Evolution Regents Practice Ms. Fazio

TEACHER ANSWER KEY March 18, 2008

4

1. The dichotomous key shown can be used to identify birds *W*, *X*, *Y*, and *Z*.

Bird X is most likely



1. Certhidea

3. Camarhynchus

4. Platyspiza

2. Geospiza

4 Bird *X* is most likely *Platyspiza*. Following the dichotomous key, bird *X* is known to have a relatively stout and heavy beak (1.b.), with a lower beak having a curved bottom surface (2.b.) and a mostly flat lower edge of the upper beak (3.b.). These characteristics indicate that bird *X* is most likely *Platyspiza*.

Wrong Choices Explained:

(1) Bird X is *not* most likely *Certhidea*. This species has a relatively long, slender beak (1.a.). Bird W closely matches these identification characteristics.

(2) Bird X is *not* most likely *Geospiza*. This species has a relatively stout and heavy beak (1.b.), with a lower beak having a flat and straight lower surface (2.a.). Bird Y somewhat matches these identification characteristics.

(3) Bird X is *not* most likely *Camarhynchus*. This species has a relatively stout and heavy beak (1.b.), with a lower beak having a curved bottom surface (2.b.) and a mostly distinctly bent lower edge of the upper beak (3.a.). Bird Z closely matches these identification characteristics.

<u>1</u>

2. The diversity within the wild bird species in the accompanying diagram can best be explained by which process?



- 1. natural selection
- 2. asexual reproduction

3. ecological succession

4. mitotic cell division

1 *Natural selection* is the process that best explains the diversity within the wild bird species illustrated in the diagram. Scientists theorize that a single ancestral finch species inhabited an isolated area with many diverse habitats and food types. As the finches reproduced over several generations, it is theorized, a number of small variations in beak shape appeared in the population as a result of mutation and recombination. Each beak shape that promoted the survival of its owner was perpetuated in the species. Over many generations, the finch varieties underwent speciation until they now represent distinct species.

WRONG CHOICES EXPLAINED

(2) *Asexual reproduction* is not the process that explains the diversity within this species. Asexual reproduction is a type of reproduction that minimizes the variations that occur within species. Birds of all species utilize sexual, not asexual, reproduction.

(3) *Ecological succession* is not the process that explains the diversity within this species. Ecological succession refers to the replacement of one plant community by another in a natural environment that has been disturbed or destroyed, eventually establishing a self-perpetuating climax stage.

(4) *Mitotic cell division* is not the process that explains the diversity within this species. Like asexual reproduction, mitotic cell division tends to maintain stability, rather than variety, in species.

<u>4</u>

3. What is the most probable reason for the increase in the percentage of variety *A* in the population of the species shown in the accompanying graph?



1. There is no chance for variety A to mate with variety *B*.

3. Variety A is less fit to survive than variety Bis.

2. There is no genetic difference between variety 4. Variety A has some adaptive advantage that A and variety B.

variety B does not have.

4 Variety A has some adaptive advantage that variety B does not have is the most probable reason for the increase in the percentage of variety A. The graph shows that, in the first generation counted, these two varieties were represented equally in this population. Over time, variety A became more and more common until in the 56th generation it represented approximately 95% of the population's members. It is likely that members of variety A display traits that make them more likely to survive under a particular set of environmental conditions than members of variety B.

WRONG CHOICES EXPLAINED

(1) There is no chance for variety A to mate with variety B is not the most probable reason for the increase in the percentage of variety A. There is no information given in the question to support this hypothesis. As members of the same species, variety A and variety B are by definition able to mate and produce fertile offspring.

(2) There is no genetic difference between variety A and variety B is not the most probable reason for the increase in the percentage of variety A. Most characteristics displayed by organisms that help to differentiate them as distinct varieties are controlled by genetic patterns such as dominance and blending inheritance. It is the very difference in these genetic patterns that creates the observed differences between these varieties.

(3) Variety A is less fit to survive than variety B is is not the most probable reason for the increase in the percentage of variety A. If this were true, members of variety A would die off, allowing variety *B* to dominate in the population.

2

4. The accompanying diagram illustrates a proposed evolutionary path of certain organisms, based on the theory of evolution.

Which statement could best be inferred from the information in this diagram?



- 1. Evolution does not involve gradual change.
- 2. Evolutionary changes can result in extinction.
- 3. Evolution begins with plants.

4. Evolution produces organisms that all fill the same niche.

2 Evolutionary changes can result in extinction is the statement that can best be inferred from the information in this diagram. The diagram illustrates an ancestral species (A) whose members undergo evolutionary change brought on by natural selection. Over time, many different species develop, but some cease to exist because of their inability to adapt to changing environmental conditions. Some of these species (C, D, H, L, O, and P) are shown to pass out of existence in the fossil record (become extinct) with no new species developing from their lines. Other species (A, B, E, F, G, I, and N) also become extinct but pass some of their traits on to one or more of the three present-day species represented by J, K, and M.

WRONG CHOICES EXPLAINED

(1) *Evolution does not involve gradual change* is not a statement that can be inferred from the information in this diagram. In fact, the opposite can be inferred. The pattern of evolution illustrated spans 100 million years, with new species arising from ancestral species *A* only 16 times in that period. This calculates to a new species arising in this line only once every 6,250,000 years. This pace of evolutionary change can be thought of as gradual.

(3) *Evolution begins with plants* is not a statement that can be inferred from the information in this diagram. There is no data in the diagram that allows this inference to be made. It is not known whether species A is a plant, an animal, or another life form.

(4) *Evolution produces organisms that all fill the same niche* is not a statement that can be inferred from the information in this diagram. There is no data in the diagram that allows this inference to be made. It can be assumed, however, that the species shown filled available environmental niches, capitalizing on whatever variations gave them an advantage in those habitats.

1

5. Which statement is best supported by fossil records?

1. Many organisms that lived in the past are now extinct.	3. The struggle for existence between organisms results in changes in populations.
2. Species occupying the same habitat have	4. Structures such as leg bones and wing bones can originate from the same type of tissue found

1 Many organisms that lived in the past are now extinct is the statement that is best supported by fossil records. Fossils are the preserved remains (or other evidence) of organisms that lived long ago. Fossils collected from different parts of the world indicate that many animal and plant species existed in the past that are not found alive today. When all members of a species are eliminated from Earth, the species is said to be extinct. Dinosaurs and cycads are among the many extinct species for which scientists have collected fossil remains and/or imprints.

WRONG CHOICES EXPLAINED

(2) The statement Species occupying the same habitat have identical environmental needs is not well supported by fossil records. A stable ecosystem contains many different species with diverse, not identical, environmental needs. Although dinosaurs and cycads inhabited the same environments, they did not have an identical set of environmental needs. The fossil record provides much direct evidence of this sort of environmental diversity.

(3) The statement The struggle for existence between organisms results in changes in populations is not well supported by fossil records. The best way to observe this phenomenon is to study the behaviors of living species populations rather than the fossils of dead organisms. By observing how the frequency of genetic traits changes over several generations in a population, the researcher can infer a relationship between selection pressures and the adaptive value of the traits being studied.

(4) The statement Structures such as leg bones and wing bones can originate from the same type of tissue found in embryos is not well supported by fossil records. The best way to observe this phenomenon is to study the embryology of living species rather than the fossils of dead organisms. By observing the development of embryonic tissues in living organisms, the researcher can infer that parts of the skeleton develop from certain types of embryonic tissues.

<u>3</u>

6. Which statement represents the major concept of the biological theory of evolution?

1. A new species moves into a habitat when another species becomes extinct.

2. Every period of time in Earth's history has its own group of organisms.

3. Present-day organisms on Earth developed from earlier, distinctly different organisms.

4. Every location on Earth's surface has its own unique group of organisms.

3 *Present-day organisms on Earth developed from earlier, distinctly different organisms* is the statement that represents the major concept of the biological theory of evolution. This statement acknowledges that living species change over many generations as selection forces in nature work to eliminate individuals of the species that are less well-adapted than other, better-adapted individuals. As time and generations pass, the characteristics of a better-adapted subgroup of the species may change to the point that the subgroup looks very different from the parent species. Examination of the fossil record shows many instances where present-day species are clearly descendants of, but different from, ancestral forms. This concept is known as the theory of natural selection.

WRONG CHOICES EXPLAINED

(1) A new species moves into a habitat when another species becomes extinct is not a statement that represents the major concept of the biological theory of evolution. Under certain circumstances, however, it may represent a concept in ecology. A habitat is a group of environmental conditions in

which a community of organisms exists. In a balanced habitat, each environmental niche (role) is inhabited by a single species. It is true that the extinction of one species from such a habitat and niche may eventually result in the introduction of a new organism into the habitat as the vacant niche is filled. However, this occurrence does not represent the theory of natural selection, which is the major concept of the biological theory of evolution.

(2) Every period of time in Earth's history has its own group of organisms is not a statement that represents the major concept of the biological theory of evolution. It is true that geologists and paleontologists can estimate the age of certain rocks based on the fossils of ancient organisms found embedded in them. However, this fact does not represent the theory of natural selection, which is the major concept of the biological theory of evolution.

(4) *Every location on Earth's surface has its own unique group of organisms* is not a statement that represents the major concept of the biological theory of evolution. It is true that each ecosystem on Earth hosts a unique community of plants and animals. However, this situation does not represent the theory of natural selection, which is the major concept of the biological theory of evolution.

<u>3</u>

7. The accompanying diagrams show the bones in the forelimbs of three different organisms.

Differences in the bone arrangements support the hypothesis that these organisms



1. are members of the same species

3. have adaptations to survive in different environments

2. may have descended from the same ancestor

4. all contain the same genetic information

3 Differences in the bone arrangements support the hypothesis that these organisms *have adaptations to survive in different environments*. A careful examination of the skeletal structures illustrated shows a similar pattern of the types and locations of bones in the forelimb. This similarity indicates that these organisms are related and share a common ancestor. It is theorized that the precise nature of these forelimbs has evolved over time as ancestral species adapted to a varied environment in different ways. Human forelimbs are specialized for grasping in a forest environment, while whale forelimbs function as flippers in a marine environment and bat forelimbs function as wings in an air environment.

WRONG CHOICES EXPLAINED

(1) These differences do not support the theory that these organisms *are members of the same species*. Although basically similar, there are clear differences in the bone structure of the forelimbs shown. These anatomical differences point to the probability that these organisms are members of different species.

(2) These differences do not support the theory that these organisms may have descended from the same ancestor. In fact, it is likely that these three organisms evolved from a common ancestor. However, it is the similarities, not the differences, in these structures that help to support this idea.
(4) These differences do not support the theory that these organisms all contain the same genetic information. The structures shown result from the unique genetic information found in each of these organisms. Because the structures are different, it is likely that the genetic information that created them is different as well.

<u>4</u>

8. Which situation would most likely result in the highest rate of natural selection?

1. reproduction of organisms by an asexual method in an unchanging environment	3. reproduction of organisms in an unchanging environment with little competition and few predators
2. reproduction of a species having a very low mutation rate in a changing environment	4. reproduction of organisms exhibiting genetic differences due to mutations and genetic recombinations in a changing environment

4 *Reproduction of organisms exhibiting genetic differences due to mutations and genetic recombinations in a changing environment* is the situation that would most likely result in the highest rate of natural selection. Genetic differences among individuals lead to many variations in the species. The changing environment provides a variety of selection pressures on the species. The combination of these factors will likely lead to a relatively rapid rate of natural selection and speciation (evolution of new species).

WRONG CHOICES EXPLAINED

(1) *Reproduction of organisms by an asexual method in an unchanging environment* is not the situation that would most likely result in the highest rate of natural selection. This is a very stable situation in which genetic variation and selection pressures are few. In this case natural selection and speciation will likely be slow or nonexistent.

(2) *Reproduction of a species having a very low mutation rate in a changing environment* is not the situation that would most likely result in the highest rate of natural selection. This is a relatively stable situation in which genetic variation is small, although selection pressures are high. In this case natural selection and speciation will likely be slow.

(3) *Reproduction of organisms in an unchanging environment with little competition and few predators* is not the situation that would most likely result in the highest rate of natural selection. This is a relatively stable situation in which selection pressures are low. In this case natural selection and speciation will likely be slow.

<u>3</u>

9. Some behaviors such as mating and caring for young are genetically determined in certain species of birds. The presence of these behaviors is most likely due to the fact that

1. birds do not have the ability to learn	3. these behaviors helped birds to survive in the past
2. individual birds need to learn to survive and reproduce	4. within their lifetimes, birds developed these behaviors

3 The presence of these behaviors is most likely due to the fact *that these behaviors helped birds to survive in the past*. Instinctive behaviors, like physical traits, are determined at least in part by genetic factors. These behaviors can be inherited and are subject to the same evolutionary forces as physical traits such as feather color.

