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### Multiple Choice Questions

- Decide which of the choices best completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided.
- Use the procedure described by your teacher to answer each question. For example, “fill in the circle that corresponds to your choice” or “make an X over the letter corresponding to your choice.”

*Use the following information to answer the next question.*

#### Ungulates

Ungulates, such as deer, reindeer, and elk, are hooved mammals. These animals have keen hearing, clear vision, supple, well-conditioned muscles, and razor sharp reflexes. The evolution of the four-chambered stomach in ungulates developed as a result of a need to eat quickly in the open and chew later in the safety of cover. This process is called ruminating or “chewing the cud.” In other words, ungulates regurgitate and then re-chew their food.

- Which of the following would be considered a physiological adaptation of ungulates?
  - their ability to hibernate to avoid cold winters
  - their ability to stand perfectly still, which helps them avoid predators
  - their four-chambered stomach
  - their long legs, which help them outrun predators
  
- Which type of DNA mutation can be passed on to succeeding generations?
  - body mutation
  - gamete mutation
  - mutagenic agent
  - somatic cell mutation
  
- In nature there are many selective agents. Humans have created a number of selective agents that help to artificially select against both insects and bacteria. Which row identifies these groups of selective agents?

Row	Selective agents against insects	Selective agents against bacteria
a.	pesticides	fungicides
b.	herbicides	antibiotics
c.	antibiotics	herbicides
d.	pesticides	antibiotics

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*Use the following information to answer the next question.*

### Bighorn Sheep

Bighorn sheep are named for their most notable characteristic, the massive headgear worn by the males of the species. Though both sexes have horns, it is the male (ram) that grows the large spiral or curl that is normally associated with bighorn sheep. The horns are permanent and consist of a sheath of keratin covering a bony core. Horns grow throughout life and reach maximum size at 8 to 10 years of age.

“The largest big-horn of which I have ever been able to get authentic record was one killed in Montana by a ranch friend of mine, and carefully weighed and measured at the time. At the shoulder he stood just 1.1 metres; he weighed very nearly 181 kilograms and his single unbroken horn was in girth 48 centimetres, and in length along the curve 107 centimetres. But such a ram is a giant. The largest I have myself shot I had no means of weighing: it was just after the rutting season, and he was as gaunt as a greyhound. At the shoulder he stood 1.04 metres; and his horns, which were thick for their length, were in girth 41.9 centimetres, and in length 76.2 centimetres.”

*Ranch Life and The Hunting Trail, Theodore Roosevelt, 1896*

4. In this article, three characteristics of male big horn sheep were identified. Which row below identifies the term and its definition that best describes the differences between these two rams?

Row	Term	Definition
a.	variation	a visible or invisible difference between one individual and other members of the population
b.	adaptation	a structure, behaviour, or physiological process that helps an organism survive and reproduce
c.	biological species	population of organisms capable of interbreeding and producing fertile offspring
d.	mutation	a permanent change in a cell's DNA

5. In his work *On the Origin of Species by Means of Natural Selection*, Darwin proposed that all life on Earth had descended from some unknown organism. In evolutionary terms, this proposal has been called
- gradualism.
  - descent with modification.
  - catastrophism.
  - uniformitarianism.
6. Darwin used the term “fitness” to describe organisms. Which of the following best defines an organism’s fitness when used in an evolutionary perspective?
- having traits that increase an organism’s chances for surviving to reproduce
  - having the strength needed to run long distances
  - having gathered a large number of acquired characteristics in the organism’s lifetime
  - having the ability to keep itself from going extinct

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*Use the following information to answer the next two questions.*

### **Calgary Doctor says Superbug Spreading in Canada**

A superbug that causes infections--from large, boil-like lesions to hemorrhagic pneumonia and, in rare cases, flesh-eating disease--is poised to “emerge in force” across Canada, a new report warns.

While the prospect of a flu pandemic has governments scrambling to develop emergency plans, an epidemic of community-associated methicillin-resistant *Staphylococcus aureas*, or CA-MRSA, is raging in the United States and beginning to entrench itself here, infectious disease experts report today in the *Canadian Medical Association Journal*.

The organism is an “old foe with new fangs,” a pathogen that is virulent, drug-resistant, and has the uncanny ability to “disseminate at large,” according to the CMAJ report.

