Chapter 23

The Evolution of Populations

Note to the Instructor:
Some of the questions in this chapter require more time to answer than do typical questions; therefore, fewer
questions should be included in an exam period.

1) Which of the following is NOT a requirement for maintenance of Hardy-Weinberg equilibrium?
   A) an increasing mutation rate
   B) random mating
   C) large popula tion size
   D) no migra tion
   E) no na tural selection

2) In a population that is in Hardy-Weinberg equilibrium, the frequency of the allele *a* is 0.3. What is the percentage of the population that is homozygous for this allele?
   A)3
   B) 9
   C) 21
   D) 30
   E) 42

3) In a population that is in Hardy-Weinberg equilibrium, the frequency of the allele *a* is 0.3. What is the percentage of the population that is heterozygous for this allele?
   A) 3
   B) 9
   C) 21
   D) 30
   E) 42

4) The gene pool can best be described as the
   A) group of genes not described by the Hardy-Weinberg theorem.
   B) total number of gene loci that occur in each species.
   C) total aggregate of genes in a population at any time.
   D) group of genes responsible for polygenic traits.
   E) genes only found in isolated populations.

5) Gene frequencies in a gene pool may shift randomly and by chance. This is called
   A) artificial selection.
   B) adaptive radiation.
   C) climatic shift.
   D) genetic drift.
   E) natural selection.

6) Through time, the movement of people on Earth has steadily increased. This has altered the course of
   human evolution by increasing
   A) nonrandom reproduction.
   B) geographical isolation.
   C) genetic drift.
   D) mutations.
   E) gene flow.

7) Natural selection is most closely related to
   A) diploidy.
   B) gene flow.
   C) genetic drift.
   D) assortative mating.
   E) differential reproductive success.

8) Which of the following is likely to have been produced by sexual selection?
   A) a male lion's mane
   B) bright colors of female flowers
   C) the ability of desert animals to concentrate their urine
   D) different sizes of male and female pine cones
   E) camouflage colora tion in animals

9) In a Hardy-Weinberg population, the frequency of the *a* allele is 0.4. What is the frequency of
   individuals with *Aa* genotype?
   A) 0.16
   B) 0.20
   C) 0.48
   D) 0.60
   E) Cannot tell from the information provided.

10) Which of the following is one important evolutionary feature of the diploid condition?
   A) Only diploid organisms can reproduce sexually.
   B) Recombination can only occur in diploid organisms.
   C) Genes are more resistant to mutation in diploid cells.
   D) Diploid organisms express less of their genetic variability than haploid organisms.
   E) Diploid organisms are more likely to clone successfully than are haploid organisms.

11) In a population with two alleles, *A* and *a,* the frequency of *a* is 0.6. What would be the frequency of heterozygotes if the population is in Hardy-Weinberg equilibrium?
   A) 0.16
   B) 0.36
   C) 0.4
   D) 0.48
   E) 0.64

12) You sample a population of butterflies and find that 42% are heterozygous for a particular gene. What would be the frequency of the recessive allele in this population?
   A) 0.09
   B) 0.3
   C) 0.49
   D) 0.7
   E) Allele frequency cannot be estimated from this information.

13) The decrease in the size of plants on the slopes of mountains as altitudes increase is an example of
   A) a cline.
   B) a bottleneck.
   C) relative fitness.
   D) genetic drift.
   E) speciation.

14) Which of the following is the unit of evolution? In other words, which of the following can evolve in the Darwinian sense?
   A) gene
   B) chromosome
   C) individual
   D) population
   E) species

15) Natural selection tends to reduce variation in gene pools. Which process serves to balance natural
   selection by creating new alleles?
     A) meiosis
     B) sex
     C) mutation
     D) migra tion
     E) reproduction

16) In a large, sexually reproducing population, the frequency of an allele changes from 60% to 20%. From
   this change, one can most logically assume
     A) that the allele is linked to a detrimental allele.
     B) that the allele mutates readily.
     C) that random processes have changed allelic frequencies.
     D) that there is no sexual selection.
     E) that the allele reduces fitness.

