Assessment Method Tools: EVOLUTION

To show that students have a basic understanding of the competitive theories pertaining to evolution.

When discussing the concept of evolution, competitive theories and those who proposed them will be discussed. Topics addressed may include: natural selection, genetic basis of evolution, origin of species, divergent evolution, adaptive radiation, convergent evolution, and/or patterns of descent.

Questions will be embedded in an examination (5-10 of the below listed questions) to determine if the students recognize the differences in competing evolutionary theories. Correct answers to embedded questions will indicate a mastery of the objective.

1. Evolutionary theory predicts that species are related, not independent. Four of the following examples provide support for this prediction, but one is irrelevant. Which of examples listed below does not support the claim that species are related?
   A. Many dinosaurs and other organisms went extinct following a huge asteroid impact at the end of the Cretaceous.
   B. The endostyle of lancelets (invertebrate chordates) and the thyroid gland of vertebrates develop similarly, and both produce iodinated proteins.
   C. All prokaryotes and eukaryotes use DNA to carry their genetic information.
   D. Ground squirrel species found on the North and South sides of the Grand Canyon are very similar to each other.

2. Which of these conditions are always true of populations evolving due to natural selection?
   Condition 1: The population must vary in traits that are heritable.
   Condition 2: Some heritable traits must increase reproductive success.
   Condition 3: Individuals pass on all traits they acquire during their lifetime.
   A. condition 1 only
   B. condition 2 only
   C. conditions 1 and 2
   D. conditions 2 and 3

3. Which of the following is the best modern definition of evolution?
   A. descent without modification
   B. change in allele frequencies in a population over time
   C. survival of the fittest
   D. inheritance of acquired characters

4. Evolution by natural selection changes the population but not the individual.
   A. true
   B. false

5. How can Darwinian fitness be estimated?
   A. Document how long different individuals in a population survive.
   B. Count the number of offspring produced by different individuals in a population.
   C. Determine which individuals are strongest.
   D. Determine which phenotype is the most common one in a given population.

6. Evolution by natural selection is progressive.
   A. True
   B. False

7. Which of the following statements is correct?
   A. When individuals change in response to challenges from the environment, their altered traits are passed on to offspring.
   B. Species are created independently of each other and do not change over time.
C. Populations—not individuals—change when natural selection occurs.
D. The Earth is young, and most of today’s landforms were created during the floods at the time of Noah.

8. Gill pouches in chick, human, and house-cat embryos are an example of:
   A. structural homology
   B. developmental homology
   C. analogy/convergent evolution
   D. the inheritance of acquired characters

9. Some beetles and flies (insects) have antler-like structures on their heads, much like male deer (chordates) do. The existence of antlers in beetle, fly, and deer species with strong male-male competition is an example of:
   A. structural homology
   B. developmental homology
   C. genetic homology
   D. analogy/convergent evolution

10. What is an adaptation?
    A. a trait that improves the fitness of its bearer, compared with individuals without the trait
    B. a trait that changes in response to environmental influences within the individual’s lifetime
    C. an ancestral trait—one that was modified to form the trait observed today
    D. a trait that is reduced in size or complexity but increases the fitness of its bearer

11. Why does the presence of extinct and transitional forms in the fossil record support the pattern component of the theory of evolution by natural selection?
    A. It supports the hypothesis that individuals change over time.
    B. It supports the hypothesis that weaker species are eliminated by natural selection.
    C. It supports the hypothesis that species evolve to become more complex and better adapted over time.
    D. It supports the hypothesis that species have changed through time.

12. Which of the following is a correct restatement of Darwin’s phrase “descent with modification”?
    A. Species change over time, and those that exist today descended from other, preexisting species.
    B. Humans are different from a preexisting ancestor species that lived in trees.
    C. Ancestral species are more primitive and lower down on the phylogenetic tree than are descendant species alive today.
    D. Natural selection changes species over time.

13. The theory of evolution by natural selection is attributed to:
    A. Charles Darwin alone
    B. Charles Darwin and Gregor Mendel
    C. Charles Darwin and Alfred Russel Wallace
    D. Charles Darwin and Jean-Baptiste de Lamarck

14. Which of the following is a statement of the law of succession?
    A. Species in the fossil record were succeeded, in the same region, by similar species.
    B. Species in the fossil record were always succeeded, in the same region, by species more closely adapted to the current environment.
    C. Species in the fossil record were succeeded, in the same region, by larger and more complex species.
    D. Species in the fossil record were succeeded, in the same region, by species that were more successful.

