READTHEORY *Reading and Writing, Improved.*

Name _____

Date _____

Biological Adaptation

Natural Selection

The theory of natural selection is the centerpiece of *On the Origin of Species* and of evolutionary theory. It accounts for the adaptation and evolution of organisms, those innumerable features that so wonderfully equip them for survival and reproduction. Furthermore, it accounts for the divergence of species from common ancestors and thus for the endless diversity of life. According to Darwin, an organism that exhibits favorable characteristics will tend to survive and reproduce in greater numbers than others of their kind, thus ensuring the perpetuation of those characteristics in succeeding generations.

It is by way of this passive choosing, this *natural selection*, that the physical features of an entire population come to change over time. This can be observed in nature: the hardiest plant survives the drought while others wither and die; the quickest antelope outruns its predators while others are caught and killed; the prettiest songbird attracts a mate while others are relegated to solitude. It can be observed that in any system in which resources are limited, a competition to acquire those resources arises and the best, or the "fittest," as Darwin would say, are predisposed by nature to secure those resources. The fittest organisms are those that are best suited to specific environmental pressures. They elude predators, withstand extreme climate, obtain food, and attract mates, and they do it better than others of their kind.

Biological Adaptation

Within the larger theory of natural selection lies the theory of biological adaptation. A biological adaptation constitutes any change in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment. Although this may sound eerily similar to the theory of natural selection itself, there is a subtle, yet important, difference. Natural selection is a mechanism (the only mechanism) known to cause the evolution of adaptations, so many biologists would define an adaptation as a characteristic that has evolved by natural selection. The word "adaptation" also refers to the process whereby the members of a population become better suited to some feature of their environment through change in a characteristic that affects their survival or reproduction.

Adaptations in Action: Striking Examples

- In most terrestrial vertebrates, the skull bones are rather rigidly attached to one another, but in snakes they are loosely joined. Most snakes can swallow prey much larger than their heads, manipulating them with astonishing versatility.

- Among the 18,000 to 25,000 species of orchids, many have extraordinary modifications of flower structure and astonishing mechanisms of pollination. In pseudocopulatory pollination, for example, part of the flower is modified to look somewhat like a female insect, and the flower emits a scent that mimics the attractive sex pheromone (scent) of a female bee, fly, or thynnine wasp, depending on the orchid species. As a male insect "mates" with the

  flower, pollen is deposited precisely on that part of the insect's body that will contact the stigma of the next flower visited.
- After copulation, male red back spiders (relatives of the "black widow" spider), often somersault into the female's mouthparts and are eaten. This suicidal behavior might be adaptive, because males seldom have the opportunity to mate more than once, and it is possible that a cannibalized male fathers more offspring.
- The Phasmatodea, or stick bug, exhibits a unique camouflage that gives it a stunning resemblance of many species of sticks or leaves found in its natural habitat. This makes it extremely difficult to spot by predators.

1) The author mentions the stick bug in order to

A. exemplify biological adaptation

B. define natural selection

C. compare uses of camouflage

D. show the evolution of adaptation

E. explain common adaptations

2) The author makes mention of each of the following involving the life of Charles Darwin EXCEPT his

I. publications
II. interests as a youth
III. travels to Patagonia
IV. effect on the scientific community
V. travels to the Galapagos Islands

A. I only

B. III only

C. both II and III

D. both III and IV

E. both IV and V

3) Which of the following choices accurately depicts the process of natural selection?

A. Evidence from a recent study suggests that a staggering 400 billion trees belonging to 16,000 different species make up the Amazon rainforest. This high level of plant diversity results from optimal growth conditions found in this unique region. Given its enormous tree population, the Amazon rainforest boasts the highest level of carbon sequestration of any rainforest in the western hemisphere.

B. The Egyptian Plover is sometimes referred to as the crocodile bird because it is famous for its alleged symbiotic relationship with crocodiles. According to a story dating to Herodotus, the crocodiles lie on the shore with their mouths open, and the plovers fly into the crocodiles' mouths so as to feed on bits of decaying meat that are lodged between the crocodiles' teeth.

C. Vaccines are often unnecessary in many cases where the threat of death from disease is small. During the early nineteenth century, mortality for the childhood diseases whooping cough, measles, and scarlet fever fell drastically before immunization became available. This decreased mortality has been attributed to improved personal hygiene, water purification, effective sewage disposal, and better food hygiene and nutrition.

D. Bactrian camels live in the rocky and arid regions of Central and Eastern Asia, where temperatures range from -20°F in winter to 100°F in summer. The camel's humps help them to survive these harsh conditions. Their humps are filled with fat, which can be converted into energy and water in lean times. The humps also enable them to forgo sweating until their body temperatures reach nearly 105°F.

E. Up until the Industrial Revolution, peppered moths were typically whitish in color with black spots, although they were found in a variety of shades. As the Industrial Revolution reached its peak, the air in London became full of soot, and the once-white trees and buildings that moths used for camouflage became stained black. The birds began to eat more of the lighter-colored moths because they were more easily spotted than the darker ones. Over the course of a few months, dark moths started appearing in the area and lighter moths became scarce.

