

1) Directional selection on a quantitative trait is represented by a:

- a) linear fitness function
- b) u-shaped fitness function
- c) inverted u-shaped fitness function
- d) fluctuating fitness function
- e) none of the above

2) In a large population of stellate dung beetles, you measure five different traits that have continuous distributions, and estimate the following variance components:

	Additive genetic	Dominance genetic	Environmental
horn length	46.5	15.6	248.1
elytra length	73.0	365.2	292.2
pronotum width	42.4	10.6	53.0
head width	51.3	17.4	118.6
femur length	16.5	18.2	67.3

Which trait has the highest heritability?

- a) horn length
- b) elytra length
- c) pronotum width
- d) head width
- e) femur length

3) You are conducting a long-term study of the grackles (birds) on the UH campus. After a particularly hot summer, the population is much smaller because many birds have died. Because you have marked all birds individually as part of your study, you know the distribution of several morphological characters before and after the drought. You calculate the selection differentials and selection gradients for each trait (shown below; asterisks indicate significant differentials or gradients).

trait	s	Beta
Body mass	+0.29*	-0.18
Bill length	+0.41**	+0.27*
Wing length	+0.17*	+0.32*
Tarsus length	+0.11*	+0.09

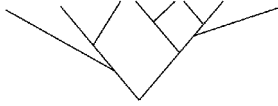
Which traits changed because of a correlated response to selection?

- a) all traits
- b) wing length
- c) bill length
- d) bill length and wing length
- e) tarsus length

4) You are trying to reconstruct the evolutionary history of the seven species given below, using the traits a - j. For each trait, x is the ancestral state, while x' is the derived state. On the basis of these characters, which pair represents sister taxa?

- |                    |               |
|--------------------|---------------|
| I a'bcdefgh'ij     | a) II and III |
| II abcdefg'hij     | b) III and IV |
| III ab'c'de'fghij' | c) III and V  |
| IV ab'cde'fghij'   | d) IV and V   |
| V abcdef'ghi'j     | e) IV and VI  |
| VI abcdef'ghij     |               |
| VII abcd'ef'ghij   |               |

5) For the phylogeny given below, how many independent contrasts are possible?



- a) five
- b) six
- c) seven
- d) eight
- e) nine

6) Which of the following is not a synapomorphy?

- a) the wings of butterflies and beetles
- b) the bony skeleton of fish and mammals
- c) the body shape of whales and sharks
- d) the horns of buffalo and the horns of antelope
- e) the hands of humans and chimpanzees

7) Males of Gunnison's Sage Grouse aggregate during the breeding season in leks where they display to females. Females chose a particular male as a mate, and after mating, go off and raise the offspring on their own. Unlike regular sage grouse, male Gunnison's sage grouse have elaborate head plumes (feathers). Females are more likely to mate with males that have longer head plumes. The most likely explanation for female preferences is:

- a) plume length indicates a high quality male
- b) plume length indicates a competitively superior male
- c) plume length indicates the amount of material benefit a female will receive
- d) plume length indicates the age of a male
- e) plume length is a signal of male territory quality

8) What is not true of traits that evolve via sensory bias?

- a) the trait has been shaped by natural selection in a different context (e.g., foraging)
- b) females prefer the trait because it leads to higher quality offspring
- c) females prefer the trait because it more strongly stimulates the female nervous system
- d) female preference for the trait evolves before males begin to use it in mating
- e) females receive no benefit from having a preference

9) Nepotism is defined as:

- a) directing help to relatives
- b) being altruistic
- c) acting in the best interests of the species
- d) increasing inclusive fitness
- e) acting as a helper

10) In Pied Kingfishers the secondary males gain most fitness by:

- a) increasing their opportunity to mate in their second year
- b) increasing their payoff from altruism during helping by being extra helpful
- c) increasing the rate of feeding of young when they are a parent
- d) maximizing the indirect component of inclusive fitness
- e) helping to raise young to whom they are highly related

11) Poison Aster is a desert plant that only occurs in soils that contain high levels of selenium, a metal that is toxic to most plants. Although poison aster can grow in soil without selenium, it never occurs there. Individuals of this species sequester the metal in their tissues. You wish to test whether sequestering the metal is an adaptation to insect predators. You perform a common garden experiment, transplanting some individuals into soil without selenium, and some back into soil with selenium. What alternate hypothesis best describes your predictions?

