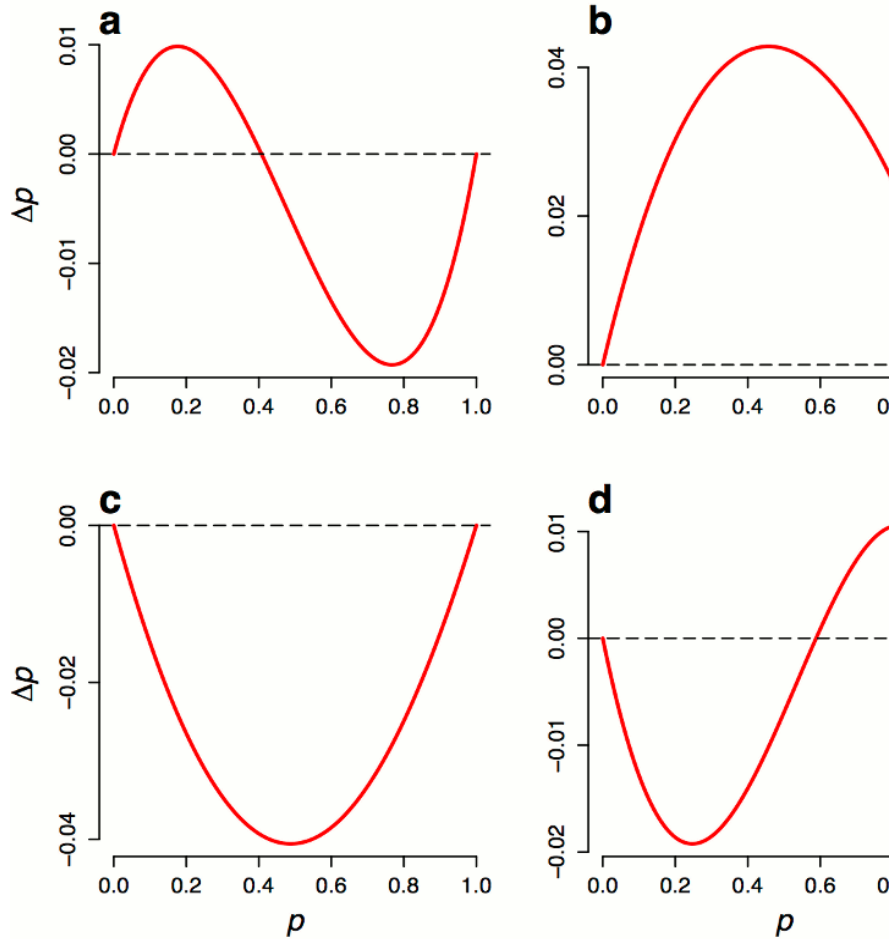


Name:

Question 1

The following figure shows four hypothetical relationships between change in the frequency of an allele ($\Delta p = p' - p$) in the next generation and its frequency in the current generation (p). The current frequency of the allele is $p = 0.4$. Under which evolutionary scenario do you expect the frequency of the allele in the next generation to be approximately unchanged ($p' = 0.4$)? Ignore genetic drift.