WRONG CHOICES EXPLAINED

(1), (2), (4) Birds do not have the ability to learn, individual birds need to learn to survive and reproduce, and within their lifetimes, birds developed these behaviors are not the most likely reasons for the presence of these behaviors. The traits described in the question are identified as genetic traits. Genetic traits are not learned or acquired but are passed on from parents to offspring by the processes of meiosis and fertilization.

<u>3</u>

10. Base your answer on the diagram shown, which represents the relationships between animals in a possible canine family tree, and on your knowledge of biology.

According to the diagram, which group of organisms has the most closely related members?



- 1. cats, weasels, and wolves
- 2. bears, raccoons, and hyena dogs
- 3. jackals, foxes, and domestic dogs

4. African hunting dogs, hyena dogs, and domestic dogs

3 According to the diagram, the group of organisms that includes *jackals, foxes, and domestic dogs* has the most closely related members. The diagram shows that all three of these species share a wolflike common ancestor of relatively recent origin. This common ancestor is represented by the three-way split shown near the top of the family tree just below the representation of these three organisms. This factor indicates a close relationship among jackals, foxes, and domestic dogs.

WRONG CHOICES EXPLAINED

(1), (2), (4) The groups of organisms that include *cats*, *weasels*, *and wolves*; *bears*, *raccoons*, *and hyena dogs*; and *African hunting dogs*, *hyena dogs*, *and domestic dogs* do not have the most closely

related members. These three groupings share common ancestors but of relatively ancient origin. The family tree shows the branches leading to the organisms in these groups splitting off into distinct lines at irregular intervals, with many intervening ancestral stages separated by long periods of evolutionary time. These factors indicate more distant relationships than that described in the correct answer above.

<u>4</u>

11. Base your answer on the diagram shown, which represents the relationships between animals in a possible canine family tree, and on your knowledge of biology.

According to the canine family tree, weasels, foxes, and domestic dogs all most likely originated from the



Canine Family Tree



2. bear dog

4. Miacis

4 According to the diagram, weasels, foxes, and domestic dogs all most likely originated from *Miacis*. Although foxes and domestic dogs share a wolflike common ancestor of relatively recent origin, the weasel line split off the family tree very early and at a time before *Miacis* became extinct. Therefore, only *Miacis* could logically have been the originator (or ancestor) of the weasel line as well as that of foxes and domestic dogs.

WRONG CHOICES EXPLAINED

(1), (2), (3) According to the diagram, weasels, foxes, and domestic dogs all did not most likely originate from the *wolf*, the *bear dog*, or *Marctus*. Each of these organisms appears in the family tree long after the origin of the weasel line and so could not have been the originator (or ancestor) of the weasel.

<u>1</u>

12. When the antibiotic penicillin was first introduced, it was immediately effective in combating staphylococcus bacterial infections. After a number of years, there were outbreaks of staphylococcal infections that did not respond to treatment with penicillin. The best explanation for this situation is that

1. members of the original population of bacteria	3. the bacteria that caused the new outbreaks
that were penicillin resistant survived and	were from populations that had never been
reproduced, creating a more resistant population	exposed to penicillin
2. the bacteria that survived exposure to penicillin learned to avoid it	4. during each generation, the bacteria modified their own DNA to increase their ability to resist penicillin and passed this ability on to their

1 Members of the original population of bacteria that were penicillin-_resistant survived and reproduced, creating a more resistant population is the statement that best explains this situation. In this case, the penicillin provided an environmental selection pressure that eliminated the strains of staphylococcus bacteria susceptible to the antibiotic. A small number of bacteria having the random genetic trait of penicillin resistance were thus selected for survival under this changed set of environmental conditions. These surviving cells successfully reproduced more bacteria with this same genetic resistance.

descendants

WRONG CHOICES EXPLAINED

(2) The bacteria that survived exposure to penicillin learned to avoid it does not explain this situation. Bacteria are not mobile enough to avoid the diffusion of a chemical antibiotic in their environment. This order of life does not have the ability to learn to avoid potential toxins.
(3) The bacteria that caused the new outbreaks were from populations that had never been exposed to penicillin does not explain this situation. Controlled laboratory experiments indicate that naturally occurring colonies of staphylococcus bacteria are susceptible to penicillin.
(4) During each generation, the bacteria modified their own DNA to increase their ability to resist penicillin and passed this ability on to their descendants does not explain this situation. This order of life does not have the ability to carry out a planned alteration of its own genetic structure.

 $\overline{13}$. Which statement about the rates of evolution for different species is in agreement with the theory of evolution?

1. They are identical, since the species live on the same planet.	3. They are different, since each species has different adaptations that function within a changing environment.
2. They are identical, since each species is at risk of becoming extinct.	4. They are different, since each species has access to unlimited resources within its environment.

3 They are different, since each species has different adaptations that function within a changing environment is the statement that is in agreement with the scientific theory of evolution. Each species is subjected to mutagenic agents and environmental selection pressures at different rates and different degrees. Each species' reaction to changing selection pressures is dependent on the unique set of adaptations shared among its members. For this reason, it is extremely unlikely that two different species will evolve in identical ways.

WRONG CHOICES EXPLAINED

(1) The statement they are identical, since the species live on the same planet is not in agreement with the theory of evolution. The theory of evolution has as a central tenet the extreme variation that exists among living things on Earth. This variation has come about because each species evolves in a unique manner, leading to different evolutionary patterns.

(2) The statement they are identical, since each species is at risk of becoming extinct is not in agreement with the theory of evolution. While each species is at risk of becoming extinct, the fact that some do become extinct and others do not is an illustration of the differences among species in terms of their evolutionary patterns.

(4) The statement they are different, since each species has access to unlimited resources within its environment is not in agreement with the theory of evolution. The theory of evolution assumes a limited supply of essential resources, a condition that promotes intraspecies competition. This intraspecies competition is thought to be a major force driving evolution, selecting for survival those individuals with favorable adaptations that help them to compete for these resources.

<u>4</u>

 $\overline{14}$. Which concept is not a part of the theory of evolution?

1. Present-day species developed from earlier species.	3. Complex organisms develop from simple organisms over time.
2. Some species die out when environmental changes occur.	4. Change occurs according to the needs of an individual organism to survive.

4 Change occurs according to the needs of an individual organism to survive is a concept that is not part of the theory of evolution. The scientific theory of evolution holds that changes in living things occur not as a function of need but as a function of random mutation of the DNA in living cells. The organisms inheriting these changes are then subjected to environmental selection pressures that eliminate individuals displaying unfavorable adaptations and promote the survival of those displaying favorable adaptations.

3

WRONG CHOICES EXPLAINED

Present-day species developed from earlier species is a concept that is included in the scientific theory of evolution. All living things arise from preexisting living things by reproduction. It is a logical extension of this concept that present-day life forms have arisen from preexisting life.
 Some species die out when environmental changes occur is a concept that is included in the scientific theory of evolution. Every major environmental change affects living things in some way. When the change is significant enough, whole species may die out if they have no members with adaptations that would allow them to survive the changed conditions. This natural process, known as extinction, has played itself out many times in the history of Earth.

(3) Complex organisms develop from simple organisms over time is a concept that is included in the scientific theory of evolution. A study of the fossil record shows that ancient life forms were less complex than similar forms fossilized more recently. These are in turn less complex than related species alive today. It is assumed from these observations that evolution tends to favor increasing complexity.

1

15. The diagram (see image) shows a process that can occur during meiosis. The most likely result of this process is



1. a new combination of inheritable traits that can appear in the offspring

2. an inability to pass either of these chromosomes on to offspring

3. a loss of genetic information that will produce a genetic disorder in the offspring

4. an increase in the chromosome number of the organism in which this process occurs

1 The most likely result of this process is *a new combination of inheritable traits that can appear in the offspring*. The process illustrated is translocation. In this process, equivalent portions of two homologous chromosomes are exchanged during synapsis, increasing the likelihood that genetic combinations on the resulting strands will be altered. If these altered strands subsequently participate in fertilization, the genetic changes will be passed on to the resulting offspring.

WRONG CHOICES EXPLAINED

(2) An inability to pass either of these chromosomes on to offspring is not the most likely result of this process. The altered chromosome strands have the same chance of participating in fertilization as the unaltered strands.

(3) A loss of genetic information that will produce a genetic disorder in the offspring is not the most likely result of this process. This process does not result in the loss of genetic information. The translocated segments of these chromosomes contain the same alleles, although they may carry different specific information concerning the traits they control.

(4) An increase in the chromosome number of the organism in which this process occurs is not the most likely result of this process. This process does not result in the formation of additional chromosomes. Unless the homologous chromosomes fail to disjoin during meiosis, the number of chromosomes will not increase.

3

16. Organism X appeared on Earth much earlier than organism Y. Many scientists believe organism X appeared between 3 and 4 billion years ago, and organism Y appeared approximately 1 billion years ago. Which row in the chart shown most likely describes organisms X and Y?

Row	Organism X	Organism Y
(1)	simple multicellular	unicellular
(2)	complex multicellular	simple multicellular
(3)	unicellular	simple multicellular
(4)	complex multicellular	unicellular

3 Row (3) unicellular/simple multicellular most likely describes organisms X and Y. Fossil evidence suggests that the first unicellular organisms appeared on Earth between 3 and 4 billion years ago. It also suggests that during the subsequent 2 to 3 million years, life forms evolved only slowly to produce the first simple multicellular organisms. Finally, it suggests that complex multicellular organisms have evolved only during the last 1 billion years.

WRONG CHOICES EXPLAINED

(1), (2), (4) Rows (1) simple multicellular/unicellular, (2) complex multicellular/simple multicellular, and (4) complex multicellular/unicellular most likely do not describe organisms X and Y. These sequences are not supported by fossil evidence. See correct answer above.

2

 $\overline{17}$. Which population of organisms would be in greatest danger of becoming extinct?

1. A population of organisms having few variations living in a stable environment. 2. A population of organisms having few variations living in an unstable environment.

3. A population of organisms having many variations living in a stable environment.

4. A population of organisms having many variations living in an unstable environment.

2 A population of organisms having few variations living in an unstable environment would be in greatest danger of becoming extinct. Under these conditions, a change in environmental conditions that is beyond the capacity of the limited varieties of this population to react to may cause elimination of the species from this environment.

WRONG CHOICES EXPLAINED

(1) A population of organisms having few variations living in a stable environment would not be in greatest danger of becoming extinct. As long as the environment remains stable, the lack of variation will not come into play as a factor affecting the survival of this population because there will be few new environmental challenges to which it will have to adapt.

(3) A population of organisms having many variations living in a stable environment would not be

in greatest danger of becoming extinct. This population will have the greatest chance of survival because its many variations will enable it to adapt to environmental change in an environment that is relatively unchanging.

(4) A population of organisms having many variations living in an unstable environment would not be in greatest danger of becoming extinct. This population will presumably have the adaptations needed to respond to changes that may occur in the environment in which it lives.

1

18. The relationship of some mammals is indicated in the diagram (see image). Which statement about the African elephant is correct?



1. It is more closely related to the mammoth than 3. It is not related to the Brazilian manatee or the it is to the West African manatee.

2. It is more closely related to the West Indian manatee than it is to the mastodon.

mammoth.

4. It is the ancestor of Steller's sea cow.

1 It is more closely related to the mammoth than it is to the West African manatee is the correct statement about the African elephant. The diagram shows that the lines containing the African elephant and the West African manatee diverged in the far distant past. This fact indicates that they are less closely related than species whose lines diverged more recently. The lines containing the African elephant and the mammoth diverged relatively more recently, indicating that these species are more closely related to each other than either is to the West African manatee.

WRONG CHOICES EXPLAINED

(2) It is more closely related to the West Indian manatee than it is to the mastodon is not the correct statement about the African elephant. The lines containing the African elephant and the mastodon diverged relatively more recently, indicating that these species are more closely related to each other than either is to the West African manatee.

(3) It is not related to the Brazilian manatee or the mammoth is not the correct statement about the African elephant. The lines containing the African elephant, the Brazilian manatee, and the mammoth are all shown in the diagram to be connected, indicating that all species in the diagram shared a common ancestor in the distant past.

(4) It is the ancestor of Steller's sea cow is not the correct statement about the African elephant. The lines containing the African elephant and Steller's sea cow diverged in the relatively distant past, so these species are not in a direct line of descent. The diagram shows that Steller's sea cow became extinct at about the same time as did mammoths and mastodons and prior to the appearance of the African elephant. These facts make it impossible for the African elephant to have been the ancestor of Steller's sea cow.

<u>4</u>

19. Base your answer on the diagram (see image) and on your knowledge of biology. Letters *A* through *J* represent different species of organisms. The vertical distances between the dotted lines represent long periods of time in which major environmental changes occurred. Which species was the first to become extinct?



4 Species D was the first to become extinct, according to the information provided. Some time after species D evolved from species A, it went out of existence. The chart shows that it appeared and disappeared within the second of four evolutionary periods represented.

WRONG CHOICES EXPLAINED

(1), (2), (3) Species E, J, and C were not the first to become extinct. The chart shows that species E and C became extinct in the third evolutionary period. Species J appears in the fourth and most recent evolutionary period and is presumably still extant.