*Calgary Herald, January 2, 2007*

7. Which of the following statements best explains the development of antibiotic-resistant bacteria such as CA-MRSA?
  - a. The DNA in some of gametes in the individual bacterial cells mutated when exposed to specific mutagens. These mutations provided a selective disadvantage when these bacteria were exposed to methicillin.
  - b. The environment exerted natural selective pressure on the individual bacterial cells, resulting in their resistance to methicillin.
  - c. Some individual bacterial cells had a mutation that provided a selective advantage when exposed to the antibiotic methicillin. These bacteria survived and passed this now-helpful mutation on to their offspring.
  - d. All of the *Staphylococcus aureas* are members of the same species and, as such, are capable of interbreeding and producing viable (fertile) offspring.
  
8. Which of the following is NOT a critical element in the theory of evolution by natural selection?
  - a. Individual members of a species vary in physical characteristics.
  - b. The members of all species compete with each other for limited resources.
  - c. Natural selection causes individual organisms to become adapted to the environment.
  - d. Those organisms in a population best adapted to a given environment will be most likely to survive to reproductive age and have offspring of their own.
  
9. According to the modern concept of evolution, which of the following statements would be most correct?
 

The giraffe developed a long neck because

  - a. it needed one and such a neck was passed onto their offspring.
  - b. giraffes with longer necks had a better chance to survive than those with shorter necks.
  - c. a giraffe with a sudden change in neck length was born to two parents with shorter necks.
  - d. the environment peculiar to giraffes caused their necks to grow longer.

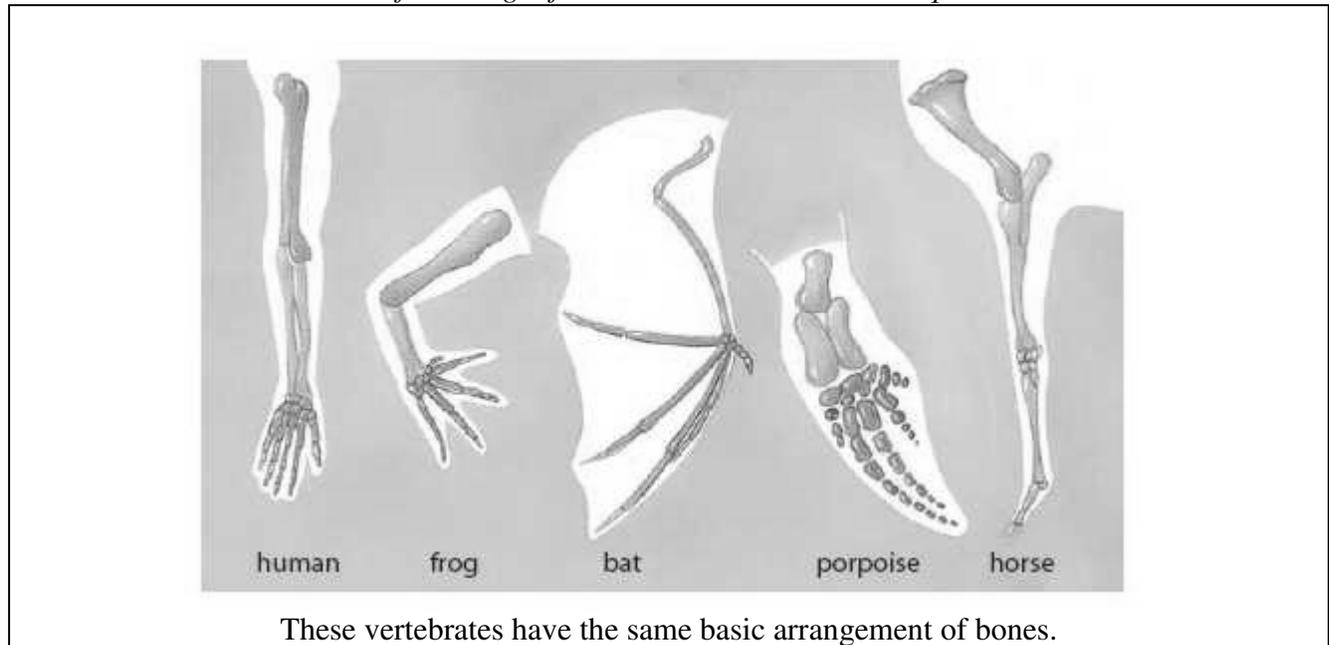
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*Use the following information to answer the next two questions.*

- I. Present forms of life have arisen by descent and modification from an ancestral species.
- II. The mechanism for modification is natural selection working for long periods of time.
- III. Parents pass on to their offspring variations that they have developed through use or disuse of certain organs. Thus, the individual offspring can adapt to their environment.

