

CHAPTER 9: EVIDENCE FOR PLANT AND ANIMAL EVOLUTION

QUESTIONS SOMETIMES ASKED ABOUT THE THEORY OF EVOLUTION

Many questions about evolution arise in Christian circles. We'll discuss just a few that we frequently hear.

1. If the theory of evolution is correct, shouldn't we see animals that are half-cat/half-dogs alive today?

The theory of evolution does not predict such an outcome. It says that dogs and cats share a common ancestor. It predicts that if you look at canine fossils from three million years ago, they should look fairly similar to modern dogs; fossils from six million years ago will look a little more different, fossils from nine million years ago still more different, and so on. If you look at feline fossils from three million years ago, they should look fairly similar to modern cats; fossils from six million years ago will look a little more different, and so on.

As you trace both lines of fossils backward in time, they will look less and less like modern dogs and cats, and at some point, they will look more and more like each other. Far enough back in time (about 60 million years) both fossil lines will trace back to the same life form that was a common ancestor of both dogs and cats. This is, in fact, what scientists see in the fossil record.

2. The second law of thermodynamics says that entropy (disorder) is always increasing. Doesn't this contradict the theory of evolution, which says that the orderliness and complexity of living organisms are increasing over time?

Entropy is a quantity that physicists have defined carefully to measure the disorder in a system. The second law of thermodynamics is a law of nature that says entropy (disorder) never decreases in a closed system.

A closed system is something that doesn't exchange any energy with the outside. For example, imagine a closed box with oxygen and nitrogen on the inside, with oxygen on one side of the box and nitrogen on the

other. Even if no energy is exchanged with the outside, these two gasses would mix over time, thereby increasing entropy.

On the other hand, if a system is open, it can absorb energy from the outside and use that energy to actually decrease its own entropy and thereby increase order inside itself. For example, living cells in your body receive energy in the form of chemicals; they absorb and can use this energy to decrease the chemical disorder inside themselves. Similarly, the living organisms of the earth, are able to decrease their entropy over time because they receive a steady stream of orderly energy from the sun. The second law of thermodynamics allows the entropy of biological systems to decrease over time as long as an outside energy source is available.

3. *Doesn't evolution predict that changes in lifeforms should be gradual? Aren't there big gaps in the fossil record where new lifeforms suddenly appear?*

When an ecological environment stays stable for a long period of time, the species living in that environment seldom change. They often become so well adapted to the environment that they change very little, if at all, for as long as the environment is stable. But if big changes happen to an ecological environment—perhaps due to a natural disaster, a changing climate, a shift in the geology, or new species moving into the area to compete with old species—then plants and animals can evolve fairly quickly.

To scientists, “evolving quickly” means changing in a few tens or hundreds of thousands of years. That’s slow by human standards but quick compared to the time scales of geology, which are important for determining what sorts of fossils will be found. For example, if an environment was stable for tens of millions of years and then changed fairly rapidly (by geological standards) and then was stable again for tens of millions of years, the fossil record in these rocks would probably show two long periods with many fossils in which the species did not change very much. Sandwiched between these two long periods would be a short period with fewer fossils where the species were changing “quickly.” (This sort of scenario is sometimes referred to as *punctuated equilibrium*.) This situation would cause the fossil record to appear as if new species arose fairly rapidly, with only a few transitional fossils. When geologists find those kinds of transitional fossils, they can look for clues in the rocks themselves to determine whether the environment changed during that time.

Sometimes gaps appear in the fossil record because geological processes happen that destroy some fossils. Imagine a location that accumulates sediments and fossils for 40 million years. Then a natural disaster happens, or water erosion takes place, destroying the top layers of rock and wiping out 15 million years worth of sedimentary rock and fossils. After that, sediment and fossils began to accumulate again. Geologists examining those fossils today might notice what appears to be an abrupt change in fossils at some point. This might seem puzzling at first glance, but geologists can test whether layers of rock and fossils were destroyed. They can do this by comparing the rock layers at one location to rock layers at neighboring locations that did not suffer a natural disaster or erosion.