<u>2</u>

20. Base your answer on the diagram (see image) and on your knowledge of biology. Letters *A* through *J* represent different species of organisms. The vertical distances between the dotted lines represent long periods of time in which major environmental changes occurred. Which species appears to have been most successful in surviving changes in the environment over time?



1. A	3. <i>C</i>
2. <i>B</i>	4. <i>H</i>

2 Species *B* appears to have been the most successful in surviving changes in the environment over time. Species *B* appeared in the first (earliest) evolutionary period and has survived throughout the intervening periods until the present time.

WRONG CHOICES EXPLAINED

(1) Species A has not been the most successful in surviving changes in the environment over time in the sense that it has not survived until the present day. However, in terms of the number of extant species that have evolved from species A during the intervening period, species A was able to give rise to four extant species (F, G, H, and I), compared to only two extant species (B and J) in the evolutionary line of species B. In this respect, species A has proven more adaptable than species B. (3), (4) Species C and H have not been the most successful in surviving changes in the environment over time. Species C was a relatively short-lived species that appeared and disappeared within the third evolutionary period. Species H evolved only recently in the fourth evolutionary period, and its ultimate success is unknown.

<u>2</u>

21. If mitotic cell division is the only way a particular species of single-celled organism can reproduce, it is most likely that

mutations can *not* occur in this species
 the rate of evolution in this species is slower than in one that reproduces sexually

3. the number of organisms of this species in an area will remain constant

4. this species belongs to the animal kingdom

2 It is most likely that *the rate of evolution in this species is slower than in one that reproduces sexually*. Mitosis is a form of cell division that normally results in daughter cells that are genetically identical to the parent cell. Species that depend on mitosis as their primary reproductive mechanism do not experience much genetic variation and, for this reason, do not evolve as rapidly as species that employ sexual reproduction as their primary reproductive mechanism.

WRONG CHOICES EXPLAINED

(1) It is *not* most likely that *mutations can not occur in this species*. Gene mutations are random, relatively infrequent events that affect the sequence of specific nucleotides in a strand of DNA. The randomness of mutations makes it just as likely that they will occur in species that reproduce by asexual means as in species that reproduce by sexual means.

(3) It is *not* most likely that *the number of organisms of this species in an area will remain constant*. The population of a particular species in a particular area is dependent on the carrying capacity of the ecosystem, not on whether it is multicellular or unicellular or whether it reproduces by mitosis or by other means.

(4) It is *not* most likely that *this species belongs to the animal kingdom*. There are many species of unicellular protists that reproduce by mitotic cell division. There is no information given in the question that identifies the species in question as a member of the animal kingdom.

$\frac{2}{22}$. In order for new species to develop, there *must* be a change in the

- 1. temperature of the environment
- 3. genetic makeup of a population
- 2. migration patterns within a population
- 4. rate of succession in the environment

3 There must be a change in the *genetic makeup of a population* in order for new species to develop. New species differ from ancestral species in the specific genetic information contained in the nuclei of their cells. This changed genetic information results in altered physical, chemical, and behavioral characteristics that distinguish one closely related species from another. Without genetic change, evolution cannot occur.

WRONG CHOICES EXPLAINED

(1) In order for new species to develop, the *temperature of the environment* need not change. Temperature of the environment is an abiotic condition that helps to define the characteristics of a particular ecosystem. Abiotic conditions do not directly determine the formation of new species, although they may provide selection pressures that help to shape the evolutionary process.
(2) In order for new species to develop, the *migration patterns within a population* need not change. Migration is a common behavioral trait found in many species that promotes survival of the species in a changing environment. Migration does not directly determine the formation of new species, although it may contribute to the evolutionary process by isolating subpopulations of a species that can inbreed to create unique gene pools that help to differentiate a new species from its parent species.

(4) In order for new species to develop, the *rate of succession in the environment* need not change. Ecological succession is a process by which one natural community replaces another until a stable climax community becomes established. Ecological succession does not directly determine the formation of new species, although it may provide selection pressures that help to shape the evolutionary process.

4

23. Which statement is not part of the concept of natural selection?

1. Individuals that possess the most favorable variations will have the best chance of reproducing.	3. More individuals are produced than will survive.
2. Variation occurs among individuals in a population.	4. Genes of an individual adapt to a changing environment.

4 Genes of an individual adapt to a changing environment is the statement that is not part of the concept of natural selection. Nineteenth-century naturalist Charles Darwin wrote his book On the Origin of Species by Means of Natural Selection long before other scientists had discovered that the gene is the cellular component that determines variation within a species. The concept that individual organisms can adapt to changing environmental conditions by altering their physical traits is part of the long-discredited theory of "use and disuse" proposed by eighteenth-century

<u>3</u>

scientist Jean Lamarck.

WRONG CHOICES EXPLAINED

(1), (2), (3) Individuals that possess the most favorable variations will have the best chance of reproducing, Variation occurs among individuals in a population, and More individuals are produced than will survive are all statements that are consistent with Darwin's theory of natural selection. Darwin based his theory on observations he made of closely related finch species that inhabit the Galapagos Islands off the coast of Ecuador.

<u>4</u>

24. The diagram (see image) shows the evolution of some different species of flowers.

Which statement about the species is correct?



1. Species *A*, *B*, *C*, and *D* came from different ancestors.

3. Species *A*, *B*, and *C* can interbreed successfully.

2. Species *C* evolved from species *B*.

4. Species *A* became extinct.

4 Species A became extinct is the statement about the species that is correct. Extinction is the elimination of a species from existence on Earth. As time progresses from the left to the right along the time line in the diagram, species A is shown branching off the ancestral line in the relatively distant past and becoming extinct soon thereafter (as indicated by termination of the line labeled A). It is likely that the variations that distinguished species A from the ancestral line did not promote the species' survival under changing environmental conditions.

WRONG CHOICES EXPLAINED

(1) Species A, B, C, and D came from different ancestors is not the statement about the species that is correct. The branching pattern shown in the diagram is used to indicate that all four of these species share a common ancestor that existed in the far distant past. This ancestral species, indicated by the dot at the far left, existed as a single species for a relatively long time before giving rise to variations that eventually evolved into separate species A, B, C, and D.
 (2) Species C evolved from species B is not the statement about the species that is correct. Tracing back in time (toward the left in the diagram), it can be shown that the lines resulting in species B and C branched off from the ancestral line in the relatively distant past. This pattern indicates that species B and C share a common ancestor, not that species C evolved from species B.
 (3) Species A, B, and C can interbreed successfully is not the statement about the species that is correct. The diagram indicates that A, B, and C are biologically different species even though they share a common ancestor. By definition, different species cannot interbreed and produce fertile offspring. In addition, the diagram indicates that species A became extinct in the relatively distant past and so cannot interbreed with species living at the present time.

<u>2</u>

25. Base your answer on the chart and on your knowledge of biology.

According to most scientists, which sequence best represents the order of biological evolution on Earth?



1.
$$A \to B \to C$$
 3. $B \to A \to C$

 2. $B \to C \to A$
 4. $C \to A \to B$

2 $B \rightarrow C \rightarrow A$ is the sequence that best represents the order of biological evolution on Earth. The most scientific theories of biological evolution hold that early life forms were most likely simple unicellular forms (B) that were replaced by progressively more complex multicellular forms (C) until many different forms of life were present on Earth (A).

WRONG CHOICES EXPLAINED

(1), (3), (4) The sequences $A \rightarrow B \rightarrow C$, $B \rightarrow A \rightarrow C$, and $C \rightarrow A \rightarrow B$ are all incorrect because they do not follow the pattern of biological evolution described above.

<u>2</u>

 $\overline{26}$. Which factor could be the cause of the other three in an animal species?

the inability of the species to adapt to changes
 extinction of the species
 a lack of genetic variability in the species
 a decrease in the survival rate of the species

2 A lack of genetic variation in the species is the factor that could be the cause of the other three. Genetic variation provides the raw material for evolutionary change. As environmental conditions change, species with high levels of genetic variation will be those that can most readily adapt, resulting in new varieties that can withstand, or even prosper in, the changed environment.

WRONG CHOICES EXPLAINED

(1) *The inability of the species to adapt to changes* is *not* the factor that could be the cause of the other three. A species' ability to adapt is dependent on its level of genetic variation.

(3) *Extinction of the species* is *not* the factor that could be the cause of the other three. Extinction is the complete and permanent elimination of a species from the ecosphere. Extinction is the ultimate result of a species' inability to adapt to change, which in turn is dependent on its level of genetic variation.

(4) A decrease in the survival rate of the species is not the factor that could be the cause of the other three. A decrease in survival rate may represent a significant step toward the species' extinction. A reduced survival rate of a species indicates its lack of adaptability, which in turn is dependent on its level of genetic variation.

4

27. Natural selection and its evoluntionary consequences provide a scientific explanation for each of the following *except*

1. the fossil record

2. protein and DNA similarities between different organisms

- 3. similar structures among different organisms
- 4. a stable physical environment

4 *A stable physical environment* is *not* explained scientifically by natural selection and its evolutionary consequences. The relative stability of the physical environment is due to a combination of biotic and abiotic factors working together to create a dynamic equilibrium that favors evolutionary stability.

WRONG CHOICES EXPLAINED

(1) *The fossil record* is explained scientifically by natural selection and its evolutionary consequences. By studying the fossilized remains of various species in successive undisturbed layers of sedimentary rock, scientists note and can date species change over long periods of geologic time. These changes are thought to be evidence of natural selection and its evolutionary consequences.

(2), (3) *Protein and DNA similarities between different organisms* and *similar structures among different organisms* are explained scientifically by natural selection and its evolutionary consequences. Closely related organisms share common ancestors that have passed their genetic traits along from generation to generation. These organisms often display similar biochemistry and similar structures because they share a common genetic history. These similarities are thought to be evidence of natural selection and its evolutionary consequences.

<u>1</u>

28. Which factor contributed most to the extinction of many species?

- 1. changes in the environment
- 2. lethal mutations

- 3. inability to evolve into simple organisms
- 4. changes in migration patterns

1 *Changes in the environment* is the factor that contributed most to the extinction of many species. Species of modern plants, animals, and other groups of organisms represent a successful evolution of adaptations that permit survival of those species under the set of environmental conditions that exists today. As environmental conditions change, species with high levels of genetic variation will be those that can most readily adapt, resulting in new varieties that can withstand, or even prosper in, the changed environment. A reduced survival rate of a species indicates its lack of adaptability, which in turn is dependent on its level of genetic variation. Extinction is the ultimate result of a species' inability to adapt to change.

WRONG CHOICES EXPLAINED

(2) *Lethal mutations* is *not* the factor that contributed most to the extinction of many species. Gene mutations are random, relatively infrequent events that affect the sequence of specific nucleotides

in individual strands of DNA. When passed on to an offspring generation, lethal (deadly) mutations normally result in the deaths of the individual offspring that receive them before they are able to reproduce and pass on the lethal gene mutation to the next generation. For this reason, lethal mutations are not thought to result in species extinctions.

(3) *Inability to evolve into simple organisms* is *not* the factor that contributed most to the extinction of many species. Studies of the fossil record indicate that the process of evolution favors the evolution of simpler forms into more complex forms over geologic time. For this reason, inability to evolve into simpler organisms is not thought to result in species extinctions.

(4) *Changes in migration patterns* is *not* the factor that contributed most to the extinction of many species. Species survival is dependent on successful adaptation to a particular set of environmental conditions. Animal migration patterns develop and change to allow these species to avoid environmental changes that are unfavorable for their survival. For this reason, changes in migration patterns are not thought to result in species extinctions.

4

29. Meiosis and fertilization are important for the survival of many species because these two processes result in

- 1. large numbers of gametes3. cloning of superior offspring
- 2. increasingly complex multicellular organisms 4. genetic variability of offspring

4 Meiosis and fertilization are important for the survival of many species because these two processes result in *genetic variability of offspring*. Meiosis is a type of cell division in which paired alleles (genes controlling the same traits) are segregated into gametes (sex cells). Fertilization recombines allele pairs of the parents into new and unique combinations, resulting in genetic variation. Species with high levels of genetic variation will be those that can most readily adapt to changing environmental conditions, resulting in new varieties that can survive these environmental changes.

WRONG CHOICES EXPLAINED

(1) It is *not* true that meiosis and fertilization are important for the survival of many species because these two processes result in *large numbers of gametes*. The production of large numbers of gametes is an adaptation common to many species that release their gametes into the environment during the fertilization phase of reproduction. Because many of these gametes die before they can achieve fertilization, the production of large numbers of gametes helps to ensure the survival of such species. Meiosis and fertilization are just as likely to result in relatively small numbers of gametes in many internally fertilizing species.

