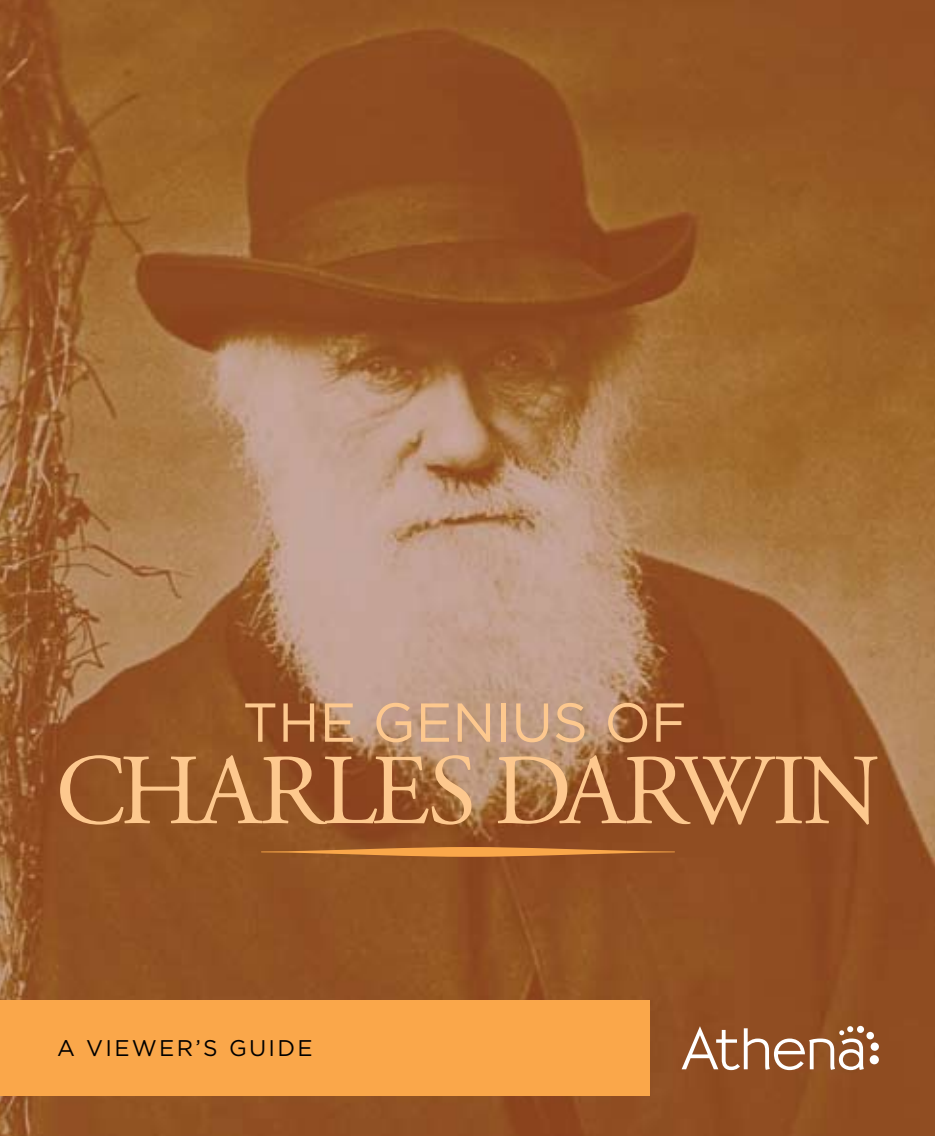


THE GENIUS OF CHARLES DARWIN

A VIEWER'S GUIDE

Athena

EVOLUTION: FACT OR THEORY?

In everyday usage, a "theory" oftentimes means an unproven idea at best, or mere guesswork at worst. In scientific parlance, however, a theory carries much more weight: it is the framework through which scientists interpret known facts. A theory is accepted as valid when it fits all the observations in a rational way and predicts future outcomes. Facts, meanwhile, do not indicate absolute truths, but rather data that have been confirmed to such an extent that they cannot reasonably be denied.

Throughout these programs, Richard Dawkins refers to evolution as a "fact," which it is. Evolutionary biologists state that evolution is both a theory and a fact. All organisms have descended from earlier life forms through changes over time: that is the *fact* of evolution. The *theory* of evolution explains that fact through the means of natural selection and like concepts.