10. Which statement or statements would probably have been made by Charles Darwin?
- a. I and III
  - b. I and II
  - c. II and III
  - d. I, II, and III
11. Statement III above would most likely have been made by
- a. Carolus Linnaeus.
  - b. Alfred Wallace.
  - c. Charles Darwin.
  - d. Jean-Baptiste Lamarck.
12. Which of the following statements does NOT support the theory of evolution by natural selection?
- a. Fossils found in young layers of rock are much more similar to species alive today than fossils found in deeper, older layers.
  - b. Fossils appear in chronological order in the rock layers, so probable ancestors for a species would be found in older rocks.
  - c. Not all organisms appear in the fossil record at the same time.
  - d. The discovery of transitional fossils showed that there weren't any intermediate links between groups of organisms.
13. Which of the following statements would NOT be an example of how biogeography supports the theory of evolution by natural selection?
- a. Closely related species are almost always found in exactly the same location or habitat.
  - b. The inhabitants of an island archipelago are individually distinct yet closely related, with all of them demonstrating a relationship to the inhabitants of the nearest mainland.
  - c. Islands have fewer species because relatively few organisms can successfully cross the great water barriers.
  - d. Alpine plants of widely separated mountain ranges are often identical to each other or to those of the far north. Such distributions are often the result of migrations and extinction during glacial periods.

Use the following information to answer the next question.



14. Which row below identifies the term used, in an evolutionary sense, to describe the arrangement of bones and provides a correct definition for this term?

Row	Term	Definition
a.	analogous structures	structures that have similar structural elements and origin but may have a different function
b.	analogous structures	body parts that perform similar functions even though the organisms do not have a common evolutionary origin
c.	homologous structures	structures that have similar structural elements and origin but may have a different function
d.	homologous structures	body parts that perform similar functions even though the organisms do not have a common evolutionary origin

15. The diversification of a common ancestral species into a variety of species, all of which are differently adapted is called
- geographical barriers.
  - biological barriers.
  - adaptive radiation.
  - gradualism.

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Use the following information to answer the next two questions.

### Evolution of the Horse

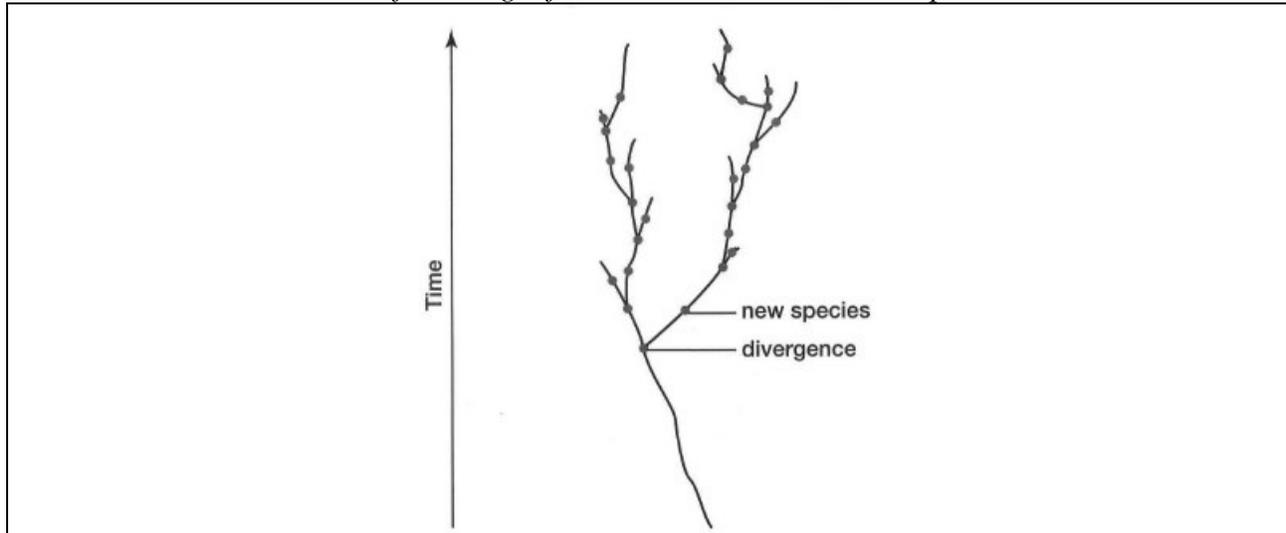
“As new fossils were discovered, though, it became clear that the old model of horse evolution was a serious oversimplification. The ancestors of the modern horse *were* roughly what that series showed and *were* clear evidence that evolution had occurred. But it was misleading to portray horse evolution in that smooth straight line, for two reasons:

1. First, horse evolution *didn't* proceed in a straight line. We now know of many other branches of horse evolution. Our familiar *Equus* is merely one twig on a once-flourishing bush of equine species. We only have the illusion of straight-line evolution because *Equus* is the only twig that survived.
2. Second, horse evolution was not smooth and gradual. Different traits evolved at different rates, didn't always evolve together, and occasionally reversed “direction.” Also, horse species did not always come into being by gradual transformation of their ancestors; instead, sometimes new species “split off” from ancestors and then co-existed with those ancestors for some time. Some species arose gradually, others suddenly.”

Source: [http://www.talkorigins.org/faqs/horses/horse\\_evolution.html](http://www.talkorigins.org/faqs/horses/horse_evolution.html)

16. The evolution of the horse demonstrates that one or more species arise from a parent species that continues to exist. This is an example of
- a. divergence.
  - b. transformation.
  - c. biological barriers.
  - d. geographical barriers.
17. In terms of the pace of evolution, the evolution of the horse is an example of
- a. gradualism.
  - b. punctuated equilibrium.
  - c. homologous structures.
  - d. analogous structures.
18. Which of the following statements is NOT true?
- a. Biological species can be described as being reproductively isolated from other species.
  - b. Both transformation and divergence (pathways to speciation) are the result of natural selection.
  - c. If populations remain isolated long enough, speciation will eventually occur because of changes accumulated in the population due to natural selection, which affects reproduction.
  - d. Behaviour is a geographical barrier that can keep the species reproductively isolated.

Use the following information to answer the next question.



19. Which row below identifies the model of evolution shown in this diagram and offers the best explanation of this model?

Row	Model	Explanation
a.	punctuated equilibrium	gradual change occurs steadily in a linear fashion; big changes (such as the evolution of a new species) occur as a result of many small changes
b.	punctuated equilibrium	evolutionary history consists of long periods of equilibrium where there is little change, interrupted by periods of speciation
c.	gradualism	gradual change occurs steadily in a linear fashion; big changes (such as the evolution of a new species) occur as a result of many small changes
d.	gradualism	evolutionary history consists of long periods of equilibrium where there is little change, interrupted by periods of speciation

Use the following information to answer the next question.

### Grand Canyon

The Grand Canyon in Arizona serves as a barrier to gene flow. While birds easily cross the Grand Canyon, it is impassable to rodents. As a result, the same bird species inhabit either side of the canyon, yet different species of squirrels inhabit opposite sides of the canyon.

20. With respect to the different populations, the Grand Canyon is

- a biological barrier to the birds.
- a geographical barrier to the birds.
- a biological barrier to the squirrels.
- a geographical barrier to the squirrels.

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## Numerical Response Questions

- Record your answer on the answer sheet provided.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.

*Use the following information to answer the next question.*

### Developing the Theory of Evolution by Natural Selection

#### Description

- A This scientist argued that the formation of Earth's crust took place through countless small changes occurring over vast periods of time, all according to known natural laws. His "uniformitarian" proposal was that the forces molding the planet today have operated continuously throughout its history. He also wrongly assumed that these causes must have acted only with the same intensities now observed, which would rule out asteroid impacts and similar events.
- B Catastrophism was first proposed by this scientist in order to explain the age of Earth. This theory suggested that Earth was 6000 years old and that geologically only catastrophic events had changed the geological structure of Earth.
- C This scientist suggested that Earth was older than 6000 years and that the physical resemblance between humans and apes might be explained by their having a common ancestry. While the theories he proposed to explain these phenomena were by and large incorrect, he proposed that a new paradigm was needed.
- D. This philosopher argued that nature is arranged from simple, imperfect forms of life to the more complex and perfect forms. He called this progression from the lowest forms (inanimate matter) to intermediate forms (such as jellyfish) to highest (such as humans) the *scala naturae*, or scale of life. This great chain of being establishes humans as the dominant and perfect form of life.

#### Individual

- |   |  |
|---|--|
| 1 | Aristotle                              |
| 2 | Georges-Louis Leclerc, Comte de Buffon |
| 3 | Jean-Baptiste Lamarck                  |
| 4 | Charles Lyell                          |
| 5 | Carolus Linnaeus                       |
| 6 | George Cuvier                          |

1. Match the individual, as numbered above, to the descriptions lettered A, B, C, and D above. Record your **four-digit answer** in the numerical answer section on the answer sheet.