15. Which of the following is considered Darwin’s greatest contribution to science?
    A. Darwin recognized the pattern of evolution (descent with modification).
    B. Darwin recognized the process of evolution (natural selection).
    C. Darwin recognized “the original species.”
    D. Darwin recognized the heritable basis of traits (genetics).

16. Which of the following is the best definition of Darwinian fitness?
    A. Darwinian fitness is the ability of an individual to survive.
    B. Darwinian fitness is the ability of a population of organisms to persist.
    C. Darwinian fitness is the ability of an individual to stay healthy by eating well-balanced meals and exercising.
    D. Darwinian fitness is the ability of an individual to survive and reproduce.

17. Darwin’s theory of evolution by natural selection is testable. What does it mean for this theory to be “testable”?
    A. If the theory is testable and correct, then a biologist should be able to observe evolution by natural selection in a real-life population.
    B. If the theory is testable and incorrect, then biologists should not be able to observe natural selection.
C. If the theory is testable, then biologists should be able to test each postulate of the theory separately.
D. If the theory is testable, then all of the above hypotheses are true.

18. For biologists studying a large flatworm population in the lab, which Hardy-Weinberg condition is most difficult to meet?
   A. no selection
   B. no genetic drift
   C. no gene flow
   D. no mutation

19. For a biologist studying a small fish population in the lab, which Hardy-Weinberg condition is easiest to meet?
   A. no selection
   B. no genetic drift
   C. no gene flow
   D. no mutation

20. The researchers had already noted that negligible mutation and migration existed in this milkweed population, and the butterflies that pollinate these plants are not affected by the toxin. Which of the following would be a logical conclusion about this milkweed population based on your answer to question 6 above?
   A. Genetic drift and selection are negligible.
   B. There is either a heterozygote advantage or inbreeding depression.
   C. There is either directional selection or sexual selection.
   D. There is either disruptive selection or genetic drift.

21. An earthquake decimates a ground-squirrel population. The surviving population happens to have broader stripes on average than the initial population. If broadness of stripes is genetically determined, what effect has the ground-squirrel population has experienced during the earthquake?
   A. directional selection
   B. disruptive selection
   C. a founder event
   D. a genetic bottleneck

22. Why is random genetic drift aptly named?
   A. It causes allele frequencies to drift up or down randomly.
   B. It is the ultimate source of genetic variability.
   C. It is an especially important mechanism in small populations.
   D. It occurs when populations drift into new habitats.

23. The Hardy-Weinberg principle acts as a null model because it describes the relationship between allele and genotypic frequencies under conditions where:
   A. none of the four evolutionary forces is acting and mating is random
   B. new species are differentiating
   C. evolution by natural selection increases the fitness of individuals
   D. individuals in a population are not mating randomly

24. Evolution by natural selection is a powerful force of change. What keeps organisms from becoming perfectly adapted to their environment?
   A. Environments change, so different alleles become more fit.
   B. Genetic drift causes random changes in allele frequencies.
   C. Mutations introduce new variation into a population.
   D. All of the above processes impede, constrain, or prohibit evolution by natural selection.

25. Genetic diversity is required for natural selection to act, but natural selection can reduce or eliminate diversity. What process can restore genetic diversity to a population?
   A. genetic drift
   B. mutation
   C. sexual selection
   D. stabilizing selection

26. Who is credited with being the first person to write about evolution?
   A. James Hutton
   B. Charles Darwin
   C. Jean Lamarck
   D. George Cuvier
27. Which of the following biological processes causes adaptation?
   A. mutation
   B. migration
   C. natural selection
   D. genetic drift

28. What is an important consequence of gene flow in natural populations?
   A. Gene flow increases the mutation rate among sedentary organisms.
   B. Gene flow moves individuals from one habitat to another on a seasonal basis.
   C. Gene flow tends to separate allele frequencies among populations.
   D. Gene flow tends to reduce genetic differences among populations.

29. In what kind of population is random genetic drift most pronounced?
   A. Drift is greatest in large populations.
   B. Drift is greatest in small populations.
   C. Drift is greatest in migrating populations.
   D. Drift is greatest in fixed populations.

