

MISCONCEPTIONS

There are many misconceptions about evolution. Here are a few of the more common misconceptions, and some very basic responses to them. For more details on any of these, consult the resources list. The first section deals with common misconceptions that stem from an incomplete or inaccurate understanding of the nature of science, while the second section deals with misconceptions that are more specifically about evolutionary concepts.

MISCONCEPTIONS ABOUT THE NATURE OF SCIENCE

Misconception: “if you believe in evolution, you can’t believe in God”

First, evolution is not something one “believes in.” Biologists do not believe in evolution; rather, they accept it as the best explanation for the diversity and unity of biological organisms.

Second, this is a false dichotomy. Evolutionary theory does not invoke God as an explanation for the adaptation of organisms. What this means is that it is not necessary to invoke God as an explanation, but this is not the same as saying that God does not exist, or that God is impossible. Evolution does not imply this at all. Science is neutral to God; God is neither required nor eliminated by scientific explanations. *Nothing about evolution precludes or disproves the existence of God.* Science, as a discipline, cannot address the question of the existence of God, since *science provides natural explanations for natural phenomena*, and God is supernatural.

Furthermore, many evolutionary biologists are devout members of their religious faith, which comprise all of the world’s major religions. Indeed, most religions accept that evolution does not conflict with their religious beliefs (see [Voices for Evolution, National Center for Science Education](#)). [[www.ncseweb.org/article.asp?category=2]]

Misconception: “evolution means that there is no purpose to life”

Again, science cannot address this question (see above). Unfortunately, some scientists have used their scientific status to postulate that there is no purpose to life; however, these are their own personal beliefs, and *not* scientific opinions. Science can only describe how the world *is*; not how the world *should be*. Also see [The Limits of Science](#).

Misconception: “evolution is just a theory”

What is really meant by this is that “evolution is just a guess.” This is a misunderstanding based on the difference between the scientific definition of theory and the colloquial use of theory. In common usage, a theory means a guess, and it is used when someone is taking a guess about a causal explanation. In science, however, a theory is as big as it gets. A scientific theory is a coherent body of interconnected statements, based on reasoning and evidence, which explains a variety of observations. Because a theory is a complex of interconnected statements, it does not stand or fall based on a single critical test. In science, specific hypotheses are tested within an explanatory theoretical framework, and if continuously supported, are added to that framework. Also see [The Nature of Science](#).

Describing evolution as “just a theory” also undermines all of the other major scientific theories (the theory of relativity, the theory of plate tectonics, the theory of quantum mechanics, the theory of gravity, etc.). Evolution is arguably the most well supported theory in all of science. Also see [Craig Nelson’s article: Effective strategies for teaching evolution and other controversial topics in The Creation Controversy and the Science Classroom, NSTA](#).

[[php.indiana.edu/~nelson1/NSTA2.html]]

Misconception: “evolution hasn’t been proven,” or “prove evolution to me”

These are meaningless statements. Gravity has never been proven either. Neither have cells, nor electricity. Evolution cannot be “proven” because it is a scientific theory. All ideas in science are accepted tentatively, with the understanding that eventually, with new evidence, they may be overturned. Evolution is extremely well accepted in the scientific community because of the vast amount of evidence that has been put forward for it (many, many examples, from many different biological disciplines), and the absence of any evidence against it. Because of the sheer quantity of evidence for evolution, it is extremely unlikely that it will ever be overturned. Also see [The Evidence for Evolution](#).

Misconception: “no one was there to see the origin of life, so any ideas about it are just a guess”

First, evolutionary theory does not specifically address the origin of *life*, but the origin of *species*. In fact, many argue that a discussion of evolution should not include the origin of life, since this issue deals with prebiotic events, and has little to do with *biological* evolution.

Second, it is true that no one was there to see the origin of life. This speaks to a larger question about methods used in the historical sciences. So how do we know anything about the past? Clues to the past are always left behind. This is how detectives figure out how a crime was committed, even if there were no eyewitnesses. Scientists use clues left in the fossil record, for example, to make *inferences* about biological history. Scientists’ ideas about the past are based on evidence; they are not “just a guess” (see “**evolution is just a theory**” above).

Misconception: “science cannot explain X , therefore evolution must be false, and creationism true”

There is a huge difference between something that is *unexplained* by science, and something that science is *unable* to explain. This argument, called the “God of the gaps” approach by philosophers, has been used countless times for phenomena that were as yet unexplained by science, but for which scientific explanations were eventually found. This line of thinking sets up a dichotomy between science and religion. It implies that if science cannot explain X , then God must be responsible for it. This argument is harmful to religion, and has been rejected for more than a century by most theologians. Following this line of reasoning, when science eventually finds an explanation for X , then that must mean that God had nothing to do with it. This is bad for religion, and most religious leaders find it to be an ineffective route to faith.

This also illustrates a common tactic used by professional creationists. Rather than put forward positive evidence for their own ideas, they try to discredit evolution, and then claim you must then accept creationism. However, even if evolution were disproved some day, creationism is not the only other option (see “**you should just teach creationism, too**” below).