17) Which factor is the most important in producing the variability that occurs in each generation of
   humans?
     A) diploidy
     B) genetic recombination
     C) genetic drift
     D) nonrandom mating
     E) natural selection

18) Most copies of harmful recessive alleles in a population are carried by individuals that are
     A) haploid.
     B) polymorphic.
     C) homozygous for the allele.
     D) heterozygous for the allele.
     E) afflicted with the disorder caused by the allele.

19) The Darwinian fitness of an individual is measured by
     A) the number of its offspring that survive to reproduce.
     B) the number of supergenes in the genotype.
     C) the number of ma tes it attracts.
     D) its physical strength.
     E) how long it lives.

20) All of the following statements about balanced polymorphism are correct EXCEPT i~
   A) is maintained by natural selection.
   B) is associated with heterogeneous environments.
   C) can be caused by frequency-dependent selection.
   D) results from the perpetuation of genetic variation.
   E) occurs in populations at Hardy-Weinberg equilibrium.

Use the following information to answer the questions below. In a hypothetical population of 1000 people, tests of blood type
genes show that 160 have the genotype AA, *480 have the genotype* AB, *and 360 have the genotype* BB.

21) What is the frequency of the *A* allele?
   A) .001
   B) .002
   C) .100
   D) .400
   E) .600

22) What is the frequency of the B allele?
   A) .001
   B) .002
   C) .100
   D) .400
   E)   .60
   0

23) What
percentage of the
population will
have type 0 blood?
   A)O
   B) 10
   C) 24
   D) 48
   E) 60

24) *H*there are 4000 children produced by this generation, how many would be expected to have AB
   blood?
   A) 960
   B) 100
   C) 1920
   D) 2000
   E) 2400

Choose among the following options to answer the following questions. Each option may be used once, more than once, or not at
all.

A. *random selection*
B. *directional selection*
C. *stabilizing selection*
D. *diversifying selection*
E. *sexual selection*

25) An African butterfly species exists in two strikingly different color patterns, each of which closely resembles other species that are distasteful to birds.

26) Brightly colored peacocks mate more frequently than do drab colored peacocks.

27) Most Swiss starlings produce 4 to 5 eggs in each clutch.

28) Fossil evidence indicates that horses have gradually increased in size over geological time.

29) The average birth weight for human babies is about 7 pounds.

30) A certain species of land snail exists as either a cream color or a solid brown color. Intermediate
individuals are relatively rare.

31) Pathogenic bacteria found in many hospitals are antibiotic resistant.

32) When we say that one organism has a greater fitness than another organism, we specifically mean
that it
A) lives longer than others of its species.
B) competes for resources more successfully than others of its species.
C) mates more frequently than others of its species.
D) utilizes resources more efficiently than other species occupying similar niches.
E) leaves more viable offspring than others of its species.

33) In peas, a gene controls flower color such that R = red and r = white. In an isolated pea pafch, there were 36 red flowers and 64 white flowers. Assuming Hardy-Weinberg equilibrium, what is the value of q for this popula tion ?

    A) .36
    B) .60
    C) .64
    D) .75
    E) .80

34) Recessive alleles in a population at Hardy-Weinberg equilibrium

    A) are not significant.
    B) remain stable indefinitely.
    C) are constantly selected against.
    D) are on a steady increase.
    E) are on a steady decrease.

35) Which term best describes a change in allelic frequencies due to an influx of new members into a popula tion?

    A) gene flow
    B) genetic drift
    C) founder effect
    D) selection
    E) convergent evolution

36) In modern terminology, diversity is understood to be a result of genetic variation. Sources of variation for evolution include all of the following EXCEPT

    A) mistakes in translation of structural genes.
    B) mistakes in DNA replication.
    C) translocations and mistakes in meiosis.
    D) recombina tion at fertiliza tion.
    E) recombination by crossing over in meiosis.