(2) It is *not* true that meiosis and fertilization are important for the survival of many species because these two processes result in *increasingly complex multicellular organisms*. Studies of the fossil record indicate that the process of evolution favors the evolution of simpler forms into more complex forms over geologic time. Meiosis and fertilization can contribute to this slow change process over millions of years, promoting long-term species survival. However, a species' increasing complexity does not necessarily guarantee its ability to survive environmental changes.
(3) It is *not* true that meiosis and fertilization are important for the survival of many species because these two processes result in *cloning of superior offspring*. Cloning is a type of asexual reproduction in which undifferentiated cells of a parent organism are cultured to produce offspring with genetic characteristics identical to those of the parent. Meiosis and fertilization are not directly involved in cloning.

4

30. Base your answer on the accompanying diagram and on your knowledge of biology. Letters A through L represent different species of organisms. The arrows represent long periods of geologic time.

Which two species are the most closely related?



1. J and L

2. *G* and *L*

4 *F* and *G* are the species that are the most closely related, according to the information presented in the diagram. These two species share a common ancestor (D) in the relatively recent geologic past, providing ample evidence of the closeness of their biological relationship.

WRONG CHOICES EXPLAINED

(1), (2), (3) *J* and *L*, *G* and *L*, and *G* and *H* are not the species that are the most closely related, according to the information presented in the diagram. Each of these pairings indicates a separation of a greater degree than that illustrated for species F and G and therefore a reduced degree of relatedness, in evolutionary terms, compared to species F and G.

2

31. Base your answer on the accompanying diagram and on your knowledge of biology. Letters A through L represent different species of organisms. The arrows represent long periods of geologic time.

Which species was best adapted to changes that occurred in its environment over the longest period of time?



1. <i>A</i>	3. <i>C</i>

2. *B* 4. *J*

2 Species *B* is the species that, according to the diagram, was the best adapted to changes that occurred in its environment over the longest period of time. An examination of the diagram reveals that species *B* was present in the geologic record at the very beginning of the data for the species listed. Over the long time frame illustrated in the diagram, species *B* provided the genetic precursors of four additional species, yet was adaptable enough to span the entire geological period illustrated in the diagram as a distinct species.

WRONG CHOICES EXPLAINED

(1) Species *A* is *not* the species that, according to the diagram, was the best adapted to changes that occurred in its environment over the longest period of time. Although species *A* was present at the earliest time recorded in this geologic record, it was able to exist as a distinct species for only a relatively short time span, which calls its adaptability as a species into question.

(3) Species *C* is *not* the species that, according to the diagram, was the best adapted to changes that occurred in its environment over the longest period of time. Species *C* existed for only a relatively short period of time before giving rise to species *K* and *L*. It is likely that species *C* did not possess sufficient adaptability to survive a major environmental change in the environment.

(4) Species *J* is *not* the species that, according to the diagram, was the best adapted to changes that occurred in its environment over the longest period of time. Species *J* is shown as a close relative of species *B*, which appeared relatively recently in the geologic record. Its adaptability and longevity are untested at this point in its evolutionary history.

<u>1</u>

32. Base your answer on the accompanying diagram and on your knowledge of biology. Letters A through L represent different species of organisms. The arrows represent long periods of geologic time.

Which two species would most likely show the greatest similarity of DNA and proteins?



1. *B* and *J*

2. G and I

1 Species B and J are the two species that would most likely show the greatest similarity in their

DNA and proteins. The diagram indicates that species J is a close relative of species B, which appeared relatively recently in the geologic record. It is likely that a study of their genetic traits, as expressed in their DNA and the proteins that derive from it, would show many similarities.

WRONG CHOICES EXPLAINED

(2), (3), (4) Species *G* and *I*, *J* and *K*, and *F* and *L* are not the species that would most likely show the greatest similarity in their DNA and proteins. Each of these pairings compares two species that are more widely separated in the chart and share more distant common ancestors than species *B* and *J* and so would show fewer similarities than species *B* and *J*.

<u>3</u>

33. In members of a bird species living on a remote island, the greatest number of beak variations in the population would most likely be found when

1. there is a high level of competition for limited resources	3. they have a large and varied food supply
2. homeostasis is limited by a severe climate	4. they are prey for a large number of predators

3 In members of a bird species living on a remote island, the greatest number of beak variations in the population would most likely be found when *they have a large and varied food supply*. A large number of available environmental niches (in this case, a large and varied food supply) provides an opportunity for the expression of variations (in this case, beak variations) in a species where these variations might not ordinarily be expressed. The absence of selection pressures regarding food choice and availability allow many variants to be successful in this species.

WRONG CHOICES EXPLAINED

(1), (2), (4) The greatest number of beak variations in the population would *not* most likely be found when *there is a high level of competition for limited resources, homeostasis is limited by severe climate*, or *they are prey for a large number of predators*. Situations such as these provide significant selection pressures that favor the presence of favorable variations capable of enhancing survival under changed environmental conditions. In general, selection pressures such as these do not allow species the luxury of proliferating a large number of mutually successful variants but rather tend to quickly eliminate all but the variety that is successful at surviving in the altered environmental condition.

2

34. The evolutionary pathways of ten different species are represented in the accompanying diagram.

Which two species are the most closely related?



2 *E* and *I* are the two species that are most closely related. Species *E* and species *I* share a single common ancestor (species F) and therefore presumably have the greatest genetic similarity.

Wrong Choices Explained:

(1), (3), (4) *C* and *D*, *G* and *J*, and *A* and *F* are not the species pairs that are most closely related. Each of these pairings shows at least one intervening ancestral species since their evolution from a common ancestor, making their genetic similarities less likely and their relatedness more remote as compared to species E and I.

<u>3</u>

 $\overline{35}$. Which process can produce new inheritable characteristics within a multicellular species?

- 1. cloning of the zygote
- 2. mitosis in muscle cells

- 3. gene alterations in gametes
- 4. differentiation in nerve cells

3 *Gene alterations in gametes* is the process that can produce new inheritable characteristics within a multicellular species. Genes are made up of molecules of DNA, whose base sequence codes for the production of specific enzymes and structural proteins that help to determine the traits of the organism. When this base sequence is altered in the gametes (reproductive cells), it can change the traits that are passed on from one generation to the next.

Wrong Choices Explained:

(1) *Cloning in the zygote* is *not* the process that can produce new inheritable characteristics within a multicellular species. Cloning is a type of asexual reproduction in which undifferentiated cells of a parent organism are cultured to produce offspring with genetic characteristics identical to those of the parent. Cloning does not occur in a zygote and does not normally result in the production of new inheritable characteristics.

(2) *Mitosis in muscle cells* is *not* the process that can produce new inheritable characteristics within a multicellular species. Mitosis is a type of cell division in which a diploid (2n) parent cell gives rise to genetically identical diploid (2n) daughter cells. Mitosis does not normally result in the

production of new inheritable characteristics.

(4) *Differentiation in nerve cells* is *not* the process that can produce new inheritable characteristics within a multicellular species. Differentiation is a process by which cells specialize to carry out specific tasks in the body. Nerve cells are already highly specialized and are not likely to differentiate. Differentiation does not normally result in the production of new inheritable characteristics.

<u>1</u>

36. Which two processes result in variations that commonly influence the evolution of sexually reproducing species?

1. mutation and genetic recombination	3. extinction and gene replacement
2. mitosis and natural selection	4. environmental selection and selective breeding

Mutation and genetic recombination are the processes that result in variations that commonly influence the evolution of sexually reproducing species. Gene mutations are random, relatively infrequent events that affect the sequence of specific nucleotides in individual strands of DNA and therefore the traits that the genes control. Mutations may be a factor influencing evolution in sexually reproducing species when they occur in gametic tissues. Genetic recombination, which occurs during meiosis and fertilization, is a fundamental driving force for genetic variation in sexually reproducing species. In this process, homologous chromosomes contributed by the parents are recombined during fertilization, allowing new allelic combinations in the zygote leading to new varieties in the offspring.

Wrong Choices Explained:

(2) *Mitosis and natural selection* are *not* the processes that result in variations that commonly influence the evolution of sexually reproducing species. Mitosis is a type of cell division in which a diploid (2n) parent cell gives rise to genetically identical diploid (2n) daughter cells. Mitosis does not normally result in the production of new inheritable characteristics. Natural selection is a process by which species change over time in response to environmental selection pressures. Natural selection may result in evolution in sexually reproducing species.

(3) *Extinction and gene replacement* are *not* the processes that result in variations that commonly influence the evolution of sexually reproducing species. Extinction refers to the complete elimination of a species from Earth. Gene replacement refers to a laboratory process by which specific genes are removed from a chromosome and replaced by other genes. Neither process contributes significantly to evolution in a sexually reproducing species.

(4) *Environmental selection and selective breeding* are *not* the processes that result in variations that commonly influence the evolution of sexually reproducing species. Environmental selection refers to a process by which environmental conditions may cause one variety of a species to survive in greater numbers than other varieties. This process may result in evolution in sexually reproducing species. Selective breeding is a technique used by plant and animal breeders to create and perpetuate new varieties. It is unlikely to influence evolution in sexually reproducing species.

<u>3</u>

37. The accompanying illustration shows an insect resting on some green leaves.

The size, shape, and green color of this insect are adaptations that would most likely help the insect



- 1. compete successfully with all birds
- 3. hide from predators

2. make its own food

4. avoid toxic waste materials

3 The size, shape, and green color of this insect are adaptations that would most likely help the insect to *hide from predators*. Displaying these characteristics allows the insect to blend into its leafy environment. Predators such as birds would have a difficult time distinguishing the insect from its background and so would be less likely to consume it than they would if the insect contrasted with its background.

Wrong Choices Explained:

(1) The size, shape, and green color of this insect are adaptations that would *not* most likely help the insect to *compete successfully with all birds*. The term "competition" implies a situation in which two species attempt to fill the same environmental niche (role) at the same time. It is unlikely that this insect would be in competition to share environmental niches, such as food sources and living space, with all bird species.

(2) The size, shape, and green color of this insect are adaptations that would *not* most likely help the insect to *make its own food*. The manufacture of food is a process carried out by a wide array of plant species but not by animals. As an animal, this insect cannot make food for its own use.
(4) The size, shape, and green color of this insect are adaptations that would *not* most likely help the insect to *avoid toxic waste materials*. Toxic wastes may be a by-product of natural metabolic processes or may be produced by human technology. Like most animal species, this insect most likely can detect and avoid toxic wastes in its environment but would use other adaptations (e.g., antennae, wings, jointed appendages) to do so.

<u>3</u>

38. Some human body structures are represented in the accompanying diagram.

In which structures would the occurrence of mutations have the greatest effect on human evolution?



1.1 and 3

3. 3 and 6 4. 4 and 6

2. 2 and 5

3 Structures *3 and 6* are those in which the occurrence of mutations would have the greatest effect on human evolution. Structure *3* represents the ovary of the human female; structure *6* represents the testis of the human male. Both of these structures are gamete-producing organs. Only mutations received in gamete-producing cells can be passed on to successive generations and therefore contribute to the evolution of the species.

WRONG CHOICES EXPLAINED

(1), (2), (4) Structures *1 and 3, 2 and 5*, and *4 and 6* are *not* those in which the occurrence of mutations would have the greatest effect on human evolution. Structure *1* represents the brain; structure *2* represents the kidney; structure 4 represents the liver; and structure *5* represents the pancreas of the human being. All of these structures are somatic (nonreproductive) organs. Mutations received in somatic cells that make up these organs cannot be passed on to future generations because those cells do not contribute their genetic material to the reproductive process.

<u>2</u>

39. A single pair of goldfish in an aquarium produced a large number of offspring. These offspring showed variations in body shape and coloration. The most likely explanation for these variations is that the

1. offspring were adapting to different environments	3. parent fish had not been exposed to mutagenic agents
2. offspring were produced from different combinations of genes	4. parent fish had not reproduced sexually

2 The most likely explanation for these variations is that the *offspring were produced from different combinations of genes*. The sexual reproductive process provides multiple mechanisms that help to maximize opportunities for the production of new genetic combinations. This process starts with the production of male and female monoploid (n) gametes and ends with fertilization and the production of a diploid (2n) zygote.

WRONG CHOICES EXPLAINED

(1) The most likely explanation for these variations is *not* that the *offspring were adapting to different environments*. The environment described is an aquarium, in which the environment is small and nearly uniform.

(3) The most likely explanation for these variations is *not* that the *parent fish had not been exposed to mutagenic agents*. Mutations are random events that affect all living organisms. It is unlikely that these parent fish would have escaped exposure to one or more mutagenic agents.

(4) The most likely explanation for these variations is *not* that the *parent fish had not reproduced sexually*. Fish are among the classes of animals that are known to utilize sexual reproduction in the production of offspring.

<u>3</u>

40. A certain species has little genetic variation. The rapid extinction of this species would most likely result from the effect of

1. successful cloning	3. environmental change
2. gene manipulation	4. genetic recombination

3 The rapid extinction of this species would most likely result from the effect of *environmental change*. As environmental conditions in an area change, a species not well-adapted to the changed condition must either migrate away from the condition or suffer a decline in its numbers as more adaptable species move in to take its place. Eventually, the nonadaptive species can reach a point where it can no longer sustain a breeding population, at which point it becomes extinct.

