

Question #58802, Biology, Other

Explain how the origin of organisms such as dinosaurs, whose gait allowed them to move without compressing their lungs, could have led to emergent properties.

Answer:

Breathing allows for the transfer of oxygen and other nutrients to all tissues and organs in the body and allows for the removal of waste, one being carbon dioxide, from the body. In order for metabolic respiration to occur in the body, oxygen is required. Metabolic respiration produces the energy in the form of ATP allowing for many cellular process to occur, including the contraction of muscles.

The predecessors of dinosaurs – tetrapods - had a sprawling gait (like that of a lizard): As the right front foot moved forward, the body twisted to the left and the left rib cage and lung were compressed; the reverse occurred with the next step. Normal breathing, in which both lungs expanded equally with each breath, was hindered during walking and prevented during running.

Therefore, as the tetrapod runs, not only is it consuming oxygen, but it also cannot take in oxygen as efficiently as when it is resting. Therefore, when running, the tetrapod has less oxygen available to its tissues than when resting, which if it needs to contract its muscles is not an efficient process.

The development of dinosaurs whose gait allowed them to move without compressing their lungs is evolutionarily advantageous because it is maximizing its intake of oxygen during an arduous, energy demanding task.

Imagine the tetrapod's lungs are a bucket filled with water with an inlet and an outlet to represent oxygen intake and oxygen consumption by the body, respectively. When the tetrapod is resting, the inlet and outlet are more or less equal to each other. However, when it is running, the inlet (oxygen intake) decreases and the outlet (oxygen consumption) increases. You can see that very rapidly, there will not be enough oxygen to sustain movement. In contrast, if we apply the same thought experiment to the dinosaur, the inlet (oxygen intake) remains constant while the outlet (oxygen consumption) still increases. You can see that even though the dinosaur will eventually run out of oxygen and have to stop running, it will be able to sustain movement longer than the tetrapod.

This is of course advantageous for preying and obtaining food, fight or flight situations, etc.