Misconception: “Darwin recanted his belief in evolution on his deathbed”

First, Darwin did not “believe in” evolution; he was convinced by the evidence he uncovered that it was the best explanation for the origin of species. Second, Darwin’s family denies he recanted his acceptance of evolution. Third, even if he had recanted, it would mean absolutely nothing for evolutionary theory. Darwin was the “father” of the field of evolutionary biology, but he was not the first to discover evolution. Several others had proposed the general idea of evolution before Darwin (e.g. Lamarck). Darwin’s contribution was to: 1) gather a lot of evidence for evolution (i.e. shared ancestry), and 2) describe the first plausible mechanism of evolution (natural selection). In addition, a *lot* of work has been done in the past century and a half to add to and modify his ideas into the explanatory framework that evolutionary theory is today. Scientists do not blindly accept evolution because Darwin “said so;” they accept it based on the overwhelming evidence for evolution, and the absence of any evidence against it.

Misconception: “evolution is racist/sexist/elitist/etc.”

All of the ideas that have been promoted in the name of evolution and Darwinism actually pre-date Darwin by centuries. Therefore, evolution and Darwinism are *not* the cause of these ideas. Darwin himself was very opposed to slavery. After Darwin’s ideas about natural selection were widely known, some people used their very naïve and incorrect interpretation of the scientific ideas to justify their political and social beliefs (e.g. Social Darwinism). They claimed that some races, for example, are biologically superior and more “fit” than others (the Nazis, for example, used these arguments). They justified their beliefs by claiming they were “natural.” However, this is the philosophical fallacy called naturalism: claiming that what is natural is good. In other words, “what is, is what ought to be.” There is no philosophical foundation to naturalism (see Robert Pennock’s book: The Tower of Babel).

The philosophy underlying social Darwinism is very different from biological evolution. On the contrary, *evolution unites all of humankind*: we are all related through common ancestry. In fact, evolutionary biologists have revealed through genetic studies that there is no biological basis for the concept of race in humans (see Joseph Graves’ book: The Emperor’s New Clothes).

There is, in fact, an extremely important social role of evolution. Evolutionary theory forms the basis and the foundation of medical and biotechnology, agriculture, conservation of

species and wildlife management, and many other fields of increasing importance to society (see [Applied Evolution](#)).

Misconception: “you should just teach creationism, too”

This is a very popular argument, even with people who do not identify themselves as creationists, since it appeals to the American sense of fairness. However, the courts have continuously ruled creationism/creation science to be a religious view, and not a science (see [NCSE’s “Eight Significant Court Decisions” by Molleen Matsumura](#)).

[[www.ncseweb.org/resources/articles/3675_eight_significant_court_decisi_2_15_2001.asp]]

As such, they violate the Establishment Clause of the First Amendment, which protects our freedom to practice the religion of our choice, without having the state force a particular religion on us. Creation science cannot, therefore, be taught as science in public schools.

Even if we could teach creationism in public schools, which type of creationism should we teach? There are many different types of creationism (see [Eugenie Scott’s Creation/Evolution Continuum](#)),

[[www.ncseweb.org/resources/articles/1593_the_creationevolution_continu_12_7_2000.asp]]

as well as hundreds of different creation stories from various cultures and religions. Should we also teach about the Raëlian view that intelligent aliens created life on earth? Which explanation (theory) for the origin of species we teach is based on how successful it is in its ability to explain the available evidence. It is not based on which explanation is more popular with the general public. We have a responsibility to teach how the world is, not how we might like it to be.

MISCONCEPTIONS ABOUT EVOLUTIONARY CONCEPTS

Misconception: “evolution violates the second law of thermodynamics”

The second law states that closed systems tend toward increased entropy (or disorder) over time. First, evolution does not always increase complexity. The evolutionary loss of a trait is quite common (e.g. the loss of eyes in cave-dwelling animals; the great reduction of the digestive system in parasitic worms, etc.). Second, the earth and the organisms on earth are not closed systems, they are open (there is an influx of energy from the sun, from organisms eating

other organisms, etc.). Since they are open (not closed) systems, the evolution of living organisms does not violate the second law of thermodynamics.

Misconception: “where are the missing links?”

When Darwin proposed his theory, he did it in spite of the fossil record, not because of it. This was because there were major gaps in the fossil record in the 19th century; the record did not show many transitional organisms. Since Darwin’s time, many more fossils have been found, including transitional organisms. As the paleontological record has developed, it continues to support evolutionary theory. For example, there are now transitional fossils between fish and amphibians, amphibians and reptiles, reptiles and mammals, and reptiles and birds.

The fossil record will never be complete (although it is getting more and more complete every day) because a special set of circumstances is required for fossilization. Many organisms did not live (or die) in an environment where they were likely to be fossilized, and organisms without hard, bony parts are very unlikely to be fossilized at all. On the other hand, organisms with skeletons are likely to be preserved, and we expect to find at least some of them in the fossil record.

