**1.** Most people have an easier time understanding a hockey game than an algebra equation because _____ has made us better at understanding _____ things than _____ things.

    A. Genetic drift; simple; complex
    B. Genetic drift; concrete; abstract
    C. Natural selection; simple; complex
    D. Natural selection; concrete; abstract

Researchers measured snout-to-vent length (SVL, a measure of overall body size) of marine iguanas and observed the percent survival of different-sized animals. The figure below shows the results.
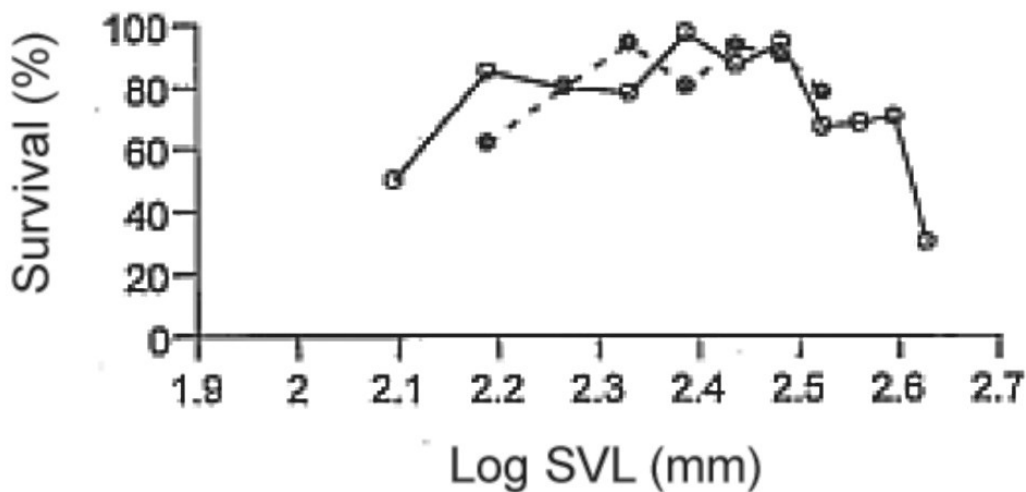
2. Based on the figure above, what type of selection for body size appears to be occurring in these marine iguanas?

    A. directional selection
    B. stabilizing selection
    C. disruptive selection
    D. sexual selection

3. Three populations of crickets in the same area look very similar, but the males have courtship songs that sound different. What is a likely function of this difference in song?

    A. a prezygotic isolating mechanism
    B. a postzygotic isolating mechanism
    C. both a prezygotic and a postzygotic isolating mechanism
    D. sexual competition between males of different populations
    E. preventing genetic drift

4. What is the most likely explanation for striking similarities between the bone structure of human arms and turtle front flippers?

    A. convergent evolution
    B. co-evolution
    C. acclimation
    D. homology
    E. homoplasy

5. A population of peas has either long pods or short pods. This trait is controlled by a single locus, which has two alleles (long and short). The long allele is dominant. If 30% of the population has the long phenotype, which of these is likely to be the approximate frequency of the long allele?

    A. 16%
    B. 30%
    C. 45%
    D. 55%
    E. 84%

6. In many species, males invest more in competition for mates because they have _____ reproductive success compared to females

    A. greater mean
    B. greater variance in
    C. smaller mean
    D. smaller variance in

7. A population of earthworms lives on an island in the middle of a river. Damming of the river causes flooding on the island, and only the highest points remain above water, creating several smaller islands with now-separate earthworm populations on them. The earthworms cannot swim. Which of the following best describes this event? The earthworm populations . . .

    A. have undergone speciation in allopatry.
    B. have undergone speciation in sympatry.
    C. have been isolated by dispersal.
   **D.** have been isolated by vicariance.