- a) plants that have been transplanted to soil without selenium will have greater insect damage than control plants
- b) plants that have been transplanted to soil without selenium will have lower seed production than control plants
- c) plants that have been transplanted to soil without selenium will have lower survival than control plants
- d) plants that have been transplanted to soil without selenium will have insect damage similar to control plants
- e) plants that have been transplanted to soil without selenium will have survival similar to control plants

12) Stabilizing selection on a quantitative trait:

- a) changes the mean but not the variance
- b) changes the mean and decreases the variance
- c) changes the mean and increases the variance
- d) doesn't change the mean but decreases the variance
- e) doesn't change the mean but increases the variance

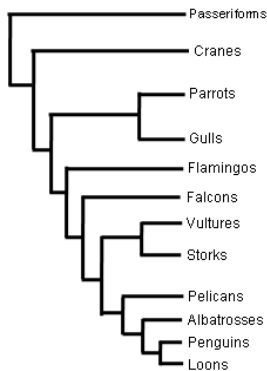
13) You are studying a population of stellate dung beetles at Brazos Bend State Park. By employing an elaborate experimental protocol, you have been able to eliminate virtually all genotype-environment covariation. You found that the covariance between fathers and male offspring in horn length was 0.45. Since these beetles use their horns in competitive interactions with other males for access to females, the length of their horn influences the number of matings they obtain. The phenotypic variance in horn length is 3.0. While you were studying the population, there was a massive die-off of females, greatly intensifying mate competition. Only those beetles that had horns that averaged 5 mm longer than the male mean were able to breed. Relative to the original population, what will be the difference in average horn length in males of this population in the next generation?

- a) 0.45 mm
- b) 0.75 mm
- c) 1.35 mm
- d) 1.50 mm
- e) 2.25 mm

14) Fur color in *Mus musculus* is controlled by two incompletely dominant alleles. Individuals that are homozygous for the  $A_1$  allele are black, individuals that are homozygous for the  $A_2$  allele are white, while heterozygotes are gray, with a chroma that is approximately 75% that of the  $A_1$  homozygotes. If the frequency of the  $A_1$  allele is 0.6, and the population is in Hardy-Weinberg equilibrium, what is the average phenotype value of the population? Assume that the phenotype values of the homozygotes are one and zero, respectively.

- a) 0.36
- b) 0.48
- c) 0.60
- d) 0.72
- e) 0.84

15) Based on the phylogeny shown below, which of the following statements is most accurate?



- a) Pelicans are more closely related to Albatrosses than Loons
- b) Vultures are more closely related to Falcons than to Pelicans
- c) Loons are more closely related to Vultures than to Storks
- d) Pelicans are more closely related to Loons than to Vultures
- e) Pelicans are more closely related to Vultures than to Loons

16) Which of the following is not an adaptation?

- a) claw size asymmetry in fiddler crabs
- b) elaborate train of the male peacock
- c) plumage pattern of grouse chicks
- d) color vision in primates
- e) changes in human height with increased nutrition

17) Yellow-headed blackbirds are sexually dimorphic. Males have a bright yellow head and a black body, while females are a uniform dull brown. You are interested in determining whether the yellow head color is important in male competition for territories. You capture males, and blacken the heads of some with hair dye, others are changed to brownish yellow with hair dye, and on still others (controls) you use blonde hair color so that the head color is unchanged. What alternate hypothesis best describes your predictions?

- a) birds with blackened heads will father fewer offspring than ones with brownish heads or controls
- b) birds with blackened heads will mate with fewer females than ones with brownish heads or controls
- c) birds with blackened heads will be less likely to hold a territory compared to ones with brownish heads or controls
- d) birds with blackened heads or brownish heads will be less likely to hold a territory compared to controls
- e) all manipulated birds, regardless of head color, will be less likely to mate than unmanipulated birds

18) What is required for the evolution of altruistic behavior?

- a) direct fitness >> indirect fitness
- b) direct fitness >> inclusive fitness
- c) indirect fitness >> direct fitness
- d) inclusive fitness >> direct fitness
- e) inclusive fitness >> indirect fitness

19) Which of the following is not a direct benefit of female choice?

