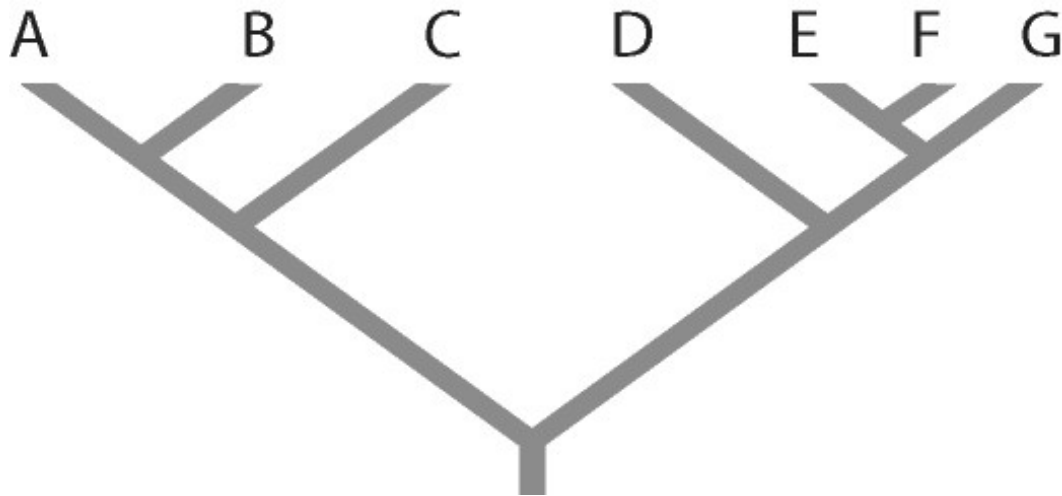


1. Eastern and Western meadowlarks look and act very similar, but sing (and are attracted by) very different songs. This is likely an example of _____ due to _____ selection.
 - A. fusion; stabilizing
 - B. fusion; disruptive
 - C. reinforcement; stabilizing
 - D. **reinforcement; disruptive**
2. Which of the following is *not* a mechanism that makes species divergence *less* likely in sympatry than in allopatry?
 - A. More gene flow in sympatry
 - B. More competition in sympatry
 - C. Different environments in allopatry lead to differences in selection
 - D. **Reinforcement is more likely in sympatry**
 - E. None of these are appropriate mechanisms; they could all be correct answers
3. The money in the kingdom of Florin consists of bills with the value written on the front, and pictures of members of the royal family on the back. To test the hypothesis that all of the Florinese \$5 bills in your wallet have pictures of the princess, you would need to turn over:
 - A. Bills that show pictures of the princess
 - B. Bills that show pictures of the queen
 - C. Bills that show the value \$5
 - D. Both A and C
 - E. **Both B and C**
4. 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 fly, then Bess is a cow
 - C. Both A and B
 - D. Neither A nor B
5. 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

Use the figure below for the next two questions



6. Which of the following forms a monophyletic group?
 - A. (A, B, C, and D)
 - B. (C and D)
 - C. (D, E, and F)
 - D. **(E, F, and G)**
7. Which of the following describes a pair of sister taxa?
 - A. **(A and B) with (C)**
 - B. (A, B and C) with (D)
 - C. (D) with (E and F)
 - D. (E) with (F and G)
8. Which of the following statements about acclimation is mostly likely to be true?
 - A. Acclimation responses are less effective than adapted responses
 - B. Acclimation responses are more effective than adapted responses
 - C. Acclimation responses tend to lead to the evolution of better adaptations
 - D. **Adaptation tends to lead to the evolution of better acclimation responses**
9. Which of these does *not* provide evidence for the idea that species change through time?
 - A. Transitional forms in the fossil record
 - B. Observations of tuberculosis bacteria that are exposed to antibiotic treatment
 - C. **Similarities in the genetic code used by very different organisms**
 - D. Vestigial traits

10. Which of the following does *not* provide evidence *against* the idea of goal-directed evolution?

- A. Parasites with simple genomes are descended from free-living organisms with more complex genomes
- B. **Blue whales evolved gradually increasing size, starting from a time when they looked more or less like small hippos**
- C. Swallows evolve to have larger body size during periods of good climate, and then to have smaller body size during periods of poor climate
- D. Ostriches have wings but don't fly

11. Which of the following types of genes in humans are known to be under disruptive selection (selection for diversity)?