WRONG CHOICES EXPLAINED

(1) The rapid extinction of this species would *not* most likely result from the effect of *successful cloning*. Cloning is a process by which nondifferentiated embryonic tissues of an adult donor organism are grown in a laboratory in an effort to create a new organism (clone) with characteristics identical to those of the adult donor. Cloning does not affect the rate of species extinction.

(2) The rapid extinction of this species would *not* most likely result from the effect of *gene manipulation*. Gene manipulation is a form of genetic engineering, which is a scientific technique that involves using restriction enzymes to snip out portions of genome of a donor organism and insert them into the genome of a recipient organism. Gene manipulation does not affect the rate of species extinction.

(4) The rapid extinction of this species would *not* most likely result from the effect of genetic recombination. Genetic recombination is a phenomenon that occurs during the process of fertilization in which homologous pairs of chromosomes that were separated during meiosis are "reunited" in the zygote (though from separate parents). Genetic recombination does not affect the rate of species extinction.

<u>1</u>

41. Which two structures of a frog would most likely have the same chromosome number?

1. skin cell and fertilized egg cell

3. kidney cell and egg cell

2. zygote and sperm cell

4. liver cell and sperm cell

1 A *skin cell and fertilized egg cell* are two structures of a frog that would most likely have the same chromosome number. Both of these cells would contain the diploid (2n) number of chromosomes. A skin cell is a diploid somatic (body) cell. A fertilized egg contains both the monoploid complement of chromosomes from the egg cell and the monoploid complement of chromosomes in the nucleus.

WRONG CHOICES EXPLAINED

(2), (3), (4) A zygote and sperm cell, a kidney cell and egg cell, and a liver cell and sperm cell are *not* two structures that would most likely have the same chromosome number. Zygotes (fertilized eggs), kidney cells, and liver cells are diploid (2n) cells, whereas sperm cells and (unfertilized) egg cells are monoploid (n) cells.

<u>3</u>

42. The accompanying diagram represents four different species of wild birds. Each species has feet with different structural adaptations.

The development of these adaptations can best be explained by the concept of



 inheritance of resistance to diseases that affect all these species
 natural selection

2. inheritance of characteristics acquired after the birds hatched from the egg

3 The development of the adaptations illustrated in the diagram can best be explained by the concept of *natural selection*. Natural selection is a theory of evolution, first advanced by Charles Darwin, that postulates that successful variations within species give members of that species a competitive advantage over others lacking the variation, allowing these members to survive more successfully within a specific environmental niche and to produce more offspring displaying the same successful variation. Over time, these successful variations accumulate in the species such that the variant becomes a separate species.

WRONG CHOICES EXPLAINED

(1) The development of the adaptations illustrated in the diagram *cannot* best be explained by the concept of *inheritance of resistance to diseases that affect all these species*. The diagrams of organisms of different species demonstrate a wide variety of form and purpose in the design and use of their feet. Disease resistance is not discussed in the question.

(2) The development of the adaptations illustrated in the diagram *cannot* best be explained by the concept of *inheritance of characteristics acquired after the birds hatched from the egg*. The view that variations can be acquired by offspring from environmental conditions within their habitat was

first advanced by Jean Lamarck and has since been disproved by competent science. (4) The development of the adaptations illustrated in the diagram *cannot* best be explained by the concept of *selective breeding*. Selective breeding is a technique used by breeders to artificially influence the production and perpetuation of favorable characteristics in farm and show animals. The species illustrated in the diagram are naturally occurring species that were not produced by selective breeding laboratory techniques.

<u>3</u>

43. The diagram below represents a nucleus containing the normal chromosome number for a species.

Which diagram bests illustrates the normal formation of a cell that contains all of the genetic information needed for growth, development, and future reproduction of this species?



3 Diagram *3* best illustrates the normal formation of a cell that contains all the genetic information needed for growth, development, and future reproduction of this species. This diagram illustrates the process of fertilization, in which a monoploid (n = 2 = < |) egg cell fuses with a monoploid (n = 2 = < |) sperm cell to produce a diploid (2n = 4 = << ||) zygote. The sperm cell and the egg cell carry one chromosome of each type (< and |) in the species.

WRONG CHOICES EXPLAINED

(1), (2), (4) Diagrams *1*, *2*, and *4* do *not* best illustrate the normal formation of a cell that contains all the genetic information needed for growth, development, and future reproduction of this species. Each of these diagrams violates the conditions by which normal fertilization would take place in this species. See correct answer above.

<u>1</u>

44. The accompanying diagram shows the effect of spraying a pesticide on a population of insects over three generations.

Which concept is represented in the diagram?



1 *Survival of the fittest* is the concept represented in the diagram. Prior to introduction of the pesticide, the light-colored variants of this insect species predominated in the population. Over three successive applications of the pesticide, the dark-colored variants became more common, indicating that the dark-colored variant is more resistant to the pesticide than the light-colored variant. The dark-colored variant, therefore, is better adapted for survival in an environment containing this pesticide.

WRONG CHOICES EXPLAINED

(2) *Dynamic equilibrium* is *not* the concept represented in the diagram. Dynamic equilibrium is a condition of steady state in living things that provides for a balance of biochemical and other factors important to the survival of living things. This diagram does not deal with balance within a living thing but with a population of living things.

(3) *Succession* is *not* the concept represented in the diagram. Ecological succession is a process by which one plant community is replaced by another until a stable and self-perpetuating climax community is created. This diagram deals with an animal, not a plant, species.

(4) *Extinction* is *not* the concept represented in the diagram. Extinction is the complete elimination of a species from the Earth, often caused by extreme environmental change. The insect species in this illustration appears to be adapting to its changed environment and increasing its numbers.

<u>3</u>

45. Meiosis and fertilization are important processes because they may most immediately result in

1. many body cells

3. genetic variation

2. immune responses

4. natural selection

3 Genetic variation may most immediately result from meiosis and fertilization. Meiosis is a type

of cell division in which the diploid (2n) number of chromosomes found in primary sex cells is reduced to the monoploid (n) number in egg cells and sperm cells; as a result of this process, half of the genetic information present in the primary sex cell is lost. During fertilization, a monoploid sperm cell from the male parent combines with a monoploid egg cell from the female parent to form a diploid zygote. The combination of genetic material in the zygote is unique and represents immediate genetic variation in the species.

WRONG CHOICES EXPLAINED

(1) *Many body cells* do not most immediately result from meiosis and fertilization. Although a zygote normally undergoes rapid mitotic cell division soon after fertilization, this does not result immediately in many cells.

(2) *Immune responses* do not most immediately result from meiosis and fertilization. Immune responses may be displayed by certain highly differentiated cells of an organism, but not an immediate result of meiosis and fertilization.

(4) *Natural selection* does not most immediately result from meiosis and fertilization. Although genetic variation is the basis for organic evolution by natural selection, this is a lengthy process requiring thousands or even millions of years to occur.

<u>2</u>

46. Information related to the organisms found on Earth during various geological time periods is represented in the chart shown.

Which statement concerning the first appearance of the organisms over the time period represented in this chart is most likely correct?



1. Life on Earth has remained the same.

2. Life on Earth has changed from primitive organisms to more complex organisms.

3. Life on Earth began with complex organisms and changed to more complex organisms.

4. Life on Earth has changed rapidly.

2 Life on Earth has changed from primitive organisms to more complex organisms is the most likely correct statement concerning the first appearance of the organisms over the time period

represented in the chart. This statement acknowledges that living species have changed over many generations as selection forces in nature have worked to eliminate individuals of the species that are less well adapted than other, better-adapted individuals. The chart shows early life forms on Earth as single-celled and simple multicellular organisms, and later forms as complex mammal and flowering plant species. Examination of the fossil record shows many instances where present-day species are clearly more complex structurally than ancestral forms.

WRONG CHOICES EXPLAINED

(1) *Life on Earth has remained the same* is not a correct statement concerning the first appearance of the organisms over the time period represented in the chart. The chart illustrates and describes a distinct change in dominant life forms on Earth over geologic time, directly contradicting the statement in this distracter.

(3) *Life on Earth began with complex organisms and changed to more complex organisms* is not a correct statement concerning the first appearance of the organisms over the time period represented in the chart. The chart shows early life forms on Earth as single-celled and simple multicellular organisms, and later forms as complex mammal and flowering plant species. This sequence illustrates a clear progression of increasing complexity of life forms.

(4) *Life on Earth has changed rapidly* is not a correct statement concerning the first appearance of the organisms over the time period represented in the chart. The chart illustrates evolutionary change over 4.6 billion years, which can be thought of as a gradual change.

<u>1</u>

47. In an area in Africa, temporary pools form where rivers flow during the rainy months. Some fish have developed the ability to use their ventral fins as "feet" to travel on land from one of these temporary pools to another. Other fish in these pools die when the pools dry up. What can be expected to happen in this area after many years?

1. The fish using ventral fins as "feet" will be present in increasing numbers.

2. "Feet" in the form of ventral fins will develop on all fish.

3. The fish using ventral fins as "feet" will develop real feet.

4. All of the varieties of fish will survive and produce many offspring.

1 The fish using ventral fins as "feet" will be present in increasing numbers would be the expected occurrence after many years. The description of this situation, though incomplete, leads us to assume that a significant reduction in available water environments has been occurring over many years. We are also led to assume that the fish species mentioned contains genetic variations including one that gives some members ("walking" fish) the ability to use their ventral fins as "feet," while other members lack this ability. Under this set of assumptions, it can be inferred that the frequency of the gene controlling this trait will increase in the gene pool since it gives "walking" fish an adaptive advantage over "nonwalking" fish.

WRONG CHOICES EXPLAINED

(2) "*Feet*" in the form of ventral fins will develop on all fish will not be the expected occurrence after many years. If we assume that this ability has developed in a single species of fish, it cannot be inferred that this same genetic change will occur spontaneously in all fish species, or even in all members of the same fish species.

(3) *The fish using ventral fins as "feet" will develop real feet* will not be the expected occurrence after many years. Real feet as found in various amphibian, reptile, bird, and mammal species are

the result of many specific genetic changes that occurred over hundreds of millions of years. It is highly unlikely that real feet will evolve within a species of fish, even if some species spontaneously develop the adaptations necessary to allow some individuals to use ventral fins to move from one pool to another.

(4) All the varieties of fish will survive and produce many offspring will not be the expected occurrence after many years. Evolutionary history shows many instances in which varieties of a species have gone out of existence. This can happen to any variety of a species whose adaptations do not give it an adaptive advantage in a changing environment. For this reason, it is unlikely that all varieties of fish will survive the assumed reduction in available water environments.

<u>3</u>

48. The accompanying diagram shows the bones in the forelimbs of two different vertebrate species.

The position and structure of these bones could best be used to make inferences about the



- 1. food preferences of these vertebrate species
- 2. intelligence of these vertebrate species
- 3. history of these vertebrate species

4. reproductive behavior of these vertebrate species

3 The position and structure of these bones could best be used to make inferences about the *history of these vertebrate species*. Because the bone structures of the forelimbs of these two species' contain virtually the same combination of bones, but specialized to accommodate the specific locomotive mechanisms used by them, it can be inferred that these species shared a common ancestor some time in the past. The degree of similarity or difference between the structures gives an indication of when this common ancestor may have lived and what it may have looked like.

WRONG CHOICES EXPLAINED

(1), (2), (4) The food preferences of these vertebrate species, intelligence of these vertebrate species, and reproductive behavior of these vertebrate species cannot be inferred solely from the position and structure of these bones. A trained biologist, however, may be able to infer these details once the exact species of cat and bird have been identified. The food preferences, relative intelligence, and reproductive behaviors of specific species of cat and bird are well known to animal behavior specialists.

<u>3</u>

49. Base your answer on the information and data table shown and on your knowledge of biology.

A biology student performed an experiment to determine which of two species of single-celled organisms would survive best when cultured together in a certain environment. The student placed 10 organisms of each species into a large test tube. Throughout the experiment, the test tube was maintained at 30°C. After the test tube was set up, the population of each species was determined each day for 5 days. The data collected are shown in the table shown.

The difference in the population sizes on the fifth day most likely resulted from

Day	Population	
	Species A	Species B
1	10	10
2	16	16
3	32	32
4	48	12
5	60	4

Data Table

1. temperature changes

3. competition between species

2. variations in light intensity

4. the buildup of nitrogen gas

3 Competition between species was most likely the cause of the difference in population sizes on the fifth day. The data set shows that both species seemed to be thriving under the conditions in the test tube habitat for the first 3 days. Then a significant downturn in the population of species B occurred even as species A continued its rapid growth pattern. We must assume that these two species were attempting to fill the same environmental niche (role) in the habitat, that some critical resource (e.g., food, space, minerals, light) required by both species became limited in that habitat, and that species A was better adapted to obtain this resource than species B in order to understand that interspecies competition was responsible for the decline in species B from Day 4 through Day 5.

