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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.

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- 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

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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.

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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.

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