EPISODE 1
LIFE, DARWIN & EVERYTHING

Highlights

- The prevailing religious teachings of Darwin's time conceived of a stable, divinely ordered natural world. Darwin, however, saw a violent, brutally dynamic system in which species constantly struggled for survival.
- Based on extensive observation and research, Darwin posited a continually escalating natural arms race in which slight variations such as faster legs, sharper teeth, or a keener sense of smell gave some life forms a competitive edge in survival and reproduction.
- Darwin didn't know precisely how species passed on physical variations to their offspring. The answer arose with 20th-century research into DNA and genetics.

Questions to Consider

1. Clearly, Darwin had mixed emotions about his idea of evolution, delaying publication of his treatise and calling it "a vile rat of a theory." Why did he feel so conflicted?
2. How would you explain natural selection to your children?
3. Dawkins says that Darwin's theory "eliminated the necessity of believing in anything supernatural." Do you agree or disagree?

EPISODE 2
THE FIFTH APE

Highlights

- According to Dawkins, evolution by natural selection discards the notion of a grand scheme in the natural world. Nature has no morality and no purpose or goal, other than survival and reproduction. All beings work for their own benefit and often exploit others in the process.

- Darwinism emphatically does not justify eugenics, genocide, ethnic cleansing, or neglecting the poor because those notions substitute human judgment for natural selection.
- Dawkins argues that kinship (behavior in family units) and reciprocity (you scratch my back, I'll scratch yours) can explain the development of altruism as a survival trait.
- Kindness, empathy, and other so-called selfless behaviors, says Dawkins, allow human beings to extract themselves from the brutal, unforgiving forces that created them.

Questions to Consider

1. Do you agree that nature has no overarching purpose or goal other than the successful transmission of genes from one generation to the next?
2. Why does Dawkins say, "Hitler was *not* a Darwinist"?
3. To what extent does capitalism exhibit the characteristics of Darwinian natural selection? How is it different?
4. How would you explain humans' altruistic impulses, such as kindness to total strangers?

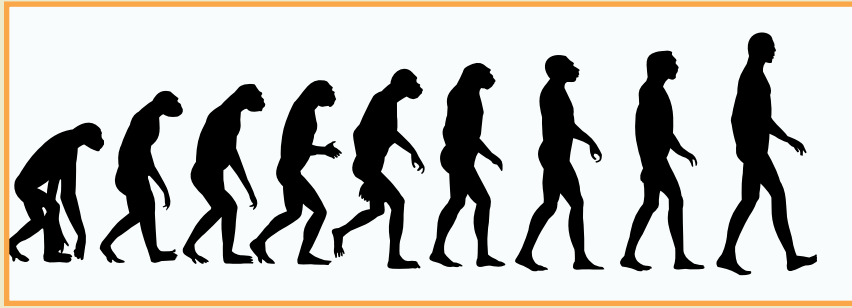
EPISODE 3
GOD STRIKES BACK

Highlights

- When confronted with the godlessness that Dawkins sees as implicit in Darwinism, some Christian fundamentalists deny or attack the idea of evolution; others try to assimilate it into their own dogma.
- Scientists see complex organs (such as the eye) and compromised functions and vestigial physical features (such as nearsightedness, wisdom teeth, and the appendix) as convincing evidence of evolution, not of intelligent design.
- In his view of a godless universe, Dawkins finds joy in the exuberance of life processes and satisfaction in humans' ability to understand them.

Questions to Consider

1. In arguing for atheism, Dawkins confronts Christians exclusively. Why do you think some Christians in particular have such difficulty with Darwin's ideas? In your experience, how do people from non-Christian faith traditions such as Jews, Buddhists, or Muslims react to evolution through natural selection?
2. How is evolution taught in your local school district? How should it be taught?
3. Do you share Dawkins's profound consolation in knowing that "every one of your ancestors successfully copulated"? Why or why not?
4. In your opinion, is it possible to reconcile evolution through natural selection with a religious tradition? Or does accepting Darwinism inevitably lead to atheism?



