

in the animal kingdom, specific traits distinguish one group of animals from another. The beaks and feathers of birds, for example, set them apart from mammals and amphibians*. Furthermore, variations in those traits differentiate one kind of bird from another. For instance, ducks have long, wide and flat beaks, and geese have shorter, thinner and taller beaks. Nonetheless, birds also share many features — eyes, feet, legs, a tail and so on — with many mammals and amphibians. (1) What allows some traits to vary so greatly, while other features remain relatively similar across a wide range of animals?

変化(性)

Some might say that a shared evolutionary history creates similarities, and adaptive responses to selective forces trigger differences. This answer provides some insight, but it does not explain all of nature's variation. Similar traits can arise independently in different animal lineages. For example, many biologists point to the development of human and octopus eyes. Both eyes have an eyelid, iris, lens, pupil* and retina*, but they are formed by completely different mechanisms. The human eye is an extension of the brain, whereas an inward-pocketing of the skin creates the octopus eye. Functionally, these eyes differ as well. The focal length of the octopus lens is fixed; the octopus focuses by moving the entire lens. In humans, changing the shape of the lens focuses the eye on objects at varying distances. Although many evolutionary modifications could arise, not all outcomes are equally feasible. For instance, some traits are not possible in specific animals because of their developmental toolkit. Developmental toolkits can be compared to Lego building blocks, because both dictate what can be built. (2) A standard set of rectangular blocks, for example, can serve as building material for many unique structures, but nothing with truly rounded edges. In the same way, an organism relies on limited developmental processes, pathways and interactions. → can serve as building material for

選択的力

拡張

Every living animal fits one of 35 distinct shapes, or body plans, all of which originated in the Cambrian period around 500 million years ago. Because these new animal shapes appeared relatively rapidly, the event is referred to as the Cambrian explosion. In this case, "rapid" is based on an evolutionary timescale; the explosion occurred over a period of at least 5 to 10 million years.

カンブリア紀

Even after many millions of years — 10 times as long as the Cambrian explosion itself — no new body plans have evolved, despite major changes, including the movement from living in water to living on land. Consequently, developmental processes might constrain the possibilities: what's possible

進化の瞬間

For one thing, structural constraints impede some forms. Consider the fictional King Kong, a scaled-up version of a gorilla. All of his proportions are the same as a normal gorilla, but his overall size is much larger. In real animals, the structural properties of bone limit the size and proportions of the creatures, especially ones that live on land. Here's a simplified mathematical explanation of Kong's impossibility based only on the thigh bone. 大腿骨

1つの型の中

Let's say that King Kong is five times taller than a normal-sized gorilla. A bone's strength depends on its cross-sectional area*, which is a function of the square of its radius*. King Kong's thigh bone is five times bigger in all dimensions, including its radius, so its strength will be increased by 5², or 25. King Kong's volume, on the other hand, varies according to length and cross-sectional area, which means that it increases by 5 × 25, or 125. With this giant gorilla's weight increasing five times more than his strength, his legs would be crushed. Such a discrepancy between strength and weight would apply to the rest of Kong's body as well. So apes could increase in size, but structural constraints impose limits.

例は... (2) (5)

square 二乗

注 amphibians 両生動物 pupil 瞳孔(どうこう) retina 網膜 cross-sectional area 断面横半径

問 1 下線部(1), (2)を日本語に訳しなさい。
問 2 キング・コングの背の高さが普通のゴリラの5倍だとして、それが現実にはあり得ないと言える構造上の理由を60字以内の日本語で説明しなさい。ただし、句読点も1字に数えます。
問 3 本文の内容と合致するものを下から二つ選び、記号で答えなさい。

- (ア) The beaks and feathers of birds are one way to differentiate mammals from amphibians.
- (イ) Human eyes and octopus eyes have no common characteristics.
- (ウ) Many evolutionary modifications could occur, but not all outcomes are equally possible.
- (エ) All the body plans of the animals alive today appeared in the Cambrian period.
- (オ) Many new body plans of animals appeared after the Cambrian explosion to adapt to the shift from living in water to living on land.

問1 (1) 広範囲にわたる動物で、比較的似ている特徴がある一方で、いくつかの特徴がそれほど大きく異なるのを可能にするのか?
(2) 例え、標準的な長方形のアロワのセットは、多くのユニークな構造体を作るのに役立つが、丸い縁を持つ、た構造体には役立たない。

問2: キング・コングの大腿骨の強度がゴリラの25倍になるのに反し、その体重は125倍となり、身体を支えるには足りず、