37) What is the measure of Darwinian fitness in a population?

    A) longevity in a species
    B) survival under adverse conditions
    C) the number of fertile offspring
    D) strength, in a predator
    E) fleetness, in a prey animal

Use the following information to answer the questions below. A large population of laboratory animals has been allowed to
breed randomly for a number of generations. After several generations, 49 *percent of the animals display a recessive trait* (aa),
the same percentage as at the beginning of the breeding program. The rest of the animals show the dominant phenotype, with
heterozygotes indistinguishable from the homozygous dominants.

38) What is the most reasonable conclusion that can be drawn from the fact that the frequency of the
    recessive trait *(aa)* has not changed over time?
    A) The population is undergoing genetic drift.
    B) The two phenotypes are about equally adaptive under laboratory conditions.
    C) The genotype *AA* is lethal.
    D) There has been a high rate of mutation of allele *A* to allele *e.*
    E) There has been sexual selection favoring allele *a.*

39) What is the estimated frequency of allele *a* in the gene pool?
    A) 0.70
    B) 0.51
    C) 0.49
    D) 0.30
    E) 0.07

40) What proportion of the population is probably heterozygous *(Aa)* for this trait?
    A) 0.51
    B) 0.42
    C) 0.21
    D) 0.09
    E) 0.07

41) A change in the frequencies of alleles in the gene pool of a small population arising from chance events
    is called
    A) gene flow.
    B) selection.
    C) genetic drift.
    D) mutation pressure.
    E) differential reproduction.

42) The most important missing evidence in Darwin's theory in 1859 was
    A) the source of genetic varia tion.
    B) the evidence of overproduction of offspring.
    C) the evidence that some organisms became extinct.
    D) the observation that variation is common in populations.
    E) the observation that competition exists in populations.

43) Cattle breeders have improved the quality of meat over the years by which process? .
    A) artificial selection
    B) directional selection
    C) stabilizing selection
    D) Only A and B are correct.
    E) A, B, and C are correct.

44) Which of the following is correct about a population that has a lethal recessive allele?
    A) The allele inevitably will mutate to a nonlethal state.
    B) This allele will ultimately bring about the extinction of this population.
    C) The allele eventually will be removed from the population by natural selection.
    D) The homozygous recessive genotype of this allele has a relative fitness of 0.

45) Which of the following statements best summarizes organic evolution as it is viewed today?
    A) It is goal directed.
    B) It represents the result of selection for acquired characteristics.
    C) It is synonymous with the process of gene flow.
    D) It is the descent of humans from the present-day great apes.
    E) It is the differential survival and reproduction of the most fit phenotypes.

The following questions refer to this information: In 2468, *two male space colonists and three female space colonists settle on an*
uninhabited Earthlike planet in *the Andromeda galaxy. The colonists and their offspring randomly mate for generations. All five of the original colonists had free ear lobes, and two are heterozygous for that trait. The allele for free ear lobes is dominant*
to the allele for attached ear lobes.

46) If one assumes that Hardy-Weinberg equilibrium applies to the popula tion of colonists on this planet, about how many people will have attached ear lobes when the planet's population reaches 10,000?
    A)0
    B) 400
    C) 800
    D) 1,000
    E) 10,000

47) If two of the original colonists died before they produced offspring, the ratios of genotypes could be
    quite different in the subsequent generations. This is an example of
    A) diploidy.
    B) gene flow.
    C) genetic drift.
    D) diversifying selection.
    E) stabilizing selection.

48) After many generations, the population on this planet has an unusually high frequency for the incidence of color blindness. This is most likely due to   .:
   A) the founder effect.
   B) sexual selection.
   C) coadapted genes.
   D) mutations.
   E) pleiotropy.