- a)
- b)
- c)
- d)
- e) All of them

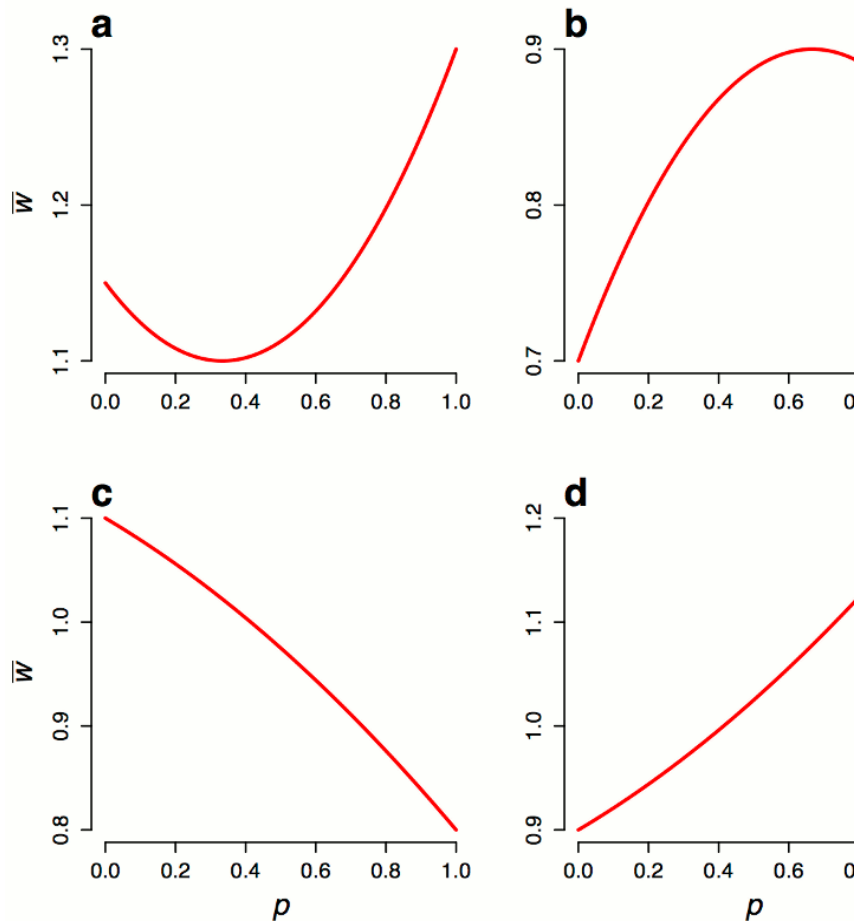
Question 2

Consider the evolutionary scenarios in the figure in previous question. In which of them is the allele deleterious?

- a)
- b)
- c)
- d)
- e) All of them

Question 3

The following figure shows four hypothetical relationships between mean fitness of a population and the frequency of an allele. The current frequency of the allele is $p = 0.9$. Under which evolutionary scenario is the allele expected to be eliminated in the future? Ignore genetic drift.



- a)
- b)
- c)
- d)
- e) All of them

Question 4

Triosephosphate isomerase (TPI) is an enzyme that plays an important role in glycolysis. In humans, there are both dominant lethal and recessive lethal mutations in the gene that encodes TPI. If the mutation rate from normal to dominant lethal TPI alleles is the same as that from normal to recessive lethal TPI alleles, and if the alleles are maintained in the human population through mutation-selection balance, what would you predict about their frequencies at equilibrium? Ignore genetic drift.

- a) Dominant lethal alleles will occur at a higher frequency than recessive lethal alleles
- b) Dominant lethal alleles will occur at a lower frequency than recessive lethal alleles
- c) Dominant lethal alleles will occur at the same frequency as recessive lethal alleles
- d) All of the above are equally likely
- e) None of the above are true

Question 5

A new neutral allele arises in a population by mutation. Which of the following statements is true?

- a) The allele is as likely to go to fixation some time in the future in a population of 10 individuals as in a population of 10,000 individuals
- b) The allele is less likely to go to fixation some time in the future in a population of 10 individuals than in a population of 10,000 individuals
- c) The allele is more likely to go to fixation some time in the future in a population of 10 individuals than in a population of 10,000 individuals
- d) None of the above is true

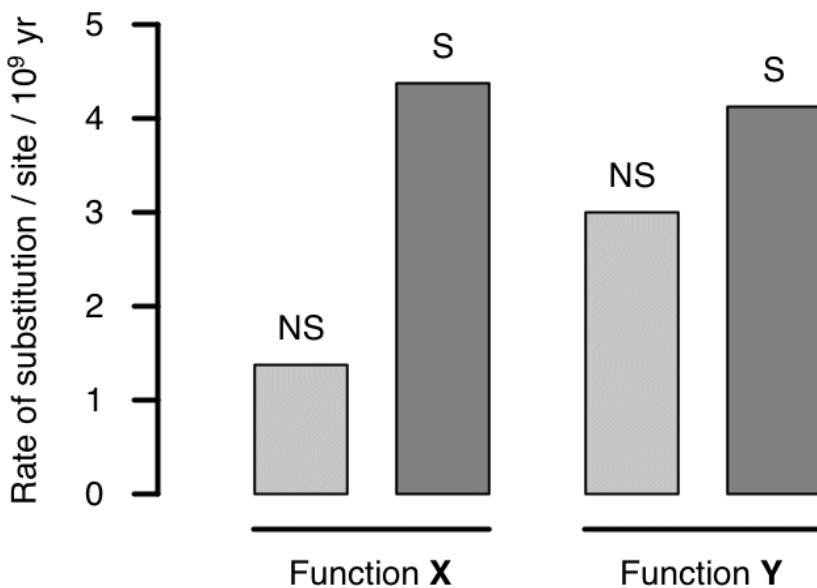
Question 6

Which of the following can lead the effective size of a population to be smaller than its census size?