30. Who develop the principle that two species cannot coexist in the same ecological niche in the same area because one species will out-compete the other?
   A. George Cuvier
   B. G. F. Gause
   C. Ernst May
   D. Godfrey H. Hardy

31. What type of genetic drift occurs when there is a severe reduction in population size due to such forces as natural catastrophe, disease, over-hunting, or loss of habitat?
   A. founder effect
   B. allelic reduction
   C. gene pool conversion
   D. bottleneck

32. Hominid brain size has increased over the last 3 million years. This is probably due to:
   A. directional selection
   B. stabilizing selection
   C. dispersive selection
   D. sexual selection

33. The two populations are:
   A. different subspecies, under the morphospecies concept
   B. different species, under the biological species concept
   C. different species, under the phylogenetic species concept

34. Three populations of birds look very similar, but the males have territorial songs that sound different. What function would this difference in song likely serve if the two populations came in contact?
   A. a prezygotic isolating mechanism
   B. a postzygotic isolating mechanism

35. Which of the following describes the most likely order of events in speciation?
   A. genetic drift, genetic isolation, divergence
   B. genetic isolation, divergence, genetic drift
   C. genetic isolation, genetic drift, divergence
   D. divergence, genetic isolation, genetic drift

36. The building of one or more new species from a parent species that continues to exist is known as:
   A. anagenesis
   B. cladogenesis
   C. branching evolution
   D. both cladogenesis and branching evolution

37. Why are genetic isolation and genetic divergence occurring in soapberry bugs, even though populations occupy the same geographic area?
A. Members of the different populations feed and mate on different types of fruit.
B. One population recently became tetraploid, and hybrid offspring cannot undergo meiosis correctly.
C. A vicariance event occurred when nonnative host plants were introduced.
D. Beak length has changed due to disruptive selection.

38. Which of the following is *not* an observation or inference on which natural selection is based?
   A. There is heritable variation among individuals
   B. Poorly adapted individuals never produce offspring.
   C. There is a struggle for limited resources, and only a fraction of offspring survive.
   D. Organisms interact with their environments

39. Analysis of forelimb anatomy of humans, bats, and whales shows that humans and bats have fairly similar skeletal structures, while whales diverged considerably in the shapes and proportions of their bones. However, analysis of several genes in the species suggests that all three diverged from a common ancestor at about the same time. Which of the following is the best explanation for these data?
   A. Whales were not properly defined as mammals
   B. Humans and bats evolved by natural selection, and whales evolved by Lamarckian mechanisms
   C. Natural selection in an aquatic environment resulted in significant changes to whale forelimb anatomy.
   D. Evolution of human and bat forelimbs were adaptive, but not for whales.

40. The smallest biological unit that can evolve over time is:
   A. a species
   B. an individual organism
   C. an ecosystem
   D. a population

41. Which of the following ideas is common to both Darwin’s and Lamarck’s theories of evolution?
   A. The fossil record supports the view that species are fixed.
   B. Evolutionary adaptation results from interactions between organisms and their environments
   C. Evolution drives organisms to greater and greater complexity
   D. Adaptation results from differential reproductive success.

42. No two human individuals are alike, except for identical twins. The chief cause of the variation among individuals is:
   A. sexual recombination
   B. new mutations that occurred in the preceding generation
   C. geographical variation within the population
   D. genetic drift due to the small size of the population

43. The average length of jackrabbit ears decreases gradually with increasing latitude. This variation is an example of:
   A. directional selection
   B. discrete variation
   C. disruptive selection
   D. polymorphism

44. Sparrows with average-sized wings survive severe storms better than those with longer or shorter wings, illustrating
   A. the bottleneck effect
   B. stabilizing selection
   C. frequency-dependent selection
   D. disruptive selection

45. The largest unit within which gene flow can readily occur is a:
   A. population
   B. species
   C. genus
   D. hybrid

Assessment Rubric:
<table>
<thead>
<tr>
<th>Needs Improvement</th>
<th>Satisfactory</th>
<th>Excellent</th>
<th>Total Students Evaluated</th>
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</thead>
<tbody>
<tr>
<td>Less than 70% grade on embedded questions</td>
<td>70-89% grade on embedded questions</td>
<td>90% or better grade on embedded questions</td>
<td></td>
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</tbody>
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**Embedded Questions**

**Excellent** - 90% or better grade on embedded questions showing comprehension of EEO #3.

**Satisfactory** - 70-89% grade on embedded questions showing comprehension of EEO #3.

**Needs Improvement** - Less than 70% grade on embedded questions showing comprehension of EEO #3.

**Evaluation/Assessment of Outcomes:**

Embedded test questions over scientific theories concerning competitive theories pertaining to evolution:

- Excellent rating: __% of students
- Satisfactory rating: __% of students
- Needs Improvement: __% of students

**Enhancement / Improvement Plan:**

**Instructor/Coordinator:**

**Date:**