- a) nuptial gift
- b) paternal care
- c) foraging territory
- d) sexy sons
- e) lower disease risk

20) Males of the Superb Bird of Paradise aggregate during the breeding season in leks where they display to females. Females chose a particular male as a mate, and after mating, go off and raise the offspring on their own. Males perform an elaborate display. Females are more likely to mate with males that have longer and more variable display. The most likely explanation for female preferences is:

- a) display complexity indicates a high quality male
- b) display length indicates a competitively superior male
- c) display complexity indicates the amount of material benefit a female will receive
- d) display length indicates the age of a male
- e) display complexity is a signal of male territory quality

21) Which of the following does not commonly show a negative phenotypic correlation (trade-off)?

- a) number of offspring, size of offspring
- b) adult size, offspring size
- c) growth rate, age at maturity
- d) lifespan, age at maturity
- e) age at maturity, clutch size

22) Shiners are small fish that live in streams. Different streams contain different suites of predators. Gobies feed on adult shiners and eat relatively few juveniles. Lancefish eat juvenile shiners; adults are too large for them to consume. Which of the following statements best describes life history variation in shiners.

- a) shiners in streams with only lancefish will have larger offspring than those in streams with only gobies
- b) shiners in streams with only gobies will have larger offspring than those in streams with only lancefish
- c) shiners in streams with only lancefish will have more offspring over their lifetime than those in streams with only gobies
- d) shiners in streams with only gobies will reproduce more often than those in streams with only lancefish
- e) shiners in streams with only lancefish will have greater reproductive effort than those in streams with only gobies

23) Traits that are important for an individual's survival or reproductive success are expected to be under strong selection. But when we assay genetic variation for such traits, they typically have some non-zero additive variance. Why?

- a) most traits are subject to density-dependent selection
- b) most traits are subject to stabilizing selection
- c) quantitative characters have a higher mutation rate because there are many loci
- d) because of environmental variance, directional selection is very weak
- e) because effective population size is usually small

24) Which of the following questions can be answered with phylogenetic information?

- a) Have the long head plumes of Gunnison's sage grouse evolved through sexual selection?
- b) Have storm petrels undergone allochronic speciation?
- c) Have growth rates of juvenile red squirrels increased with global warming?
- d) Is the bill morphology of the large cactus finch subject to disruptive selection?
- e) Do mimetic kingsnakes gain protection from predators only when sympatric with coral snakes?

25) The total variation in phenotype is equal to:

- a) genotype plus the environment
- b) the genetic variance plus the environmental variance
- c) the deviations from the population mean
- d) the standard deviation of the additive variance
- e) the number of genes which contribute to the trait

26) Size in guppies is controlled by two loci, A and B. All alleles at these loci are codominant. Which of the following populations will have the greatest additive genetic variance for size?

- a)  $A_1 = A_2 = B_1 = B_2 = 0.5$
- b)  $A_1 = B_2 = 0.7, B_1 = A_2 = 0.3$
- c)  $A_1 = B_1 = 0.6, A_2 = B_2 = 0.4$
- d)  $A_1 = A_2 = A_3 = B_1 = B_2 = B_3 = 0.333$
- e)  $A_1 = A_2 = B_1 = B_2 = 0.25, A_3 = B_3 = 0.5$

27) Male-male competition is likely to be most intense when

- a) males contribute to parental care
- b) males may have multiple mates
- c) males provide substantial resources to females
- d) males can guard territories
- e) males have large weapons