- A. Sex-determination genes
- B. Mating-system genes that control which individuals we find attractive
- C. Genes that control sexual preference (which gender we find attractive)
- D. **Immune system genes**
- E. Genes for eusociality

12. What does the biological species concept use as the primary criterion for determining species boundaries?

- A. geographic isolation
- B. niche differences
- C. **gene flow**
- D. morphological similarity
- E. genetic similarity

13. If we believe in using monophyletic groups when possible, why should we object to *How Humans Evolved* referring to therapsids as reptiles?

- A. Therapsids were more similar to mammals than to reptiles
- B. Therapsids were more similar to dinosaurs than to reptiles
- C. Real reptiles had not yet evolved at the time of the therapsids
- D. **If therapsids are reptiles, then mammals would have to be reptiles, too**

14. Which of the following is *not* a likely reason for early primates developing stereoscopic vision?

- A. Navigating through trees
- B. **Avoiding predators**
- C. Catching insects
- D. Exploiting new plant resources

15. The fossil record is relatively rich in organisms that lived in shallow water or mud, as opposed to the open ocean, or land. This is likely primarily due to:

- A. Taxonomic bias
- B. **Habitat bias**
- C. Diversity bias
- D. Abundance bias
- E. Temporal bias

16. Researchers raised 100 populations of peppered moths, starting with an equal number of homozygous white and dark individuals in each case. After 10 generations of allowing 5 pairs from each population to breed in each generation, they found that 50% of the populations were either all white, or all dark. If this effect is due to genetic drift, what would be expected if they allowed 10 pairs from each population to breed in each generation, for the same time period?

- A. About 50% of the populations would be either all white or all dark.
- B. More than 50% of the populations would be either all white or all dark.
- C. **Less than 50% of the populations would be either all white or all dark.**
- D. All of the populations would be either all white or all dark.

17. The small ground finch and the large ground finch share a recent common ancestor (about 250,000 years ago). Small ground finches are much smaller than large ground finches, but evidence shows that neither species has changed much in size in the last few thousand years. This is probably an example of:

- A. directional selection followed by disruptive selection
- B. directional selection followed by balancing selection
- C. disruptive selection followed by directional selection
- D. **disruptive selection followed by balancing selection**
- E. balancing selection followed by disruptive selection

18. European humans are descended about 98% from early modern humans, which evolved in Africa, and about 2% from Neanderthal populations that lived in Europe at that time. We might think that sexual competition between males was one of the ways that modern humans displaced Neanderthals, if modern European human populations:

- A. **shared more mitochondrial DNA than nuclear DNA with Neanderthal populations**
- B. shared less mitochondrial DNA than nuclear DNA with Neanderthal populations
- C. showed more sexual dimorphism than African populations
- D. showed less sexual dimorphism than African populations

19. Two hypothetical species of songbirds, A and B, overwinter together in mixed flocks in northern South America. In spring, species A goes to the east coast of North America, and species B goes to the west coast. Breeding takes place in North America in the spring and summer. What can you say about the isolating mechanisms of these two species?

- A. They must have different courtship patterns.
- B. They must have a post-zygotic isolating mechanism.
- C. **The two species are reproductively isolated by allopatry.**
- D. The two species are reproductively isolated by genetic incompatibility.
- E. Reinforcement must be occurring when they winter together.

20. Mutations cause _____ evolution directly, and affect _____ evolution indirectly by providing variation on which natural selection acts

- A. little; little
- B. **little; much**
- C. much; little
- D. much; much

21. Juncos are birds with white outer tail feathers that the males display during aggressive interactions and during courtship displays. Females prefer to mate with males with more white in their tails. Females have less white in their tails than do males, and display it less often. Which of the following types of selection was most likely involved in the evolution of white outer tail feathers in juncos?

- A. Artificial selection
- B. Stabilizing selection
- C. Disruptive selection
- D. **Sexual selection**
- E. Balancing selection

22. Suppose 36% of a remote mountain village *cannot* taste phenylthiocarbamide (PTC) and must therefore have two copies of the recessive PTC taster allele. If this population conforms to Hardy-Weinberg expectations for this gene, what percentage of the population must be heterozygous for this trait?

- A. 16%
- B. 32%
- C. 40%
- D. **48%**
- E. 60%

23. A wide variety of tetrapods have embryos that look very similar. This is an example of

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

24. 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

25. The lifetime Darwinian fitness of one organism is greater than that of another organism if:

- A. it lives longer than the other
- B. it is able to outcompete the other for access to resources
- C. it mates more frequently
- D. **it leaves more viable offspring than the other**
- E. c and d

26. Male zebras have been observed to stand and “face off” against hyenas and other large predators. Which explanation below is the *least* likely?