4) In the section titled, "Biological Adaptation," the author writes, "Natural selection is a mechanism (the only mechanism) known to cause the evolution of adaptations, so many biologists would define an adaptation as a characteristic that has evolved by natural selection." Which of the following accurately demonstrates this principle in action?

A. A pride of lions enters an isolated valley accessible only via a hidden mountain escarpment. There the lions find optimal conditions—minimal competition and access to shade, water, and prey in copious amounts. Nearly every lion in the pride survives. Over the span of a decade, their numbers more than double.

B. After vaccination campaigns throughout the 19th and 20th centuries, the WHO certifies the eradication of smallpox in 1979. Smallpox is one of two infectious diseases to have been eradicated, the other being Rinderpest (cattle plague), which was declared eradicated in 2011.

C. Breeding back—a process in which the deliberate selective breeding of domestic animals in an attempt to achieve an animal breed with a phenotype that resembles a wildtype ancestor—allows a targeted animal population, usually one that is extinct, to be artificially rekindled.

D. A blowfish exhibits an adaptation that enables it to fill its stomach with air, making it less attractive to predators. As a result, this blowfish survives and reproduces. Its offspring exhibit the same adaptation. They, too, survive and reproduce in greater numbers than others of their kind.

E. During winter, when weather conditions are harsh and resources are scarce, the American black bear enters the state of hibernation—a season of heterothermy characterized by low body temperature, slow breathing and heart rate, and low metabolic rate.

5) If added to the section titled, "Adaptations in Action: Striking Examples," which of the following would fit?

I. Originally distributed throughout the Southeastern US, the red wolf was nearly driven to extinction by the mid-1900s due to aggressive predator control programs, habitat destruction and extensive hybridization with coyotes.
II. Clownfish lay eggs on any flat surface close to their host anemones. Depending on the species,
clownfish can lay hundreds or thousands of eggs. The male parent guards the eggs until they hatch about six to ten days later, typically two hours after dusk.
III. The thick, shaggy hair grown by the musk ox hangs down to the ground and gives the ox the protection it needs to endure the frigid temperatures of the Alaskan tundra. Such fur helps the animal survive as winter temperatures drop to an average of -30°F.

A. I only
B. II only
C. III only
D. both I and II
E. both II and III

6) Explain the principle of natural selection in your own words.

Answers and Explanations

1) A
Core Standard: Integration of Knowledge

The author begins the passage by entreating the reader to "First imagine a stick. Now imagine a bug. Then combine these images into one." The author continues to describe how seeing such an insect makes us question how and why that insect looks the way it does. The author then provides the answer: "Whatever the final cause, an account of the efficient cause has been put forth and has been accepted in the scientific community at large." Using this information, we can understand that the author mentions the stick bug to exemplify biological adaptation. This idea is confirmed at the end of the passage, where the author provides "Striking Examples" of organisms that exhibit biological adaptations. This lets us know that **(A)** is correct.

Although natural selection is "a mechanism (the only mechanism) known to cause the evolution of adaptations," this is not the same as biological adaptation—the theory that "explains how and why an organism comes to look like a stick." Moreover, the author does not attempt to define natural selection by mentioning the stick bug. Rather, the author attempts to exemplify biological adaptation. Choice **(B)** is not correct.

Although the stick bug does use a biological adaptation to camouflage itself, the author does not mention it for the purpose of comparison. Therefore **(C)** is not correct.

In the section titled, "Biological Adaptation," we learn that "Natural selection is a mechanism (the only mechanism) known to cause the evolution of adaptations, so many biologists would define an adaptation as a characteristic that has evolved by natural selection." But while the author does address the notion of the evolution of adaptation, his or her mention of the stick bug is not meant to show it. Rather, the stick bug is mentioned to exemplify the (end) result of adaptation. This means **(D)** is incorrect.

The passage leads the reader to believe that adaptations are unique. At the end of the passage in the section, "Adaptations in Action: Striking Examples," the author gives some examples of adaptations. Using this information, we can understand that no adaptation is common, or that it would be incorrect to think so. Therefore **(E)** is incorrect.

2) B
Core Standard: Key Ideas and Details

The author discusses Charles Darwin in the section titled, "Charles Darwin: The Father of Evolution." Near the beginning of this section, the author writes, "At a young age, Darwin expressed an interest in, and perhaps even a passion for, science. His exploits as a youth were varied; he engaged in occupations ranging from that of apprentice doctor (in which he found the lectures dull and the surgery distressing) to beetle collector." This lets us know the author makes mention of Darwin's interests as a youth. This eliminates **option (II)**.

The author continues to write, "Perhaps the most notable location visited during his travels were the Galapagos Islands." This lets us know the author makes mention of Darwin's travels to the Galapagos Islands. This eliminates **option (V)**.

The author continues to write, "Darwin articulated such theories in *On the Origin of Species* (published on 24 November 1859)—a work of scientific literature considered to be the foundation of evolutionary biology." This lets us know the author makes mention of Darwin's publications. This eliminates **option (I)**.