- 28) Reciprocal altruism differs from altruism because
- altruistic acts need not be distributed to kin
  - the payoff comes when “favors” are returned
  - failure to reciprocate is punished.
  - all of the above
  - none of the above
- 29) Phylogenetic analysis can be used for:
- determining which species are most closely related
  - determining cospeciation
  - determining patterns of adaptive evolution
  - all of the above
  - none of the above
- 30) What is the best way to evaluate branches in a phylogenetic tree?
- bootstrapping
  - jackknifing
  - add more taxa
  - add more characters
  - chi-square test
- 31) Sexual conflict occurs when there is
- polygyny
  - polyandry
  - promiscuity
  - polygeny
  - all of the above
- 32) In a correlated response to selection
- a pair of traits that are functionally integrated change due to selection on one of them
  - a pair of traits that are allometrically related change due to selection on one of them
  - a pair of traits that are phylogenetically related change due to selection on one of them
  - a pair of traits that are genetically correlated change due to selection on one of them
  - a pair of traits that are in different species change in a concordant manner
- 33) Which of the following statements is false?
- Additive genetic variance is affected by allele frequencies.
  - Traits that have only dominance variance cannot evolve under selection.
  - Additive variance decreases under directional selection.
  - Additive variance for most fitness-related traits is low.
  - Additive variance can be estimated by from parent-offspring regression.
- 34) Which of the following is unlikely to be a direct benefit in mate choice?
- spermatophylax
  - male territory
  - lower pathogen load
  - nuptial gift
  - better offspring

35) In the garter snakes studied by Arnold, the feeding response to slugs was highly correlated with the feeding response to leeches ( $r_G = 0.89$  in each population). Consider a population where the response to both types of prey is initially low, because both slugs and leeches are uncommon. Global warming causes an increase in rainfall with a subsequent increase in both species, while other types of prey become rarer. How do you expect the population to evolve?

- a) slugs and leeches will comprise 89% of the diet of this population
- b) snakes will begin to eat more leeches but the feeding preference will be constrained by the response to slugs
- c) snakes will begin to eat more slugs but the feeding preference will be constrained by the response to leeches
- d) the population will become extinct because the feeding response to both prey species is low
- e) the population will become extinct because all snakes will eventually eat leeches

36) In the context of adaptation, the diverse beaks of the Galapagos finches represent an example of:

- a) how adaptation is not perfection
- b) how every trait is not an adaptation
- c) how all differences between traits are not adaptations
- d) how adaptation can constrain evolution
- e) all of the above

37) In northern elephant seals, the dominant males (“beachmasters”) father the majority of all offspring. Subdominant males mate occasionally. These are likely to be:

- a) younger males
- b) older males
- c) males that resemble females
- d) males that are the sons of the dominant male
- e) males that are larger than the dominant male

38) Which of the following could not be used to estimate the heritability of a trait?

- a) the regression of average offspring on average parent
- b) the regression of sons on fathers
- c) the regression of sons on foster fathers
- d) the regression of daughters on mothers
- e) the response to selection

39) Which of the following is most likely to be an adaptation?

- a) spot pattern differences of reticulated and Masai giraffes
- b) red pigmentation of mammalian and avian blood
- c) size differences between left and right claws of fiddler crabs
- d) plumage differences among grouse chicks
- e) amount of repetitive DNA in the genome

40) In the large cactus finch, there are four distinct dry season foraging strategies. Each strategy is associated with a specific beak morphology. What is the best explanation for why the cactus finch has not differentiated into four subspecies?

- a) There is insufficient additive variance for beak morphology.
- b) There is insufficient selection on beak morphology.
- c) Selection is relaxed during the wet season
- d) Mating is random with respect to beak morphology
- e) All of the above

41) In Pfennig’s study of Batesian mimicry in kingsnakes he used three replicas—plain brown, aposematic/non-mimetic and mimetic. What was the purpose of the aposematic replica?

- a) a control for warning coloration
- b) a control for bright coloration
- c) a control for novel coloration
- d) a control for mimetic pattern
- e) a control for handling

42) Female guppies differ within and among populations in their preference for the amount of orange on a male. Orange is a carotenoid pigment that is a consequence of male diet as well as genotype. You survey a number of streams, each with a distinct population of guppies. What overall pattern is most likely?

- a) in each population males have large amounts of orange
- b) in those populations without predators, males have large amounts of orange
- c) the average amount of orange will vary among populations
- d) the average amount of orange will vary among populations and will be correlated with the average female preference
- e) all females will come to prefer orange males because this indicates male quality

43) In a mass selection experiment on tail length, the mean of the selected parents (those that reproduce) is 24 cm, while that of the entire population is 18 cm. Tail length in the offspring population is 20 cm. Which of the following statements is most accurate?

- a) The heritability is 0.5
- b) The heritability is 0.9
- c) The heritability is 0.1
- d) The heritability is 0.3
- e) You can't estimate the heritability from these data