- a) A constant population size from generation to generation
- b) Equal proportions of females and males
- c) Fluctuations in population size from generation to generation
- d) Random mating
- e) None of the above

Question 7

The following figure shows the average rates of nonsynonymous (NS) and synonymous (S) substitution for protein-coding genes involved in cellular functions *X* and *Y*. The estimates are based on comparisons between human and rat genes. Which of the following statements about genes involved in functions *X* and *Y* is true? (*Note:* for simplicity, we refer to "genes involved in function *X*" as "*X* genes".)

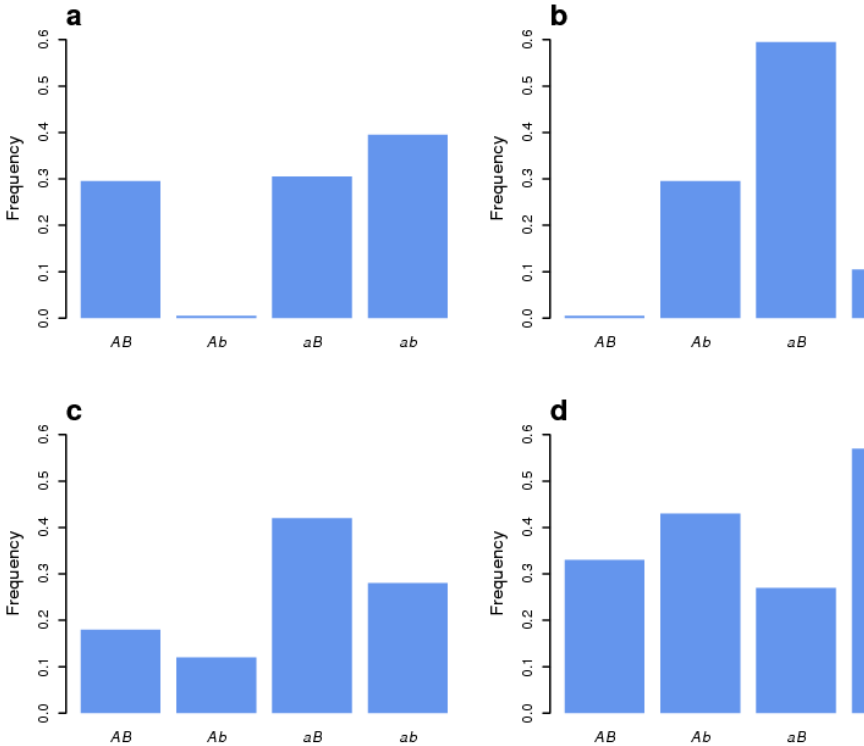


- a) Nonsynonymous mutations in *X* genes are as likely to be deleterious as nonsynonymous mutations in *Y* genes
- b) Nonsynonymous mutations in *X* genes are less likely to be deleterious than nonsynonymous mutations in *Y* genes
- c) Nonsynonymous mutations in *X* genes are more likely to be deleterious than nonsynonymous mutations in *Y* genes
- d) Synonymous mutations in *X* genes are more likely to be deleterious than nonsynonymous mutations in *Y* genes

e) Synonymous mutations in *X* genes are more likely to be deleterious than synonymous mutations in *Y* genes

Question 8

Two loci, A and B, located in chromosome III of the nematode *Caenorhabditis brenneri* have two alleles each: /A/a/ and /B/b/, respectively. You set up a laboratory population of this species with the following allele frequencies: /p_A/=0.3 and /p_B/=0.6. The /A/ allele is beneficial and the /B/ allele is neutral. You observe that the frequency of the /B/ allele remains constant over the next several generations. Which of the following were most likely to be the initial haplotype frequencies?