8. A blood culture with a population of malaria parasites is exposed to a drug treatment. Researchers notice that some parasites randomly do or do not encounter the drug. The ones that do reproduce well, whereas the ones that don't have two different responses. The majority of parasites die when they encounter the drug. Parasites with one or two copies of the *freeze* allele stop their reproductive functions when they encounter the drug: their lifespans remain normal, but they never reproduce again. If these parasites are continually exposed to this sort of treatment, we expect that natural selection on the *freeze* allele:

    A. will occur, because all of the logical conditions are met
    B. will not occur, because there is no variation in traits
    C. will not occur, because variation in traits is not heritable
    D. will not occur, because there is no variation in reproductive success
    E. will not occur, variation in reproductive success is not related to heritable traits

9. Which of the following is an example of acclimation?

    A. Some hemoglobins have a higher affinity for oxygen than others.
    B. Some animals have thick, cold-resistant skin structures
    C. Some bacteria can use the energy from sunlight to make sugars.
    D. Plants moved to low-nitrogen environments allocate more energy to roots and less to leaves.
    E. Some fungi are larger than others are.

Use this figure for the following question. The pictures below represent alternative phylogenetic models for the same set of 6 species.
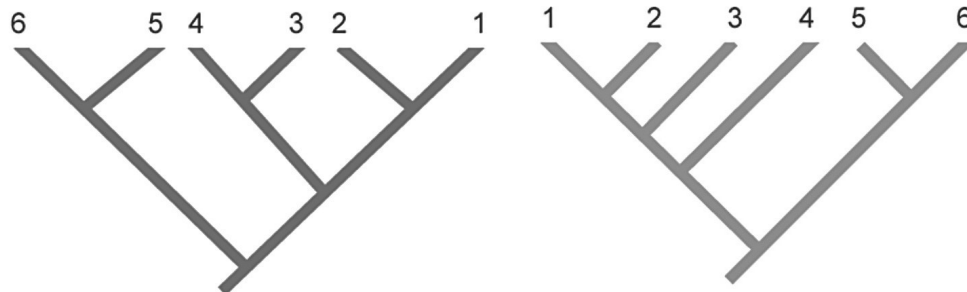
10. Which pair of taxa are sisters in the model on the left, but *not* on the model on the right?

    A. 1 and 2
    B. 3 and 4
    C. 5 and 6
    D. All of the above
    E. None of the above

11. Gypsy moths typically grow to adulthood on an individual plant. A gypsy moth population feeds on three different types of plant, all of which are hard to digest for different reasons. This population is likely to be under

    A. directional selection
    B. stabilizing selection
    C. disruptive selection
    D. balancing selection

12. Researchers have found fossils of ancient species related to horses in Colorado. Deeper deposits contain smaller species, and more recent deposits contain larger species. This observation supports the theory of _____ because it shows that _____.

    A. Evolution by natural selection; all species are related to each other.
    B. Evolution (only); all species are related to each other.
    C. Evolution by natural selection; species change over time.
   **D.** Evolution (only); species change over time.

13. Which of the following is the best example of a vestigial trait?

    A. Humans still have eyebrows, even though we have much less body hair than chimps.
    B. Penguins are flightless birds with wings that are specialized for swimming.
    C. Snakes have hinged jaws to help them swallow large meals.
    D. Fish that have evolved in caves have eye sockets but don't develop eyes.

14. A researcher wants to figure out whether oak trees are more closely related to rose bushes or to pine trees. Oak trees share a tree-like form with pines (but not roses), and share flower structure with roses (but not pines). The researcher has evidence that the common ancestor of the three species did not have a tree-like form or flowers. Based on *this information alone*, the researcher has _____ evidence that oaks are closer to roses, and _____ evidence that oaks are closer to pines.