The author continues to write, "As Darwin was an eminent scientist, his findings were taken seriously and the evidence he presented generated much scientific, philosophical, and religious discussion." This lets us know the author makes mention of Darwin's effect on the scientific community. This eliminates **option (IV)**.

The author does not mention Darwin's travels to Patagonia. This supports **option (III)**.

Since option (III) is the only one we can eliminate, choice **(B)** is correct.

3) E
Core Standard: Integration of Knowledge

In the section titled, "Natural Selection," the author describes this process. He or she writes that natural selection, "accounts for the adaptation and evolution of organisms, those innumerable features that so wonderfully equip them for survival and reproduction. Furthermore, it accounts for the divergence of species from common ancestors and thus for the endless diversity of life. According to Darwin, an organism that exhibits favorable characteristics will tend to survive and reproduce in greater numbers than others of their kind, thus ensuring the perpetuation of those characteristics in succeeding generations." Using this definition, we can examine each answer choice to check the accuracy of its depiction.

Choice **(E)** is correct because it describes a situation in which a natural predator (birds) began to eat more of their prey (lighter-colored moths) because they were more easily spotted than the darker ones. The dark moths exhibited a favorable characteristic—camouflage—which allowed them to survive and reproduce in greater numbers than others of their kind.

The existence of a large diversity of trees in the Amazon rainforest, and their power of carbon sequestration has no relationship to the process of natural selection. Therefore **(A)** is incorrect.

The example described in choice **(B)** is incorrect, as it depicts a symbiotic relationship between two organisms, not the process of natural selection.

The decline of the prevalence of disease can be attributed to improved personal hygiene, water purification, effective sewage disposal, and better food hygiene and nutrition. It is not attributed to the process of natural selection occurring in humans. Therefore **(C)** is incorrect.

The camel's humps depict a biological adaptation, not the process of natural selection. This means
(D) is incorrect.

4) D
Core Standard: Key Ideas and Details

In the section titled, "Biological Adaptation," the author writes, "Natural selection is a mechanism (the only mechanism) known to cause the evolution of adaptations, so many biologists would define an adaptation as a characteristic that has evolved by natural selection." To understand the relationship between natural selection and adaptation, we must first understand what they are. In the section titled, "Natural Selection," we learn that, "According to Darwin, an organism that exhibits favorable characteristics will tend to survive and reproduce in greater numbers than others of their kind, thus ensuring the perpetuation of those characteristics in succeeding generations." This lets us know that the correct answer must involve the increased rate of reproduction in an organism (compared to others of its kind) caused by some favorable characteristic it has. In the section titled, "Biological Adaptation," we learn that, "A biological adaptation constitutes any change in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment." This lets us know that the correct answer must also involve a favorable change exhibited in an organism. In conjunction, natural selection and adaptation work to perpetuate this characteristic (and possibly to make it more pronounced) through the succeeding generations. Choice **(D)** involves both these ideas: a blowfish exhibits an adaptation (a favorable change) that allows it to be naturally selected—to survive and reproduce in greater numbers than others of its kind. Therefore, this choice is correct.

While the pride of lions described in this choice do survive and reproduce in relatively high numbers, this is not due to the interplay between natural selection and adaption; it is not the result of the evolution of favorable characteristics. Rather, this is caused by favorable environmental conditions. Although it may be true that lions have evolved over centuries (though natural selection and adaptation) to be great predators (thereby enabling their survival and reproduction), this idea is not invoked in this choice. Therefore **(A)** is incorrect.

The successful eradication of disease is not an example of the evolution of adaptation through natural selection. Although human intervention (vaccination) does often result in the adaptation of a virus (for example, the flu virus adapts to flu vaccines each year, necessitating a new flu shot to be given annually), this choice does not describe this. It simply describes how human intervention was successful in achieving a goal. This means **(B)** is incorrect.

Breeding back involves the deliberate selective breeding of domestic animals. This is not a natural process involving the evolution of adaptation. Therefore, it does not qualify as a demonstration of such. Choice **(C)** is incorrect.

Hibernation is an example of an adaptation. No description of how this adaptation evolved through natural selection is given. So **(E)** is incorrect.

5) C
Core Standard: Integration of Knowledge

Given the title of the section in question, "Adaptations in Action: Striking Examples," we can understand that we are looking for options that include the description of an adaptation. To refresh our understanding of what an adaptation is, we can refer to the previous section, "Biological Adaptation," in which the author writes, "A biological adaptation constitutes any change in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment."

Option (I) involves the endangerment of the Red Wolf resulting from human interference. This does not constitute an example of an adaptation in action. This eliminates **option (I)**.

Option (II) provides facts about clownfish reproduction. Although it is impressive that the clownfish can lay "hundreds or thousands of eggs," this option does not explicitly mention whether this ability is meant to constitute an adaptation in action. This eliminates **option (II)**.

Option (III) describes how the musk ox's hair enables it to survive as winter temperatures drop to an average of -30°F. Since an adaptation is some characteristic that enables the organism to be better fitted to survive and multiply in its environment, we can understand that this constitutes an adaptation in action. This supports **option (III)**.

Since option (III) is the only one that contains an example of an adaptation in action, choice **(C)** is correct.