- a)
- b)
- c)
- d)
- e) All of them are equally likely

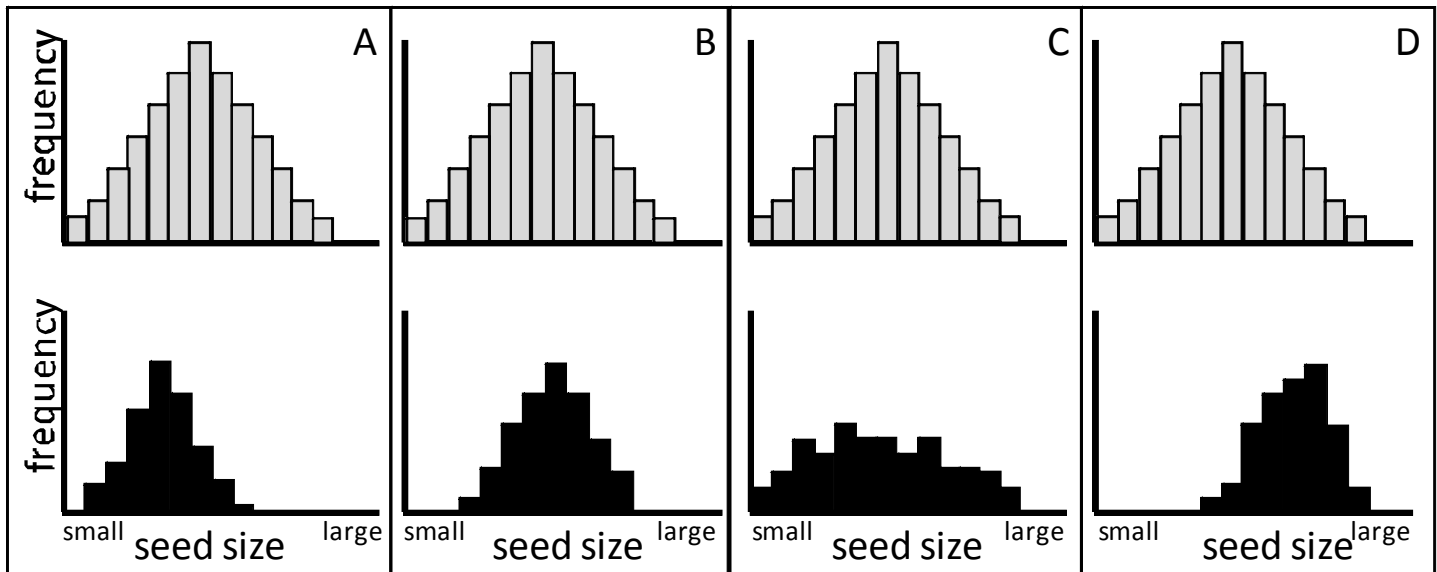
Question 9

Which of the following statements is FALSE?

- a) Heritability is a property of a population
- b) If a trait has additive variance it can be changed by selection
- c) Heritability is the proportion of phenotypic variance that is due to additive variance
- d) Only the additive genetic component can be transmitted from parents to offspring
- e) If a trait has additive variance it has no environmental variance

Question 10

In each of the figures below the gray bars represent the frequency distribution of seed sizes in *Oenothera caespitosa* before selection, and the black bars represent the distribution after a bout of selection. Which of the figures best represents directional selection in favor of larger seed size?