**Individual:**

**Description:**

\_\_\_\_\_

**A**

\_\_\_\_\_

**B**

\_\_\_\_\_

**C**

\_\_\_\_\_

**D**

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*Use the following information to answer the next question.*

### Pre-zygotic Barriers

- A Pre-zygotic barriers (also known as pre-fertilization barriers) either impede mating between species or prevent fertilization of the ovum (egg) if individuals from different species attempt to mate.

### Post-zygotic Barriers

- B In some cases, the sperm of one species successfully fertilizes the ovum of another species and the zygote (fertilized egg) is produced. However, there are several post-zygotic (post fertilization) barriers that prevent these hybrid zygotes from developing into normal, fertile individuals

### Barriers to Reproduction

- 1 Behavioural isolation: Any signals or behaviours that are species-specific prevent interbreeding in closely related species. For example, bird species that look virtually identical (such as meadowlarks) can remain separate biological species.
- 2 Hybrid inviability: Genetic incompatibility of the interbred species may stop development of the hybrid zygote at some stage during embryonic development. For example, hybrid embryos created artificially between sheep and goats die early in their developmental stages, before birth.
- 3 Habitat isolation: Although two species may live in the same general region, they may live in different habitats and rarely, if ever, encounter each other.
- 4 Temporal isolation: Many species are kept separate by temporal (timing) barriers. For example, two species may occupy the same habitat but mate or flower at different times of the day, different seasons, or in different years.
- 5 Hybrid sterility: Sometimes two species can mate and produce hybrid offspring (such as a horse and donkey producing a sterile mule or hinny). However, a reproductive barrier still exists between the two species if the hybrid offspring is sterile.
- 6 Mechanical isolation: Species that are closely related may attempt to mate but fail to achieve fertilization because they are anatomically incompatible. For example, the genitals of some species of insect operate in a lock-and-key system. If a male and female of different species attempt to breed, their genitals will not fit together.

2. Match the pre-zygotic barriers (A) to the barriers to reproduction identified by the numbers above. Record your answer from **lowest to highest numeric order** in the numerical-response section on the answer sheet.

Barriers to Reproduction: \_\_\_\_\_

Pre-zygotic Barriers (A)

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*Use the following information to answer the next question.*

### Prairie Crocus

Usually, the first spring flower people notice in the southern Yukon is the prairie crocus.

#### Statements Related to the Adaptations of the Prairie Crocus

- 1 The prairie crocus, like the sunflower, is a heliotrope. That means its flower turns through the day to follow the Sun. The petals act like a satellite dish to focus the light and warmth of the sun into the centre flower. Small insects such as ants crawl into the centre of the flower, where the temperature is significantly warmer, and move around pollinating the flower.
- 2 The fine hairs on its leaves reduce water loss by protecting the leaves from the wind.
- 3 The crocus blooms while the flower is still close to the ground and well-protected.
- 4 Unlike most plants, the stalk continues to grow even after the flower has been pollinated so that the seed pod forms as high as possible for better seed distribution.

3. Identify the statement or statements that you would consider to be adaptations that allow the prairie crocus to flower in the early spring. Record your answer from **lowest to highest numeric order** in the numerical-response section on the answer sheet.

**Statements:** \_\_\_\_\_

### Written Response Question

*Use the following information to answer the next question.*

### Snapping Shrimp

The Isthmus of Panama closed about 300 million years ago, forming a land bridge between North and South America and separating marine animals in Central America. Nancy Knowlton of the Smithsonian Tropical Research Institute in Panama has been studying this geological event and its effects on populations of snapping shrimp. She and her colleagues found that shrimp on one side of the isthmus appeared almost identical to those on the other side—having once been members of the same population.

But when she put males and females from different sides of the isthmus together, they snapped aggressively instead of courting. They had become separate species (*Alpheus angulatus* and *A. armillatus*).

Source: [http://www.pbs.org/wgbh/evolution/library/05/2/1\\_052\\_03.html](http://www.pbs.org/wgbh/evolution/library/05/2/1_052_03.html)

1. Write a unified response addressing the following aspects of speciation.

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- **Describe** how geographic isolation can result in the formation of two distinct species.

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- **Explain** why geographic isolation of a population does not have to be maintained forever for speciation to occur.

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