WRONG CHOICES EXPLAINED

(1) *Temperature changes* are unlikely to have been the cause of the difference in population sizes on the fifth day. Although we know little about the specifics of this experimental setup, we do know that the temperature was established and maintained at 30°C for the duration of the experiment. Therefore, temperature changes cannot have been responsible for this phenomenon.
 (2), (4) *Variations in light intensity* and *the buildup of nitrogen gas* are unlikely to have been

causes of the difference in population sizes on the fifth day. The data collected shows no information concerning light intensity and nitrogen gas. We must assume that these environmental factors were held constant through the duration of the experiment. Therefore, light intensity and nitrogen gas cannot have been responsible for this phenomenon.

	Process	Explanation
(1)	extinction	adaptive characteristics of a species are not adequate
(2)	natural selection	the most complex organisms survive
(3)	gene recombination	genes are copied as a part of mitosis
(4)	mutation	overproduction of offspring takes place within a certain population

 $\underline{1}$ 50. Which process is correctly matched with its explanation?

1 *Extinction--adaptive characteristics of a species are not adequate* is the combination of process and explanation that is correctly matched. Extinction is the elimination of a species from existence on Earth. Extinction occurs when a species lacks the adaptations necessary to permit its survival under changing environmental conditions, including those created by human activity.

WRONG CHOICES EXPLAINED

(2) *Natural selection--the most complex organisms survive* is *not* the combination of process and explanation that is correctly matched. Natural selection is a theory of evolution that states that the "fittest" organisms will survive. Biological "fitness" is not necessarily the same as "most complex" because many of the most biologically successful species are unicellular and simple multicellular organisms.

(3) *Gene recombination--genes are copied as a part of mitosis* is *not* the combination of process and explanation that is correctly matched. Gene recombination is a process that occurs as a part of meiosis, or gamete production, in which the genes recombine in new arrangements resulting in new variations. By contrast, mitosis is a form of cell division in which genetic combinations tend to remain the same from generation to generation.

(4) *Mutation--overproduction of offspring takes place within a certain population* is *not* the combination of process and explanation that is correctly matched. Mutation is a process by which the genetic material is altered; mutation may result in variation within a species. Overproduction of offspring is a concept closely linked to Darwin's theory of natural selection; Darwin was unaware of mutation as a source of variation in species.

<u>4</u>

51. The great variety of possible gene combinations in a sexually reproducing species is due in part to the

- 1. sorting of genes as a result of gene replication 3. pairing of genes as a result of differentiation
- 2. pairing of genes as a result of mitosis
- 4. sorting of genes as a result of meiosis

4 The sorting of genes as a result of meiosis is responsible in part for the great variety of possible gene combinations in sexually reproducing species. During meiosis, the chromosome pairs present in the diploid (2n) primary sex cells of the parent sort themselves independently into new combinations in the monoploid (*n*) gamete. These new assortments of chromosomes (and genes) then unite with similarly new assortments from a gamete produced by the other parent to form a unique recombination in the 2n zygote. In species with several chromosome pairs, the number of possible recombinations is virtually limitless and genetic variation is ensured.

WRONG CHOICES EXPLAINED

(1) The sorting of genes as a result of gene replication is not a likely source of this variation. Gene replication is the process by which molecules of DNA create exact duplicates of themselves in the early stages of cell division. This process does not involve the sorting of genes and is not by itself a source of variation.

(2) The pairing of genes as a result of mitosis is not a likely source of this variation. Mitosis is a type of cell division in which a single parent cell divides to produce two genetically identical daughter cells. Pairing of homologous chromosomes (and the genes located on them) occurs during metaphase in mitosis, but this process is not by itself a source of variation.

(3) The pairing of genes as a result of differentiation is not a likely source of this variation. Differentiation is a process by which embryonic cells take on specialized characteristics and tasks in the adult organism. Differentiation involves the activation of certain gene pairs and the deactivation of others by a mechanism that is still poorly understood. This process does not involve the pairing of genes and is not by itself a source of variation.

3

52. The information below was printed on a calendar of important events in the field of biology.

1859 Darwin Publishes On the Origin of Species by Natural Selection

This information is most closely associated with

1. an explanation for the change in types of minerals in an area through ecological succession	3. an attempt to explain the structural similarities observed among diverse living organisms
2. the reasons for the loss of biodiversity in all habitats on Earth	4. the effect of carrying capacity on the size of populations

3 This information is most closely associated with an *attempt to explain the structural similarities* observed among diverse living organisms. Charles Darwin wrote and published his book On the Origin of Species by Means of Natural Selection to inform the public and the scientific community about his theory of evolution. This theory was based on his observations of several finch species on the Galapagos Islands. He noted that, although there was a basic similarity among these species,

each had adapted in ways that made it successful in filling a specific niche in the varied Galapagos environment. He theorized that naturally occurring variations in an ancestral finch species had been "selected" by nature because they gave some members of the species an adaptive advantage over other members of the species by promoting their survival in a particular niche.

WRONG CHOICES EXPLAINED

(1), (2), (4) This information is *not* most closely associated with *an explanation for the change in types of minerals in an area through ecological succession, the reasons for the loss of biodiversity in all habitats on Earth,* or *the effect of carrying capacity on the size of populations.* These explanations come from a body of research involving the study of the natural environment. This area of study is known as ecology.

<u>2</u>

53. The Florida panther, a member of the cat family, has a population of fewer than 100 individuals and has limited genetic variation. Which inference based on this information is valid?

These animals will begin to evolve rapidly.
 These animals will begin to evolve rapidly.
 These animals are easily able to adapt to the environment.
 Over time, these animals will become less likely to survive in a changing environment.
 Over time, these animals will become more likely to be resistant to disease.

2 Over time, these animals will become less likely to survive in a changing environment is a valid inference based on this information. A small population of animals whose members lack a significant amount of genetic variation will have difficulty surviving a major environmental change (such as destruction of their habitat by human activity). Such a population has a high probability of becoming extinct under these circumstances. Such extinctions reduce natural biodiversity and ultimately threaten human survival as well.

WRONG CHOICES EXPLAINED

(1), (3), (4) *These animals will begin to evolve rapidly; These animals are easily able to adapt to the environment;* and *Over time, these animals will become more likely to be resistant to disease* are *not* valid inferences to be drawn based on this information. For the reasons stated above, this population will have a limited ability to adapt to changing environmental conditions or evolve into new varieties with new characteristics. The gene pool of this species is simply too small and lacks sufficient variation to permit extensive change.

<u>4</u>

54. Base your answer on the information below and on your knowledge of biology.

A small village was heavily infested with mosquitoes. The village was sprayed weekly with an insecticide for a period of several months. The results of daily counts of the mosquito population are shown in the graph (see image).

Which statement best explains why some mosquitoes survived after the first spraying?



1. Some mosquitoes were adapted to the climatic 3. The spraying of the insecticide represented a change that occurred over the several-month period of spraying.

change in the environment to which all adult mosquitoes were adapted.

2. All of the mosquitoes contained DNA unique to the species.

4. A natural variation existed within the mosquito population.

4 A natural variation existed within the mosquito population is the statement that best explains why some mosquitoes survived after the first spraying. Because some mosquitoes survived while others were killed, it can be inferred that the natural variation has given some members of the mosquito population a better ability than others to tolerate the insecticide used.

WRONG CHOICES EXPLAINED

(1) Some mosquitoes were adapted to the climatic change that occurred over the several-month period of spraying is not the statement that best explains why some mosquitoes survived after the first spraying. No information is given suggesting that a climatic change occurred during this several-month period.

(2) All of the mosquitoes contained DNA unique to the species is not the statement that best explains why some mosquitoes survived after the first spraying. Although this may or may not be a true statement, it is immaterial to the question of why some mosquitoes survived the initial spraving.

(3) The spraying of the insecticide represented a change in the environment to which all adult mosquitoes were adapted is not the statement that best explains why some mosquitoes survived after the first spraying. Because many mosquitoes (approximately 4,000 mosquitoes per acre, or 80%) were killed in the first spaying, it can be inferred that *not* all adult mosquitoes were adapted to the changed environment.

2

55. Base your answer on the information below and on your knowledge of biology.

A small village was heavily infested with mosquitoes. The village was sprayed weekly with an insecticide for a period of several months. The results of daily counts of the mosquito population are shown in the graph (see image).

Which statement best explains the decreased effectiveness of the insecticide?



1. The insecticide caused mutations that resulted 3. The insecticide reacted chemically with the in immunity in the mosquito.

DNA of the mosquitoes and was destroyed.

2. Mosquitoes resistant to the insecticide lived and produced offspring.

4. All of the mosquitoes produced antibodies that activated the insecticide.

2 Mosquitoes resistant to the insecticide lived and produced offspring is the statement that best explains the decreased effectiveness of the insecticide. The graph indicates that, after the first spraying, approximately 1,000 mosquitoes per acre (about 20%) survived. Assuming that the majority of these mosquitoes came into contact with the insecticide, it can be inferred that this 20% of the original population was made up of individuals genetically resistant to the insecticide's effects. As these resistant mosquitoes reached breeding age and produced a new generation of mosquitoes, the genes for insecticide resistance became more common in the population. Over several generations this resulted in an insecticide-resistant strain of the mosquito species that could sustain itself at about 3,000 resistant mosquitoes per acre. When the insecticide was removed from the environment after day 150, the mosquito population rebounded to its original density of 5,000 mosquitoes per acre.

WRONG CHOICES EXPLAINED

(1) The insecticide caused mutations that resulted in immunity in the mosquito is not the statement that best explains the decreased effectiveness of the insecticide. It is unlikely that the insecticide would cause a mutation specific to immunity to that chemical's effects. It is highly unlikely that this same mutation would occur spontaneously in many adult mosquitoes at the same time. Mutations caused by the insecticide would not be inheritable unless they occurred in gamete-producing tissues.

(3) The insecticide reacted chemically with the DNA of the mosquitoes and was destroyed is not the statement that best explains the decreased effectiveness of the insecticide. DNA is the chemically active part of the gene. Its function is to code for the production of specific structural proteins and enzymes in the cell. DNA is not capable of neutralizing chemical insecticides.

(4) All of the mosquitoes produced antibodies that activated the insecticide is not the statement that best explains the decreased effectiveness of the insecticide. Antibodies are proteins that are manufactured by the cell in response to invasion by foreign proteins or cells. Insecticides are inorganic compounds that would not be recognized or acted on by antibodies. Even if this were possible, the data indicates that only 20%, not all, of the mosquitoes were able to resist the effects

of the insecticide.

<u>2</u>

56. Changes in the genetic code of a human can be transmitted to offspring if they occur in

1. cancer cells	3. cell membranes
2. gametes	4. antibodies

2 Changes in the genetic code of a human can be transmitted to offspring if they occur in *gametes*. Gametes (i.e., sperm and egg cells) are the only cells of the human that can transfer genetic material from one generation of a species to another. This transfer occurs during the process of fertilization.

WRONG CHOICES EXPLAINED

(1) *Cancer cells cannot* transmit changes in the genetic code to offspring. Cancer is a disorder in which abnormal cells reproduce rapidly and crowd out healthy tissues. Cancer cells do not pass genetic changes on to offspring.

(3) *Cell membranes cannot* transmit changes in the genetic code to offspring. The cell membrane surrounds the cell cytoplasm and selectively regulates the transport of materials into and out of the cell. Cell membranes do not contain genetic material.

(4) *Antibodies cannot* transmit changes in the genetic code to offspring. Antibodies are substances produced by the body that link to and destroy foreign antigens that enter the body. Antibodies do not contain genetic material.

<u>3</u>

57. Which characteristics of a population would most likely indicate the lowest potential for evolutionary change in that population?

- 1. sexual reproduction and few mutations
- 3. asexual reproduction and few mutations
- 2. sexual reproduction and many mutations
- 4. asexual reproduction and many mutations

3 Asexual reproduction and few mutations are the characteristics of a population that would most likely indicate the lowest potential for evolutionary change in that population. Biological evolution is a process driven by a combination of genetic variation and selection pressure. A principal source of genetic variation is the recombination of chromosomes that occurs during sexual reproduction; this recombination does not occur in asexually reproducing species. The other principal source of this variation is the mutation of DNA molecules (genes) located on chromosomes. If these sources of variation are not present, evolution will occur very slowly or not at all.

WRONG CHOICES EXPLAINED

(1) *Sexual reproduction and few mutations* are *not* the characteristics of a population that would most likely indicate the lowest potential for evolutionary change in that population. Sexually reproducing species show a high rate of genetic variation due to the recombination of chromosomes that occurs during meiosis and fertilization. Even with few mutations, the potential of evolutionary change in this population is relatively high.