- a) A
- b) B
- c) C
- d) D
- e) none of the above

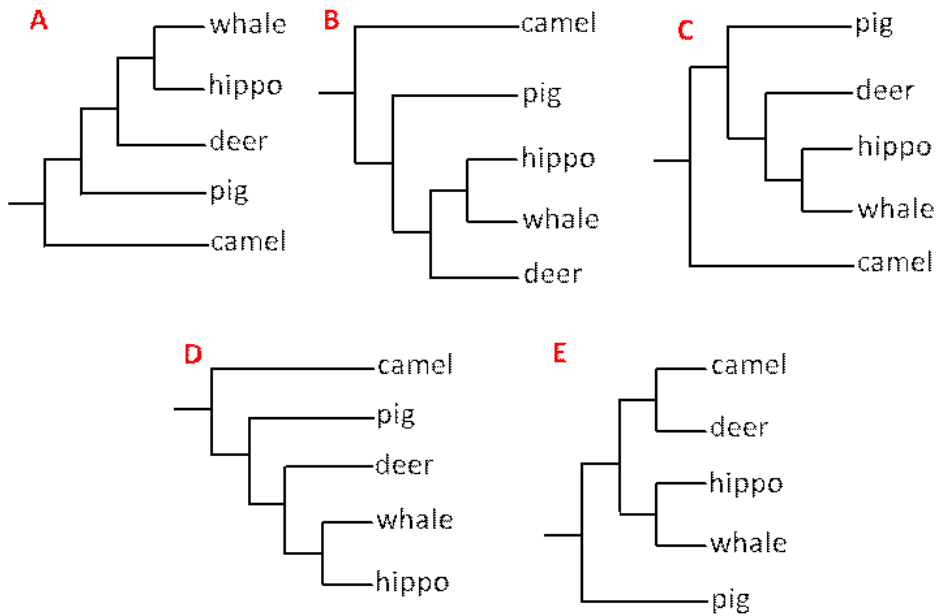
Question 11

In a population of hedgehogs, there is a genetic correlation of +0.83 between spine length and body length. Due to increased predation, hedgehogs with longer spines are more likely to survive. What change, if any, do you expect in body length?

- a) there will be no change in body length because only spines are under selection
- b) body length will increase due to a correlated response to selection
- c) the change in spine length will be constrained by the genetic correlation with body length
- d) body length will increase due to a direct response to selection
- e) none of the above

Question 12

Which of the following phylogenies does not indicate the same relationship among whales and other groups?



- a) A
- b) B
- c) C
- d) D
- e) E

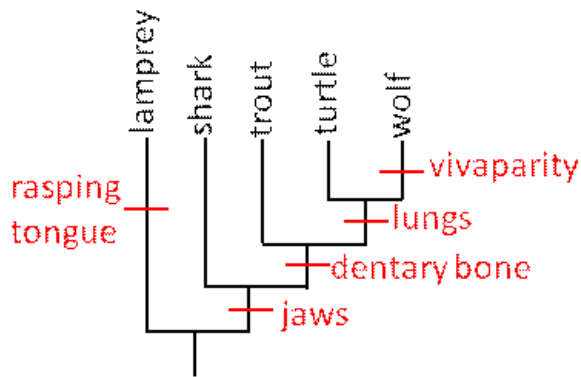
Question 13

Which of the following is NOT a synapomorphy?

- a) the ability to swim in dolphins and whales
- b) the production of milk in humans and cats
- c) the ability to fly in bats and pigeons
- d) the laying of eggs with shells in eagles and crows
- e) all of the above are synapomorphies

Question 14

The origin of five traits—a rasping tongue, jaws, the dentary bone, lungs, and viviparity—are shown on the phylogeny below.



According to the figure, which of these five traits do sharks have?

- a) a rasping tongue
- b) jaws
- c) a rasping tongue and jaws
- d) jaws, the dentary bone, lungs, and viviparity
- e) all of the traits

Question 15

Viceroy butterflies are orange and black with small white spots. Their wing color pattern is very similar to Monarch butterflies. Monarch butterflies are poisonous, but Viceroy butterflies are not. You are interested in determining whether its similar wing pattern gives Viceroy butterflies protection from predators. You capture butterflies, and change the orange color to blue on some using magic markers, others are changed to green with markers, and on still others, you use orange markers so that the color is unchanged. You release the butterflies and survey for survivors three days later. What is an appropriate null hypothesis for your experiment?

- a) butterflies with blue wings will have similar survival to ones with green or orange wings
- b) butterflies with blue or green wings will have lower survival than ones with orange wings
- c) butterflies with orange wings will have lower survival than ones with blue or green wings
- d) butterflies with orange wings will mate more than ones with blue or green wings
- e) all manipulated butterflies, regardless of wing color, will be less likely to survive than unmanipulated butterflies

Question 16

The hypothesis tested by the comparative method is that

- a) correlations are caused by similar patterns of selection
- b) correlations are caused by similar population size
- c) correlations are caused by similar genetic architecture
- d) correlations are caused by similar mutation rates
- e) correlations are caused by similar gene flow rates