- A. They are trying to impress female zebras so they can get more mating opportunities
- B. They are willing to risk their lives to protect their offspring
- C. **They are willing to risk their lives to protect the species**
- D. They are trying to save energy by warning the predators that they have been spotted and are unlikely to succeed

27. Why do researchers include information about mice when comparing humans and chimpanzees to understand human evolution?

A. We first need to understand how chimpanzees evolved from mice, before we can understand how humans evolved from chimpanzees

B. By replicating our comparisons, we reduce the possibility that our findings are due to chance

C. **The mice serve as an outgroup, indicating which traits are more likely to be basal**

D. The mice serve as a control group, so that conditions for the humans and chimpanzees can be as similar as possible

28. Why are shared, derived characters better evidence of evolutionary relatedness than shared, basal characters?

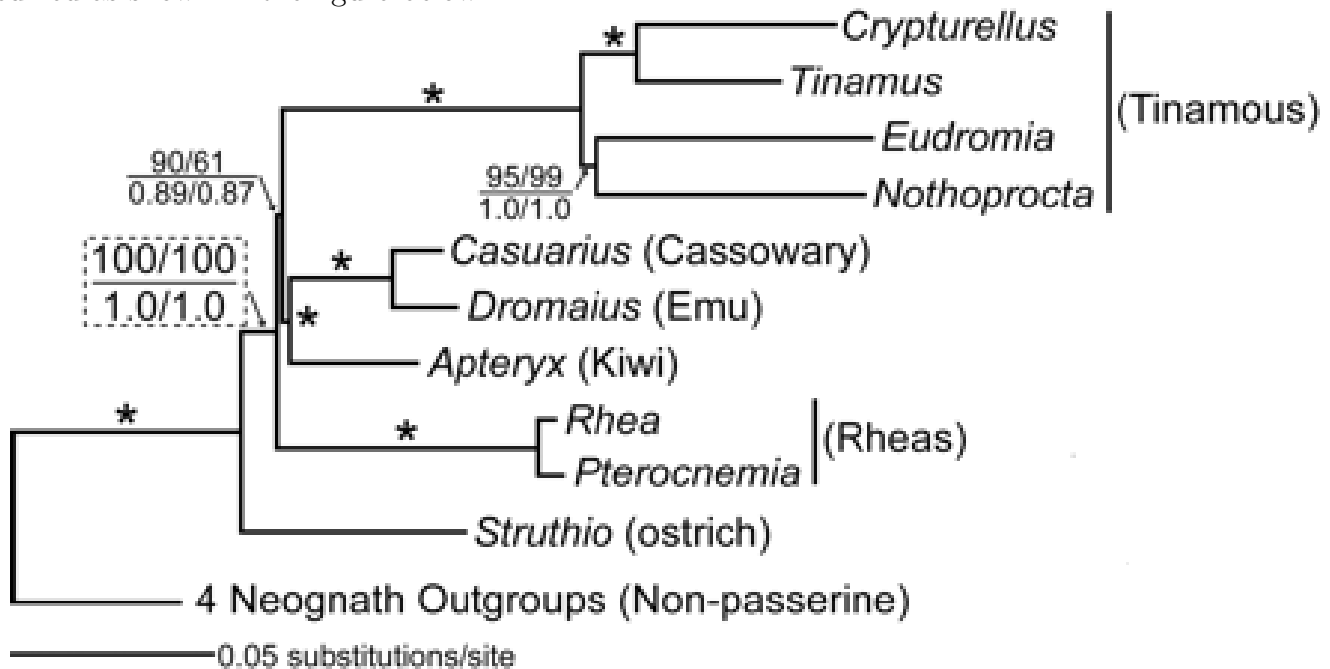
A. Because basal characters are also shared by the outgroup

B. **Because no evolutionary changes are required to explain the presence of basal characters**

C. Because basal characters cannot be measured as reliably as derived characters

D. Because the presence of basal characters is not due to convergent evolution

Use this information for the next two questions, and answer assuming the phylogeny in the figure is correct. Ratites are large, flightless birds (cassowaries, emus, rheas and ostriches). They are closely related to tinamous, which are flying birds. In the last few years, new research has changed what we know about ratite evolution, suggesting it occurred as shown in the figure below.