(2) Sexual reproduction and many mutations are not the characteristics of a population that would

most likely indicate the lowest potential for evolutionary change in that population. The combination of chromosomal recombination characteristic of sexual reproduction and a high mutation rate would give this population a high potential for evolutionary change.
(4) Asexual reproduction and many mutations are not the characteristics of a population that would most likely indicate the lowest potential for evolutionary change in that population. Asexual reproduction does not permit the recombination of chromosomes, but the fact that many mutations are occurring in this population makes the potential for evolutionary change moderately high.

<u>1</u>

58. The theory of biological evolution includes the concept that

1. species of organisms found on Earth today	3. individuals may acquire physical
have adaptations not always found in earlier	characteristics after birth and pass these acquired
species	characteristics on to their offspring
2. fossils are the remains of present-day species	4. the smallest organisms are always eliminated
and were all formed at the same time	by the larger organisms within the ecosystem

1 Species of organisms found on Earth today have adaptations not always found in earlier species is a concept included in the theory of biological evolution. Biological evolution is a process driven by a combination of genetic variation and selection pressure. As new genetic variations occur in individual members of a species, some prove to provide an adaptive advantage to these individuals under a given set of environmental selection pressures. Over time, these favorable variations are likely to be perpetuated in the species through the reproductive process, giving the species an altered set of adaptations that were not present in earlier generations.

WRONG CHOICES EXPLAINED

(2) Fossils are the remains of present-day species and were all formed at the same time is not a concept included in the theory of biological evolution. The theory of biological evolution states that fossils are the preserved remains of organisms that existed in the past. Modern scientific dating techniques have confirmed that fossils have been formed continuously for billions of years, not only from the remains of species long extinct but also from those of relatively recent and still extant species.

(3) *Individuals may acquire physical characteristics after birth and pass these acquired characteristics on to their offspring* is *not* a concept included in the theory of biological evolution. The theory of biological evolution states that the only physical characteristics in species that can be passed on to succeeding generations are those that result from genetic variation. Physical characteristics acquired during the lifetime of the organism cannot be passed on to succeeding generations.

(4) *The smallest organisms are always eliminated by the larger organisms within the ecosystem* is *not* a concept included in the theory of biological evolution. The "fittest" organisms in an ecosystem are those most able to survive selection pressures, compete for limited resources, and successfully produce more individuals of the same species. Successful species are not always the largest organisms in a particular ecosystem but rather may be among the smallest.

4

59. When a particular white moth lands on a white birch tree, its color has a high adaptive value. If the birch trees become covered with black soot, the white color of this particular moth in this

environment would most likely

1. retain its adaptive value

3. change to a more adaptive black color

2. increase in adaptive value

4. decrease in adaptive value

4 If the birch trees became covered with black soot, the white color of this particular moth in this environment would most likely *decrease in adaptive value*. Prior to the discoloration of the birch trees by soot, the moth could blend in with the tree bark color and would presumably be less likely to be eaten by birds (high adaptive value). After the discoloration, the white color of the moth would make it highly visible on the blackened birch tree bark and thus visible to the birds (low adaptive value).

WRONG CHOICES EXPLAINED

(1), (2) The white color of this particular moth in this environment would *not* most likely *retain its adaptive value* or *increase in adaptive value*. The adaptive value would decrease for the reasons explained above.

(3) The white color of this particular moth in this environment would *not* most likely *change to a more adaptive black color*. Although dark variants of this moth species would have an increased likelihood of survival and would be more likely to pass their genes for dark coloration to succeeding generations, the wording of this distracter implies that the white coloration would change as a result of "need." This is a Lamarckian concept that is not supported by modern science.

<u>3</u>

60. The graph (see image) shows the populations of two species of ants. Ants of species 2 have a thicker outer covering than the ants of species 1. The outer covering of an insect helps prevent excessive evaporation of water.

Which statement would best explain the population changes shown in the graph?



1. The food sources for species 1 increased while the food sources for species 2 decreased from January through November.

2. Disease killed off species 1 beginning in May.

3. The weather was hotter and dryer than normal from April through September.

4. Mutations occurred from April through September in both species, resulting in both species becoming better adapted to the environment. **3** The weather was hotter and dryer than normal from April through September is the statement that best explains the population changes shown in the graph. The graph shows a significant decline in the population of species 1 (solid line) beginning in May and continuing to September. At the same time, the population of species 2 (dotted line) shows an increase in population. We are told that the exoskeleton of species 2 is thicker and presumably more resistant to moisture loss than the exoskeleton of species 1. A logical inference to be drawn from this data is that species 1's decline was due to the drying effects of the environment brought on by hotter weather during the observation period. The increase in the population of species 2 is unexplained but may be due to the increased availability of a common food source made more abundant by species 1's decline.

WRONG CHOICES EXPLAINED

(1) The food sources for species 1 increased while the food sources for species 2 decreased from January through November is not the statement that best explains the population changes shown in the graph. The population of species 1 declined during this period, making increased food supplies an unlikely source of the changes noted in the data.

(2) Disease killed off species 1 beginning in May is not the statement that best explains the population changes shown in the graph. Although this may have been a factor in species 1's decline, we are given no data to support such an inference. In addition, even at its lowest point, the population of species 1 in this environment was still approximately 7,000 individuals, leaving the definition of "killed off" open to question.

(4) Mutations occurred from April through September in both species, resulting in both species becoming better adapted to the environment is not the statement that best explains the population changes shown in the graph. Mutations are infrequent and random events that result in the alteration of genetic material in the cell. It is unlikely that both species would have received the same mutation within the narrow time frame shown in this data set.

3

61. A mutation occurs in the liver cells of a certain field mouse. Which statement concerning the spread of this mutation through the mouse population is correct?

1. It will spread because it is beneficial. 2. It will spread because it is a dominant gene.

3. It will not spread because it is not in a gamete.

4. It will not spread because it is a recessive gene.

3 It will not spread because it is not in a gamete is the correct statement concerning the spread of this mutation through the mouse population. A mutation that occurs in a somatic (nonreproductive) cell, such as a liver cell, can affect only that cell or cells that arise from it by mitosis. Only a mutation that occurs in a gametic (reproductive) cell can be passed on to future generations of this species.

WRONG CHOICES EXPLAINED

(1) It will spread because it is beneficial is not the correct statement concerning the spread of this mutation through the mouse population. In addition to the fact that it cannot be passed on to future generations because it did not occur in gametic tissue, there is no information given that indicates whether or not the mutation is beneficial.

(2), (4) It will spread because it is a dominant gene and It will not spread because it is a recessive gene are not correct statements concerning the spread of this mutation through the mouse population. In addition to the fact that it cannot be passed on to future generations because it did

not occur in gametic tissue, there is no information given that indicates whether the mutation is dominant or recessive. A gene's contribution to survival and reproductive success, rather than its dominance or recessiveness, determines its spread through the gene pool of a species.

<u>4</u>

62. The evolutionary pathways of seven living species are shown in the accompanying diagram.

Which two species are likely to have the most similar DNA base sequences?



3. B and C

4. C and D

1. B and G 2. E and G

4 Species pair C and D are those that are likely to have the most similar DNA base sequences. Species C and D are depicted on the chart as sharing a close common ancestor, indicating an evolutionary and genetic relationship. Because of their relatively closer relationship, a comparison of their genomes would likely show a closer correspondence of base sequences in their DNA than in that of the other pairings shown.

WRONG CHOICES EXPLAINED

(1), (2), (3) Species pairs B and G, E and G, and B and C are not those that are likely to have the most similar DNA base sequences. Each of these pairings indicates a separation of a greater degree than that illustrated for species C and D, and therefore a reduced degree of relatedness, in evolutionary terms, compared to species C and D. Because they are more distantly related than species C and D, they are likely to share fewer DNA base sequences in common than are shared by species C and D.

<u>2</u>

63. Base your answer on the information given, the accompanying diagram, and on your knowledge of biology.

The three great lakes in Africa (Victoria, Tanganyika, and Malawi) contain a greater number of fish species than any other lakes in the world. Lake Malawi alone has 200 species of cichlid fish. The diversity of cichlid species in these African lakes could have been caused by changes in water level over thousands of years. According to one hypothesis, at one time the three lakes were connected as one large lake and all the cichlids could interbreed. When the water level fell, groups of cichlids

were isolated in smaller lakes as shown in the diagram. Over time, the groups of cichlids developed genetic differences. When the water levels rose again, the isolated populations were brought back into contact. Due to significant genetic differences, these populations were unable to interbreed. Variations in water level over thousands of years resulted in today's diversity of cichlid species.

Which discovery would support this explanation of cichlid diversity? Variations in Lake Water Level



1. The water level changed little over time.

3. Differences between cichlid species are small and interbreeding is possible.

2. The local conditions in each of the small lakes 4. Once formed, the lakes remained isolated were very different.

from each other.

2 The local conditions in each of the small lakes were very different is the discovery that would support this explanation of cichlid diversity. In addition to genetic variation in species, a changing environment that increases selection pressures is thought to drive the evolutionary mechanism. If conditions in the three ancient lakes were very different in the past, these different environments could have provided different selection pressures that favored some cichlid varieties in one lake, others in the second lake, and still others in the third. Given enough time, sufficient genetic differences could have accumulated to prevent the varieties from interbreeding even when rising water levels made it possible for them to intermingle. This situation, by definition, constitutes speciation. This hypothesis could help to explain why so many different species of cichlids became established in the lake system over geological time.

WRONG CHOICES EXPLAINED

(1) The water level changed little over time is not the discovery that would support this explanation of cichlid diversity. Without physical separation, the likelihood is small that the cichlid varieties would have ceased to interbreed. If interbreeding had continued, speciation would not have occurred.

(3) Differences between cichlid species are small and interbreeding is possible is not the discovery that would support this explanation of cichlid diversity. If the cichlid varieties could have interbred successfully, speciation would not have occurred.

(4) Once formed, the lakes remained isolated from each other is not the discovery that would support this explanation of cichlid diversity. The information given indicates that all cichlid species inhabit all three lakes. It is doubtful that these species could not have migrated over land to inhabit all three lakes.

2

64. Even though the finches on the various Galapagos Islands require different biotic and abiotic factors for their survival, these finches would most likely be grouped in the same

- 1. species, but found in different habitats
- 3. species and found in the same biosphere

2. kingdom, but found in different ecological niches

4. population, but found in different ecosystems

2 Even though the finches on the various Galapagos Islands require different biotic and abiotic factors for their survival, these finches would most likely be grouped in the same *kingdom, but found in different ecological niches*. The kingdom is the broadest grouping of organisms in the biological classification system known as binomial nomenclature. The animal kingdom to which the finches belong encompasses all multicellular organisms whose cells contain centrosomes and lack cell walls. The Galapagos Islands are well known for their varied ecological niches. A large number of available environmental niches provides an opportunity for the expression of variations (in this case, "beak variations") in a species where these variations might not ordinarily be expressed. The absence of selection pressures regarding food choice and availability allow many variants to be successful in this species.

WRONG CHOICES EXPLAINED

(1), (3) These finches would *not* most likely be grouped in the *same species, but found in different habitats* or *species and found in the same biosphere*. Each finch type illustrated in the diagram constitutes a distinct and separate species capable of mating and producing fertile offspring of the same type. The various finch species cannot interbreed with each other, a fact that ensures their status as distinct species. These finch species do inhabit different habitats (living spaces) in and around the Galapagos. All organisms on Earth inhabit the same biosphere (area of Earth that supports life).

(4) These finches would *not* most likely be grouped in the *same population, but found in different ecosystems*. A population is an ecological grouping of members of the same species that inhabit the same environment at the same time. Because the various Galapagos finch types represent separate species, they cannot be classified as being in the same population. Despite their varied environmental niches and habitats, the Galapagos Islands represent a single ecosystem because the set of abiotic conditions that affect them are reasonably uniform throughout the archipelago.

4

65. Galapagos finches evolved partly due to

- 1. cloning and recombination
- 2. migration and selective breeding
- 3. mutation and asexual reproduction
- 4. variation and competition

4 Galapagos finches evolved partly because of *variation and competition*. The source of variation in species is caused by a combination of factors including mutation and recombination. The success or failure of these variations is affected by such factors as selection pressure, competition, migration, and geographical isolation. The large number of available environmental niches

provides an opportunity for the expression of variations in a species where these variations might not ordinarily be expressed.

WRONG CHOICES EXPLAINED

(1) Galapagos finches did *not* evolve partly because of *cloning and recombination*. Cloning is a technique used in modern science and so could not have contributed to formation of the finch species. Recombination of allele pairs that occurs during sexual reproduction is likely to have played a major role in this process, however.

(2) Galapagos finches did *not* evolve partly because of *migration and selective breeding*. Migration of the ancestral finch species form the mainland of South America to the Galapagos Islands played a major role in the evolution of that species into the modern-day Galapagos finches. Selective breeding is a technique used by plant and animal breeders to create and perpetuate new varieties and so could not have contributed to formation of the finch species.

(3) Galapagos finches did *not* evolve partly because of *mutation and asexual reproduction*. Mutations are random and infrequent alterations in the genetic material of the cell that undoubtedly had a role in the production of new variants in the ancestral finch population. Like all birds, finches reproduce by sexual, not asexual, means.

