasts 50 years. Compare the number of generations each experiences and explain which is more likely to adapt.

REVIEW

8. (Unit 1) With r = 0.3 per day and K = 200, find the daily growth of a duckweed population of 100 fronds using the logistic model.

Unit 3 checkpoint

1. What usually starts the process of speciation?
   A. A single large mutation
   B. Separation of populations so gene flow stops
   C. An individual deciding to change
   D. Hybridization
2. True or false: A cave population that stops exchanging genes with surface populations can accumulate heritable differences until it becomes a separate species.

3. Which is required for natural selection?
   A. Individuals changing traits because they need them
   B. Heritable variation among individuals
   C. A population that never grows
   D. Unlimited resources

4. 20 green and 40 brown dots survive; scaled to 100, the proportion of brown is about _____.

5. Which is a pair of homologous structures?
   A. Bird wing and bee wing
   B. Human arm and bat wing
   C. Dragonfly wing and bat wing
   D. Octopus eye and fish eye

6. Whales have small pelvic bones embedded in their bodies. These are best described as:
   A. Analogous structures
   B. Vestigial structures inherited from four-legged ancestors
   C. New adaptations for swimming
   D. Fossils

7. Two 20-base sequences that differ at 4 positions are _____% identical.

8. True or false: Independent lines of evidence, such as fossils and DNA comparisons, give largely matching pictures of evolutionary relationships.

9. An antibiotic is used and resistant bacteria become common. What caused the resistance mutations?
   A. The antibiotic created them
   B. They arose randomly before or during treatment; the antibiotic selected them
   C. The bacteria chose to mutate
   D. The patient's immune system

10. If 10 of 1,000 bacteria are resistant and an antibiotic kills 90% of the rest, about _____% of survivors are resistant (one decimal).

11. Which species is most at risk of extinction from rapid environmental change?
   A. One with short generations and high genetic variation
   B. One with long generations, low variation and nowhere to move
   C. One that is widespread
   D. One that eats many foods