49) Over a period of time, the frequency of an allele in a small population decreases from 0.01 to 0.003. Which of the following might explain this change?
   A) The allele is disadvantageous when homozygous.
   B) Migrants entering the population had a lower frequency of that allele than did current members of the popula tion.
   C) One member of the population who was homozygous recessive for the allele accidentally died.
   D) A and B are correct.
   E) A, B, and C are correct.

50) Genetic recombination is a critical process in evolution. This statement is supported by the continuous
   existence of which of the following in evolving populations?
   A) sex
   B) bacterial conjugation
   C) exchange of chromosome regions in meiosis (crossing over)
   D) AandC
   E) A, B, and/ or C

51) What effect do sexual processes (meiosis and fertilization) have on the allelic frequencies in a
   popula tion?
   A) They tend to reduce the frequencies of deleterious alleles and increase the frequencies of
      advantageous ones.
   B) They tend to increase the frequencies of deleterious alleles and decrease the frequencies of
      advantageous ones.
   C) They tend to selectively combine favorable alleles into the same zygote but do not change allelic
      frequencies.
   D) They tend to increase the frequency of new alleles and decrease the frequency of old ones.
   E) They have no effect on allelic frequencies.

52) The frequency of the *a* allele in Population 1 is 0.3. The frequency of the *a* allele in Population 2 is 0.8,
and the frequency of the *a* allele in Population 3 is 0.4. For which of the following w~uld gene flow cause the greatest change in alleleic frequencies?
   A) if some members of Population 1 joined Population 3
   B) if some members of Population 3 joined Population 1
   C) if some members of Popula tion 2 joined Popula tion 3
   D) if some members of Population 2 joined Population 1
   E) if some members of Population 3 joined Population 2

The following questions utilize the following information: You are studying three populations of cardinals. Population 1 has
ten birds, of which one is brown (a recessive trait) rather than red. Population 2 has 100 birds. In that population, ten of the
birds are brown. Population 3 has 30 birds, and three of them are brown. Use the following options to answer the questions:

A. Population 1
B. Population 2
C. Population 3
D. They are all the same.
E. It is impossible to tell from the information given.

53) In which population is the frequency of the allele for brown feathers highest?

54) In which population would it be LEAST likely that an accident would significantly alter the frequency of the brown allele?

55) Which population is MOST likely to be subject to the bottleneck effect?

56) Variations in populations can be demonstrated by studying which of the following?
   A) morphological characteristics
   B) proteins
   C) DNA sequences
   D) Band C are correct.
   E) A, B, and C are correct.

57) Your friend Forrest says he is having trouble with this Hardy-Weinberg idea, and in particular the idea of assortative mating. He says, "How can you ever have an equilibrium in humans? Thejvast majority of mating is highly assortative. We prefer mates of our own race, social standing, educational
level, and ethnicity." Which of the following would be your response to Forrest?
   A) "You are correct. That is why the Hardy-Weinberg concept is only a theorem; it doesn't apply to all populations."
   B) "Although you are correct that much mating is assortative, when it comes to the Hardy-Weinberg theorem, we are concerned only with the specific genotype. So, mating can be assortative for one trait like race, while still being random for other traits like blood type."
   C) "You are correct. However, the Hardy-Weinberg theorem is relevant only to a population, and mating within populations is still random."
   D) "You may be correct. However, those things you mentioned are all nongenetic. When it comes to
   genetic traits, mating is not assortative."
   E) "Although it may appear that you are correct, the human population is so large that mating can be considered random."

58) In a population with two alleles, A and a, the frequency of A is 0.2. Organisms that are homozygous for
A die before reaching maturity. In five generations, what would be the frequency of individuals with aa genotypes?
   A) less than 0.04
   B) 0.04
   C) 0.32
   D) 0.64
   E) greater than 0.64

59) An allele in a popula tion is said to be fixed if
   A) it is the only one in the gene pool.
   B) it has a higher relative fitness compared to another allele.
   C) it is selected for in the homozygous condition.
   D) it is selected against in the homozygous condition.
   E) its frequency in the population is unchanging.