    A. no; no
    B. no; some
    C. some; no
    D. some; some

15. In the figure below, which group is *not* a clade?
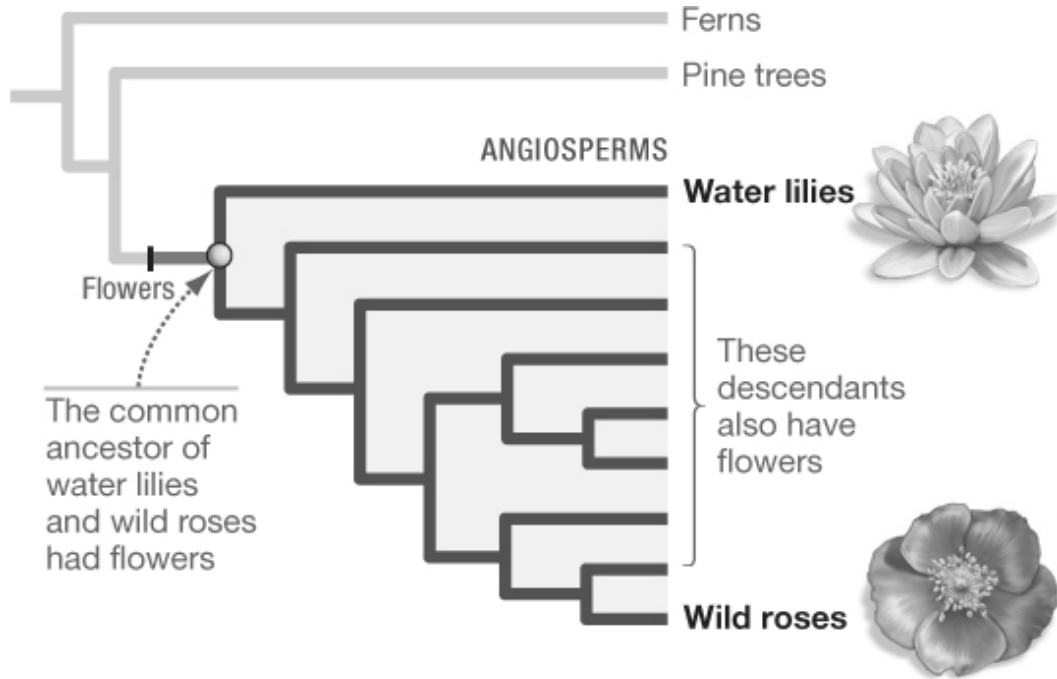
    A. Ferns
    B. Non-flowering plants (ferns and pines)
    C. Flowering plants (indicated by the dark color)
    D. Water lilies
    E. Dicots (all the *flowering* plants shown, *except* the water lilies)

16. Which of the following is an advantage of the phenetic approach over the cladistic approach to estimating phylogenetic trees?

    A. allows the use of genetic information
    B. allows the use of phylogenetic information
    C. requires less information to implement
    D. allows trait evolution to be mapped to the tree
    E. is a more accurate model of how evolution took place

17. Dolphins and icthyosaurs are very distantly related, but have many similarities, relating to swimming and catching fish efficiently, that they don't share with closer relatives. This is most likely due to:

    A. developmental homology
    B. structural homology
    C. genetic homology
    D. adaptation by natural selection
    E. the inheritance of acquired characteristics

18. Which of the following is true about *both* natural selection and genetic drift?

    A. They increase the average fitness of a population.
    B. They are random processes.
    C. They change the frequencies of alleles.
    D. They have strong effects on large populations.
    E. They increase variation.

19. Two closely related diploid populations are living in sympatry. In order to diverge into two species, they must overcome the barrier of:

    A. gene flow
    B. competition
    C. both gene flow and competition are likely to be barriers
    D. neither gene flow nor competition is likely to be a barrier

20. Environments all over the world are changing as a result of global warming. Could this influence natural selection?

    A. No. The environment is always changing. Global warming is nothing new.
    B. No. Existing species from hot environments will simply expand their ranges.
    C. Yes. Traits associated with reproductive success in warmer environments are likely to increase in frequency.
    D. Yes. Mutation rates are likely to increase, because mutations occur more frequently in hot environments.

21. Which of the following is the most predictable outcome of increased gene flow between two populations?

    A. lower average fitness in both populations
    B. higher average fitness in both populations
    C. increased genetic difference between the two populations
    D. decreased genetic difference between the two populations
    E. increased genetic drift

22. Two related species of pine live in the same forest. The first species mates in the spring, and the second in the fall. This is likely a(n) ――――――― adaptation.