29. Based on this tree:

- A. Ratites and tinamous are both monophyletic groups
- B. Ratites are a monophyletic group, but tinamous are not
- C. **Tinamous are a monophyletic group, but ratites are not**
- D. Neither ratites nor tinamous are monophyletic

30. Assuming ratites had an ancestor which could fly:

- A. Flight must have been lost more than once during the evolution of ratites
- B. Flight must have been regained by an ancestor of the tinamous
- C. Both A and B must be true
- D. **Either A or B must be true, but we can't tell which one**

31. A researcher wants to test the effects of a vitamin-enhanced diet on mice. The researcher puts 4 mice each in six different cages. Three of the cages are supplied with a regular diet, and three with an enhanced diet.

a) Why does the researcher give some mice a regular diet, if the purpose is to test the enhanced diet? How will the results from the group with a regular diet be used (2 points)?

The mice with a regular diet are a control group. Their results will be used to make sure the mice are progressing as expected without vitamins, and to compare with the results from the treatment group.

One point for control group. One point for comparison.

b) How many independent replicates are there in each of the experimental groups (i.e., control and treatment)? Explain your answer (2 points).

Mice in a single cage should not be considered as independent. They share something with each other (the cage) which is not the experimental variable and which they don't share with other mice. The cages here are the experimental replicates. There are three in each group, or six total.

One point for the idea that replicates are cages and not mice. One point for the correct answer.

32. You are asked to construct a phylogeny that reflects the evolutionary history of four species. Compared to a known outgroup, Species 1 has derived characters A and B. Species 2 has derived characters A, F, G. Species 3 has derived characters A, B and E. Species 4 has derived characters A, C, D, E, F, G.

a) What approach should you use to construct this phylogeny? (1 point)

The cladistic approach.

b) What feature of the data led you to choose this approach? (1 point)

We have information about derived traits, so we can use a cladistic approach. We use the cladistic approach when we can because it is better than the phenetic approach.

The relevant feature of the data is that we have information about derived traits.

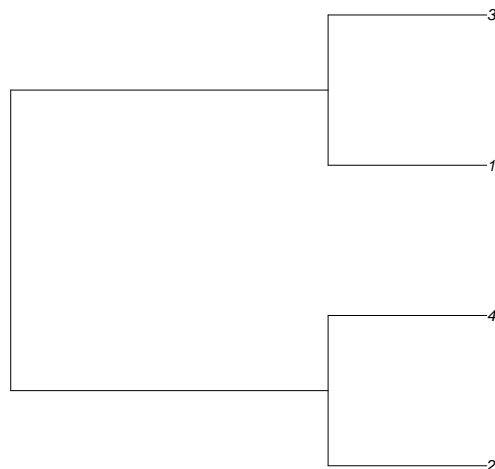
c) Which of the traits above will *not* be useful in inferring the relationship between these four species? (1 point)

A is not useful because all of the four species have it. C and D are not useful on a cladistic tree because only one species has them.

Half mark for each set. No deduction for saying E is not useful (it doesn't turn out to be useful).

d) Draw a tree to show what phylogeny you would infer from these data. Hint: simplify by using the answer from c). You don't need to mark traits on the tree. (2 points)

We first group 2 and 4, because they share two synapomorphies (F and G, if we ignore A). 3 shares a relevant synapomorphy (B) with 1. It doesn't share any synapomorphies with the *group* 2 and 4, so we group it with 1.



One point for correctly grouping 2 and 4. Second point if the whole tree is right. No points or deductions for traits or outgroups.

33. Red-yellow birds have R and Y alleles at a locus that determines their color. Birds with RR are red, birds with YY are yellow and birds with RY are orange? Researchers study a particular population and find 15 red birds, 30 orange birds and 5 yellow birds.

a) What type of dominance is seen in the R allele (1 point)?

Co-dominance. Incomplete dominance or neither allele dominant also acceptable.

b) What are the *genotype* frequencies of the birds in this population (1 point)?

15/50, 30/50, 5/50. Equivalently 30%, 60%, 10%.

Full marks for correct answer, otherwise half a point for clear, correct work.

c) What are the *allele* frequencies of the birds in this population (2 points)?

There are $2 \cdot 15 + 30 = 60$ R alleles and $30 + 2 \cdot 5 = 40$ Y alleles, so the frequencies are 0.6 and 0.4.

Full marks for correct answer, otherwise 1 point for clear, correct work.

d) What are the Hardy-Weinberg *expected* genotype frequencies for these allele frequencies (2 points)?

The expected frequencies are $RR : p^2 = 0.36$, $RY : 2pq = 0.48$, $YY : q^2 = 0.16$.

Full marks for correct answer, otherwise 1 point for clear, correct work.