<u>2</u>

66. In a group of mushrooms exposed to a poisonous chemical, only a few of the mushrooms survived. The best explanation for the resistance of the surviving mushrooms is that the resistance

1. was transmitted to the mushrooms from the poisonous chemical	3. was transferred through the food web to the mushrooms
2. resulted from the presence of mutations in the mushrooms	4. developed in response to the poisonous chemical

2 The best explanation for the resistance of the surviving mushrooms is that the resistance *resulted from the presence of mutations in the mushrooms*. Gene mutations are random, relatively infrequent events that affect the sequence of specific nucleotides in individual strands of DNA and therefore the traits that the genes control. A random mutation received by one mushroom in its spore-producing tissues may be passed on to successive generations of mushrooms resulting from the mutated spore. This mutation may lie dormant for many generations until the selection factor (in this case, the poisonous chemical) is introduced into the environment, at which time the favorable phenotype of the gene can be expressed.

Wrong Choices Explained:

(1), (3), (4) The best explanation for the resistance of the surviving mushrooms is *not* that the resistance *was transmitted to the mushrooms from the poisonous chemical, was transferred through the food web to the mushrooms*, or *developed in response to the poisonous chemical*. Each of these responses implies that the mushrooms' resistance to the chemical was an acquired characteristic received from the environment of the mushrooms. Acquired characteristics cannot be passed on to future generations unless they result from mutations of reproductive tissues.

<u>3</u>

67. In an environment that undergoes frequent change, species that reproduce sexually may have an advantage over species that reproduce asexually because the sexually reproducing species produce

- 1. more offspring in each generation
- 3. offspring with more variety

2. identical offspring

4. new species of offspring in each generation

3 In an environment that undergoes frequent change, species that reproduce sexually may have an advantage over species that reproduce asexually because the sexually reproducing species produce *offspring with more variety*. The key to this variation is meiosis, the process by which male and female gametes are formed. During meiosis, homologous pairs of chromosomes are separated randomly, resulting in monoploid (*n*) gametes displaying a wide genetic variability. When male and female gametes fuse during fertilization, a diploid (2n) zygote is formed that displays a unique set of genetic phenotypes. These phenotypes may lie dormant for many generations until environmental change (a selection factor) occurs, at which time favorable phenotypes can be expressed.

Wrong Choices Explained:

(1) It is *not* true that in an environment that undergoes frequent change, species that reproduce sexually may have an advantage over species that reproduce asexually because the sexually reproducing species produce *more offspring in each generation*. Although some sexually reproducing species produce large numbers of offspring, it is the variability of those offspring, not their number, that ensures species survival during periods of environmental change.
 (2) It is *not* true that in an environment that undergoes frequent change, species that reproduce sexually may have an advantage over species that reproduce asexually because the sexually reproducing species produce *identical offspring*. Sexual reproduction is known to produce offspring with many different, not identical, characteristics.

(4) It is *not* true that in an environment that undergoes frequent change, species that reproduce sexually may have an advantage over species that reproduce asexually because the sexually reproducing species produce *new species of offspring in each generation*. It is not reasonable to assume that new species are formed in each generation. Speciation (the creation of new species) is a process that requires genetic mutation, genetic recombination, significant environmental change, geographical isolation, and long periods of time to accomplish.

<u>2</u>

68. Mutations that occur in skin or lung cells have little effect on the evolution of a species because mutations in these cells

- 1. usually lead to the death of the organism
- 3. are usually beneficial to the organism
- 2. cannot be passed on to offspring
- 4. lead to more serious mutations in offspring

2 Mutations that occur in the skin or lung cells have little effect on the evolution of a species because mutations in these cells *cannot be passed on to offspring*. Gene mutations are random, relatively infrequent events that affect the sequence of specific nucleotides in individual strands of DNA and therefore the traits that the genes control. Mutations received in somatic (nonreproductive) cells such as lung and skin cells cannot be passed on to future generations because these cells do not contribute their genetic material to the reproductive process. Only mutations received in gamete-producing cells can be passed on to successive generations.

Wrong Choices Explained:

(1), (3) It is *not* true that mutations that occur in the skin or lung cells have little effect on the evolution of a species because mutations in these cells *usually lead to the death of the organism* or *are usually beneficial to the organism*. Mutations in somatic cells may alter the functioning of these cells that may lead to either positive or negative effects on these cells. It is highly unlikely that a mutation in a single somatic cell would result either in the death of the organism or in beneficial effects to the organism.

(4) It is *not* true that mutations that occur in the skin or lung cells have little effect on the evolution of a species because mutations in these cells *lead to more serious mutations in the offspring*. Mutations that are received by a somatic cell cannot be represented in the offspring in any way. See correct answer above.

<u>3</u>

69. The teeth of carnivores are pointed and are good for puncturing and ripping flesh. The teeth of herbivores are flat and are good for grinding and chewing. Which statement best explains these observations?

1. Herbivores have evolved from carnivores.	3. The two types of teeth most likely evolved as a result of natural selection.
2. Carnivores have evolved from herbivores.	4. The two types of teeth most likely evolved as a result of the needs of an organism.

3 The two types of teeth most likely evolved as a result of natural selection is the statement that best explains the observations presented in the question. It is likely that in the evolutionary past an ancestral mammal species related to today's carnivorous mammals and herbivorous mammals displayed a variety of different tooth shapes and an omnivorous nutritional pattern. Different tooth shapes would have given this ancestral mammal species an advantage over other species when seeking out scarce food of all kinds. Distinct variations of this single species may have become isolated from each other, allowing the variation in tooth shape to become characteristic of several separate, though related, mammal species. Over a long period of evolutionary change, it is likely that these mammal species such as the carnivorous mountain lion, with sharp, tearing teeth, and the herbivorous elk, with flat, grinding teeth.

Wrong Choices Explained:

(1), (2) *Herbivores have evolved from carnivores* and *carnivores have evolved from herbivores* are *not* the statements that best explain the observations presented in the question. While it is impossible to know for certain what the nutritional pattern of a theoretical ancestral mammal might have been, it is likely that it was not distinctly carnivorous or herbivorous but took advantage of whatever food sources were available.

(4) *The two types of teeth most likely evolved as a result of the needs of an organism* is *not* the statement that best explains the observations presented in the question. The notion that evolutionary change occurs as a result of need is not consistent with concepts of modern science. There is substantial scientific evidence that evolution is a process that requires genetic mutation, genetic recombination, significant environmental change, geographical isolation, and long periods of time to accomplish.

<u>1</u>

70. Base your answer on the accompanying diagram that shows some evolutionary pathways. Each letter represents a different species.

Which two organisms are most closely related?



1 Organisms *F* and *I* are the two organisms that are most closely related. These two organisms share an immediate common ancestor (C) and for this reason are likely to share most of their genetic traits in common (be closely related to each other).

Wrong Choices Explained:

(2) Organisms F and H are not the two organisms that are most closely related. These two organisms share a remote common ancestor (B) and for this reason will share some, but not most, of their genetic traits in common.

(3) Organisms A and G are not the two organisms that are most closely related. Organism A is an extremely remote ancestor of organism G and for this reason will share relatively few genetic traits in common with G.

(4) Organisms G and J are not the two organisms that are most closely related. These two organisms share an extremely remote common ancestor (A) and for this reason will share relatively few of their genetic traits in common.

<u>2</u>

71. Base your answer on the accompanying diagram that shows some evolutionary pathways. Each letter represents a different species.

The most recent ancestor of organisms D and F is



2 The most recent ancestor of organisms D and F is organism B. The lines in the diagram extending downward (into the past) from organisms D and F converge at organism B, the most recent common ancestor.

Wrong Choices Explained:

(1) The most recent ancestor of organisms D and F is *not* organism A. Organism A is an ancestor of both D and F but not the most recent common ancestor.

(3) The most recent ancestor of organisms D and F is *not* organism C. Organism C is an ancestor of F but not of D.

(4) The most recent ancestor of organisms D and F is *not* organism I. Organism I is a contemporary species that is closely related to F but which shares relatively few genetic traits with D.

<u>4</u>

1.A

2. B

72. Base your answer on the accompanying diagram that shows some evolutionary pathways. Each letter represents a different species.

If A represents a simple multicellular heterotrophic organism, B would most likely represent



- 1. a single-celled photosynthetic organism
- 3. a complex multicellular virus

2. an autotrophic mammal

4. another type of simple multicellular

heterotroph

4 If *A* represents a simple multicellular heterotrophic organism, *B* would most likely represent *another type of simple multicellular heterotroph*. The process by which species evolve into new species over long periods of geological time results in a gradual change of genetic traits leading to ever-more highly adapted and complex organisms. The driving forces behind this process are thought by scientists to include genetic mutation, intraspecies competition, and natural selection. It is likely that *B* would show some changes compared to *A* but that these changes would be minor ones, and so most major traits (e.g., muticellularity, heterotrophic nutrition) will remain largely unchanged in the transition.

Wrong Choices Explained:

(1), (2), (3) If A represents a simple multicellular heterotrophic organism, B would not most likely represent a single-celled photosynthetic organism, an autotrophic mammal, or a complex multicellular virus. These alterations are too drastic to be expected of the process thought by scientists to drive evolutionary change. See correct answer above.

<u>2</u>

73. A mutation changes a gene in a cell in the stomach of an organism. This mutation could cause a change in

1. both the organism and its offspring	3. its offspring, but not the organism itself
2. the organism, but not its offspring	4. neither the organism nor its offspring

2 This mutation could cause a change in *the organism, but not its offspring*. Only mutations received in gamete-producing cells may be passed on to successive generations and therefore contribute to the alteration of phenotypes. The mutation described may cause an alteration in the stomach tissues of this individual organism, but this alteration will not be passed on to subsequent generations because it occurred in somatic, not gametic, tissue.

WRONG CHOICES EXPLAINED

(1), (3), (4) This mutation could *not* cause a change in *both the organism and its offspring; its offspring, but not the organism itself*; or *neither the organism nor its offspring*. A mutation in a somatic (body) cell cannot be passed on to offspring. See correct answer above.

<u>1</u>

74. A certain protein is found in mitochondria, chloroplasts, and bacteria. This provides evidence that plants and bacteria

1. have some similar DNA base sequences

- 3. digest proteins into simple sugars
- 2. can use carbon dioxide to make proteins
- 4. contain certain pathogenic microbes

1 The fact that a certain protein is found in mitochondria, chloroplasts, and bacteria provides evidence that plants and bacteria *have some similar DNA base sequences*. Specific DNA base

sequences provide codes for the production of specific proteins in living cells. When the same specific protein is found in different species, this fact provides evidence that DNA sequences are similar in those species and implies a genetic relationship between them.

WRONG CHOICES EXPLAINED

(2) The fact that a certain protein is found in mitochondria, chloroplasts, and bacteria does *not* provide evidence that plants and bacteria *can use carbon dioxide to make proteins*. Carbon dioxide is an inorganic by-product of the process of cellular respiration. Carbon dioxide is taken up by plants in the process of photosynthesis and is used in the production of glucose, not proteins. Most bacteria do not use carbon dioxide for any purpose.

(3) The fact that a certain protein is found in mitochondria, chloroplasts, and bacteria does *not* provide evidence that plants and bacteria *digest proteins into simple sugars*. When proteins are digested within living cells, the simple subunits that immediately result are amino acids, not simple sugars.

(4) The fact that a certain protein is found in mitochondria, chloroplasts, and bacteria does *not* provide evidence that plants and bacteria *contain certain pathogenic microbes*. Pathogenic (disease-causing) microbes such as viruses may invade the living cells of any organism. The presence of a specific protein in the cells of different species may be an indication of the presence of a specific microbe, though it is unlikely that a plant and a bacterium would be susceptible to the same types of microbes.

<u>4</u>

75. The evolutionary pathways of five species are represented in the accompanying diagram.

Which statement is supported by the diagram?



- 1. Species C is the ancestor of species B.3. Species X evolved later than species D but before species B.4. D the species C is the ancestor of species B.
- 2. Species *D* and *E* evolved from species *B*.

4. Both species *C* and species *D* are related to species *X*.

4 Both species C and species D are related to species X is the statement that is supported by the diagram. In this representation, species X is a common ancestor of species B, C, D, and E. Although species X may be extinct, an analysis of its DNA would reveal a close similarity to species C and D, indicating a genetic relationship among these three species.

WRONG CHOICES EXPLAINED

(1) Species C is the ancestor of species B is not the statement that is supported by the diagram. As

represented in the diagram, species *B* predates species *C* in a direct evolutionary line. Therefore, species *C* is the descendant, not the ancestor, of species *B*. (2) Species *D* and *E* evolved from species *B* is not the statement that is supported by the diagram. The evolutionary line that gave rise to species *D* and *E* branched off from the line that gave rise to species *B* before any of these species appeared in the geological record. Although species *B*, *D*, and *E* share a common ancestor (species *X*), species *D* and *E* could not have evolved from species *B*.