It is also important to remember that not all fossils are ancestors. When creationists talk about transitional fossils, what they are really talking about is ancestry—but no one is suggesting that we have found a direct line to primitive ancestors. Extinction breaks the chain. Most species that have ever existed are extinct and much of what we see is probably collateral kin (i.e. other branches of the tree) rather than lineal kin. If we HAD a full fossil record, we could reconstruct all ancestry with relative certainty, but it is hard to reconstruct the tree without all the pieces. But the parts of the fossil record that have been discovered do show transitional organisms, and do support evolutionary theory.

Misconception: “evolutionists cite homology as similarity due to common ancestry, then claim it as evidence for common ancestry—a circular argument”

This argument, as stated, is indeed circular. However, an understanding of the historical development of the idea of homology shows that it is not a circular argument. Homology is now defined as similarity due to common ancestry. This is a current definition. Originally, homology was just a *pattern* that required an explanation. The pattern of homology is when a trait is

similar in two different species, *even if it is not functionally necessary for them to be similar*. The best explanation for homologies is common ancestry. In addition, even now, it is not just assumed that two similar traits are homologous (or similar due to common ancestry). This is a hypothesis that requires testing. Also see [The Evidence for Evolution \(Similarity\)](#).

Misconception: “evolutionists cite similarity of vertebrate embryos as evidence for evolution, even though those drawings are faked”

Vertebrate embryos do have similar features during the early stages of development. For example, we all have tails and gill pouches, even if those characteristics are lost later in development. The best explanation for similarity in early embryos is a shared ancestry of all vertebrates. Also see [The Evidence for Evolution \(Similarity\)](#).

The problem that creationists picked up on and are using to try to debunk evolution, is that many textbooks today still use drawings done by Haeckel, an early embryologist. Haeckel’s drawings (which were meant to illustrate his idea of “ontogeny recapitulates phylogeny”) were indeed inaccurate (he drew them from memory). Regardless, the textbooks that still use this drawing today do not typically use it to illustrate similarity of embryos as evidence for evolution, but to illustrate von Baer’s law, which is that general features of a group appear early in development while specialized features appear later.

Misconception: “evolution means people come from apes/monkeys/etc.”

First of all evolutionary biology is concerned with the history of all organisms, not just humans (which is a particularly well studied organism). Second, we don’t “come from apes,” we share a common ancestor with the great apes (gorillas, chimps, orangutans, etc.). Since the great apes are still around today, by definition, they cannot be our ancestors. Evolution does say that we share an ancestor with the apes. It also says that we are more closely related to apes than we are to horses or ferns or bacteria (i.e. we share a more recent common ancestor with apes, and chimpanzees in particular, than we do with other organisms). Also see [Human Evolution \(Our Primate Origins\)](#).

Misconception: “complex organs (like the human eye) cannot be produced by chance, they must have been designed”

This is the classic *argument from design*; however, it is based on an incomplete understanding of the mechanisms of evolution. Evolution is not random; adaptations are not produced by “chance.” Mutation does produce random (chance) variation, and if mutation were the only mechanism of evolutionary change, it would be a random process. However, natural selection, a *nonrandom* process, acts on this random variation to produce adaptations like the eye.

Likewise, *irreducible complexity* arguments state that complex organs are “irreducibly complex,” you cannot take away one of the “parts” and still have a functional organ, therefore, it must have been made all at once. Evolution by natural selection does not make a complex organ all at once. They are the products of many small changes (produced by mutation) that are selected for, modified, and that accumulate over a long period of time. Each of the intermediate steps is functional. For example, there are many gradations in light-sensing organs, from the very simple to the very complex (vertebrate and molluscan eyes), and each of these serves an adaptive function for the organism. See Kenneth Miller’s book: *Finding Darwin’s God* for an excellent analysis of design and irreducible complexity arguments.

You may also hear *probability* arguments, in which an astronomically small probability is stated that some trait evolved by natural causes. Again, these arguments are based on the *assumption* that the trait appeared in its current modern form all at once. Indeed, this would be highly improbable. However, this is not the way evolution works. Evolution by natural selection is a gradual, step-by-step process, with incremental changes occurring through mutations that are then selected for if advantageous.

Misconception: “microevolution (or limited change within a species) has been observed, but this has nothing to do with macroevolution (speciation, etc.)”

The difference between microevolution and macroevolution is only a matter of degree. The same exact genetic mechanisms act at both scales. Given enough time, microevolutionary processes (mutation, natural selection, genetic drift, etc.), produce enough change between two populations of the same species that they are considered two separate species. Studies of natural populations have shown current rates of microevolutionary changes that are orders of magnitude faster than what is typically found in the fossil record. The distinction between microevolution

and macroevolution is descriptive (e.g. how patterns are described) and not mechanistic (e.g. how those patterns came about).

Misconception: “survival of the fittest”

This is a very common misconception about natural selection. Fitness, as used by evolutionary biologists, is a measure of the relative success of one genotype over another (in a particular environment). The fitness of a genotype is a function of the *survival* rate of all individuals with that genotype, *as well as the average reproductive success* (i.e. the fecundity) of all individuals with that genotype. So, rather than “survival of the fittest,” it is more like: “the fittest genotype is the one in which individuals with that genotype have a higher survival rate *and* have lots of kids who survive.” Not as catchy.

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