60) Gene flow is a concept best used to describe an exchange between
   A) species.
   B) males and females.
   C) popula tions.
   D) individuals.
   E) chromosomes.

61) A balanced polymorphism exists through diversifying selection in seedcracker finches from Cameroon
in which small- and large-billed birds specialize in cracking soft and hard seeds, respectively. If long-term climatic change resulted in all seeds becoming hard, what type of selection would then operate on the finch population?
A) Diversifying selection would still operate.
B) directional selection
C) stabilizing selection
D) sexual selection
E) No selection would operate because the population is in Hardy-Weinberg equilibrium.

62) You are maintaining small population of fruit flies in the laboratory by transferring the flies to a new culture bottle after each generation. After several generations, you notice that the viability of the flies has decreased greatly. A way to solve the problem might be to
A) cross your flies with flies from another lab.
B) reduce the number of flies that you transfer at each generation.
C) transfer only the largest flies.
D) change the temperature at which you rear the flies.
E) shock the flies with a brief treatment of heat or cold to make them more hardy.

63) *Cecropia* moths overwinter as pupae inside cocoons and emerge as adults ready to mate and lay eggs
on host plants such as wild cherry the following spring. It is adaptative for eggs to be laid as soon as
trees have leafed out and there is larval food available. *Cecropia* has a bimodal emergence curve. Most
adults emerge in May and probably receive a selective advantage most years. But some adults do not
emerge until later in the summer and, in years in which there are late frosts, they have the selective advantage. This bimodal emergence curve is likely maintained in the population by
A) stabilizing selection.
B) directed selection.
C) diversifying selection.
D) genetic drift.
E) mutation.

64) Which of the following is NOT a criterion for a Hardy-Weinberg equilibrium involving two alleles?
A) The frequency of all genotypes must be equal.
B) The relative fitness of all genotypes must be equal.
C) Matings must be random.
D) Populations must be large.
E) Gene flow from other populations must be zero.

65) The modem synthesis incorporates information from many areas of science. Which of the following
was totally unknown to Darwin?
   A) paleontology
   B) taxonomy
   C) biogeography
   D) geology
   E) population genetics

66) All of the following important concepts of population genetics are due to random events or chance
EXCEPT
   A) mutation.
   B) the bottleneck effect.
   C) the founder effect.
   D) natural selection.
   E) sexual recombina tion.

67) The probability of a mutation at a particular gene locus is _____ and the probability of a mutation in
the genome of a particular individual is _
   A) high; low
   B) low; high
   C) low; low
   D) high; high
   E) modera te; modera te

68) Male satin bowerbirds adorn stations called bowers with parrot feathers, flowers, and other bizarre
ornamentations in order to attract females. Females inspect the bowers and, if suitably impressed,
allow males to mate with them, after which they go off to nest by themselves. The evolution of this
behavior is best described as due to
   A) survival of the fittest.
   B) artificial selection.
   C) sexual selection.
   D) natural selection.
   E) diversifying selection.

69) Female wasps, which are protected by the use ofa painful stinger, often make their presence conspicuous by rapidly moving their usually long antennae. These wasps are often mimicked by flies
with short antennae who give the appearance of rapidly moving long antennae by waving their forelegs in front of their bodies. Which of the following statements concerning this behavior is NOT consistent with current evolutionary theory?
   A) Natural selection cannot fashion perfect organisms.
   B) The behavior of the flies may be a compromise if their short antennae are adapted for other uses.
   C) Variation in leg-waving behavior may have been present in ancestral populations and available for natural selection, while variation in antennallength may not have.
   D) Given enough time, these flies will develop longer antennae and become perfect mimics.
   E) Organism are often locked into historical genetic constraints.