    A. fusion
    B. reinforcement
    C. hybridization
    D. exclusion
    E. reuniting

23. Darwinian fitness refers to organisms' ability to:

    A. compete for resources
    B. compete for mates
    C. be physically strong and fast
    D. have long lives
    E. complete the cycle of surviving, growing and reproducing

24. Which pair of statements is logically equivalent?

    A. All cows can fly; all flies can cow
    B. All cows can fly; all flying things are cows
    C. All cows can fly; no non-cows can fly
    D. No cows can fly; no flying things are cows
    E. No cows can fly; no non-cows can't fly

25. For the purposes of this question, assume that all cows can fly. Which of the following is then logically correct?

    A. If Bess is a cow, then Bess can fly
    B. If Bess can't fly, then Bess is not a cow
    C. Both A and B
    D. Neither A nor B

26. Barn owls have extremely good night vision, and so did their recent ancestors. The extreme adaptation to seeing well at night likely resulted from ――――――― selection followed by ――――――― selection.

    A. disruptive; directional
    B. disruptive; stabilizing
    C. stabilizing; disruptive
    D. directional; disruptive
    E. directional; stabilizing

27. A flood followed by a mudslide wipes out most of the ponds where a population of frogs live, killing all of the frogs in the affected ponds, but not the frogs that live in the remaining ponds. This is an example of _____ and we would expect that the population would show _____ as a result of this event.

    A. a bottleneck effect; reduced genetic variation
    B. a bottleneck effect; adaptations to surviving floods
    C. gene flow; increased genetic variation
    D. gene flow; adaptations to surviving floods

28. The cladistic approach to estimating phylogenetic trees is most like the approach of which species concept?

    A. morphospecies concept
    B. biological species concept
    C. ecological species concept
    D. phylogenetic species concept

29. Which of the following processes increase genetic variation in a population?

    A. natural selection and genetic drift
    B. natural selection and mutation
    C. natural selection and gene flow
    D. gene flow and genetic drift
    E. gene flow and mutation

30. In a scientific experiment, a "control group":

    A. is kept in an unchanging environment
    B. is left alone by the experimenters
    C. is treated similarly to the treatment group, except for one key variable.
    D. is only subjected to one variable at a time
    E. is not measured

Short-answer questions

Answer questions *in pen*. *Briefly* show necessary work and equations. Points may be *deducted* for wrong information, even when the correct information is also there.

31. Some researchers want to test whether bright spots on damselfish are related to social hierarchy. They want to compare fish with different patterns by seeing how other damselfish react to them.

a) The researchers are debating whether to: manipulate fish appearance with paint; manipulate fish appearance with diet; or choose fish who naturally have more or brighter spots. Assuming all three methods can reliably change fish appearance, suggest a possible *disadvantage* of each method (3 points).

b) In addition to the points above, list two other points that could help to make this a good experiment (2 points).

32. A researcher collects 20 peppered moths and finds that 8 are homozygous for the dark allele (D); 8 are homozygous for the light allele (L); and four are heterozygous.

a) What are the estimated genotype frequencies in this population (2 points)?

b) The moths homozygous for L are light, where as all the others are dark. What type of dominance is seen in the DL allele? What are the estimated phenotype frequencies for this population (2 points)?

c) The researchers determine that there are more homozygotes in this population than would be expected from Hardy-Weinberg assumptions. What is a possible biological reason for this (1 point)?

33. Researchers collect related bacteria from a wheat field (bacterium W), a natural grassland (G), and a natural forest (F) and measure their ability to do certain chemical reactions. The W bacterium is successful at reactions 1, 2, 3, 4, 5. The G bacterium is successful at 1, 3 and 6. F is successful at 1 and 7.

a) Under what circumstances or assumptions would you do a phenetic (distance-based) analysis of these data (1 point)?

b) Under what circumstances or assumptions would you do a cladistic (evolution-based) analysis of these data (1 point)?

c) Do a phenetic analysis, and draw the most likely tree (2 points).

d) Assume that you learn about the ancestor, do a cladistic analysis, and get a different answer than above, and eventually conclude that your phenetic analysis was wrong. What is a specific, biological reason why the phenetic analysis might have been wrong (1 point)?