Fossil hunters need to know where to look before they can find the transitional fossils they seek. Several decades ago, very few transitional fossils were known that linked modern whales to ancient land-dwelling mammals. Once the first few transitional fossils had been found, scientists knew to look for them in a specific part of the globe—central Asia and the Indian Ocean, and when they knew where to look, they found more. (See “Whales—Land or Sea Creatures.” on this website.)

As more and more fossils are found, more and more gaps in the fossil record are filled in. The new fossils allow scientists to test predictions they have made based on previously known fossils. The current fossil record and the new fossils being discovered provide strong support for common ancestry and are consistent with the predictions of the theory of evolution.

4. Can evolution really produce big changes, like changing fish into reptiles or reptiles into birds?

People sometimes distinguish between microevolution and macroevolution. Microevolution refers to small changes within a species or when one species splits into several very similar species—changes that can happen in just a few decades or centuries. Macroevolution refers to the larger changes from one life form to another, presumably happening over several million years, as the theory of evolution predicts.

Some people argue that microevolution happens but macroevolution does not. They say that dramatically new species could not develop no matter how much time passes. But nearly all biologists believe that macroevolution has occurred and that the mechanisms of evolution are

capable of producing the major changes seen in the fossil record over millions of years.

One reason biologists believe that macroevolution is possible is that microevolution often happens at a faster pace than macroevolution. Consider an example of microevolution involving two breeds of dog that shared a common ancestor one thousand years ago. We can measure the amount of genetic and anatomical differences that have developed between the two breeds during that time. We can also measure the amount of genetic and anatomical differences between dogs and cats in the last 60 million years—roughly the time since they shared a common ancestor, according to the fossil record. If microevolution can produce a certain amount of change in just 1000 years, then macroevolution should be able to produce 100 times as much change in 10,000 times as much time (10 million years).

Although the speed of microevolution appears fast enough to produce macroevolution, this doesn't *prove* that macroevolution happened. Macroevolution is a challenging scientific problem because biological processes and living creatures are complex. (By comparison, atoms studied by physicists and stars studied by astronomers are much simpler—a few equations explain almost everything about them!) Because biology is so complex, biologists believe that they need several more decades of research to work out the details of macroevolution. The evidence they have so far is consistent with the theory of evolution, but because the details haven't all been worked out, there is still room for counter-arguments by people who say that macroevolution is impossible.

5. The first lifeforms were simple and single-celled, but modern life is more complex. Can evolution explain how life got more complex over time?

Many biologists believe that the answer is yes. The mechanisms of evolution really can make life more complex over time. A few people argue the opposite: that the mechanisms of evolution by themselves cannot make life more complex. This is discussed in more detail in other articles on this website: "Probability, Pattern, and Design," "Is the Evolution of Complexity Improbable," and "Ion Channels: An Example of How Complexity Could Evolve."

6. *Can evolution explain how life got started in the first place?*

The answer is no. The theory of evolution is a scientific model for how life changed once it got started. It does not explain how the very first life form came into being.

The origin of the first life on earth is a scientific mystery. No good evidence shows that when the earth was very young, about 4.5 billion years ago, the conditions were too extreme for any life to exist. There is fossil evidence of simple life forms dated to about 3.8 billion years ago. Some scientists are working on the hypothesis that the right sorts of chemicals were present on the earth about 4 billion years ago, and under the right sorts of conditions, these chemicals could self-organize into a very simple life form that could reproduce itself and evolve. This hypothesis is sometimes called *abiogenesis* and sometimes called *chemical evolution*. Is it possible? If it is possible, what sorts of chemicals would be required; under what sorts of conditions? What would the very first life have looked like? Scientists have some data, but even the best scientific models currently available are quite vague about how abiogenesis might have happened.

Supporters and critics of Intelligent Design respond differently to the uncertainty of the current scientific evidence. This is discussed in the article "The Very First Cell" on this website.