AVENUES FOR FURTHER LEARNING

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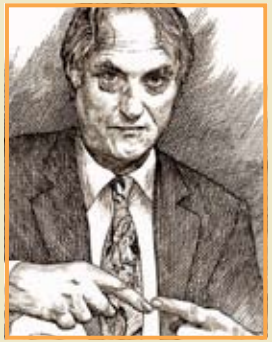

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EVOLUTION'S BIGGEST LOSERS

Major extinction events in Earth's history

Supercontinents collide; dust and debris turn day into night; behemoth glaciers lumber over once fertile seas. In *The Origin of Species*, Charles Darwin bemoaned the "extreme imperfection" of the fossil record, but today, improved understanding of the physical sciences and breakthrough discoveries such as carbon-14 dating have painted a strange and vibrant portrait of the events that led up to Earth's current population of flora and fauna. Contemporary theories posit that five great extinction cycles over the course of hundreds of millions of years greatly influenced which species survived and flourished, and which were relegated to the fossil record.

The earliest of these major extinction events occurred approximately 440 million years ago during the Ordovician-Silurian period, a time before organisms had made the transition from ocean dwelling to terrestrial. As the second-largest extinction on record, it managed to kill a staggering 85 percent of all Ordovician species. Attributed to rapid cooling and glaciation, the event essentially wiped the biological slate clean, with only the hardiest organisms surviving.

The next 100 million years passed without any great disruptions in biodiversity, until the Late Devonian extinction about 364 million years ago. By this time, primitive root plants, amphibians, and insects had begun populating land masses. While scientists have yet to determine the primary cause, they agree that it mainly affected marine creatures, particularly those living in warm waters. Terrestrial plants and animals seem to have emerged relatively unscathed, but the event eliminated about 70 percent of all species and 19 percent of the families of life present at that time.

The most destructive extinction event was the Permian-Triassic, 251 million years ago. During the early Permian, fusion of continental plates created Pangaea, a development which allowed land animals to roam freely, breeding and diversifying over a fecund period of millions of years. Eventually, however, climate change, supplemented by a possible meteorite impact and an increase in volcanism, caused the destruction of approximately 95 percent of marine and 70 percent of terrestrial species.

Following this cataclysm, it took nearly 30 million years for some of the more complex ecosystems and organisms to recover. Then, around 200 million years ago, rapid climate change produced the End Triassic extinction, which wiped out an entire class of marine life—small invertebrates called conodonts—and annihilated 76 percent of extant species. Lucky for us, several groups of synapsids, the ancestors of modern mammals, managed to survive. The resulting ecological gaps also allowed dinosaurs to evolve and become the dominant land animals.

The final massive extinction is also the best known. About 65 million years ago, major asteroid impacts or volcanic activity triggered the Cretaceous-Tertiary (K-T) extinction. Its catastrophic effects on climate and atmospheric conditions ultimately led to the decline of dinosaurs and the rise of mammals. Mammalian omnivores, insectivores, and carrion eaters thrived, with food sources abundant as larger animals died and decayed. The ancestors of crocodiles, turtles, and sharks also flourished. When all was said and done, every species of non-avian dinosaur disappeared, while the major mammal lines continued to diversify and change, setting the stage for both the evolution of modern humans and the creatures with which we share the planet.

Meteor Crater, Flagstaff, Arizona

MILESTONES IN THE EVOLUTION-CREATIONISM CONTROVERSY

The big battles between Darwinists and doubters in U.S. classrooms and courtrooms

As Dawkins makes abundantly clear, the controversy over how to teach evolution in school continues to rage around the globe. But, historically, the debate between Darwinists and creationists has generated the most heat in the United States. Here are some landmarks.

The Scopes Trial: In 1925, John T. Scopes openly defied a Tennessee law forbidding state-supported schools from teaching any theory that contradicted the Biblical story of divine creation. When the case found its way to court, the trial packed plenty of star power. Legendary lawyer Clarence Darrow defended Scopes; three-time presidential candidate William Jennings Bryan represented the prosecution. Excluding any scientific evidence on the validity of evolution and any question of the law's constitutionality, the judge limited arguments to whether Scopes had violated Tennessee law—a fact that the defense admitted. The jury found Scopes guilty and fined him $100.

Nowadays, most people believe that Scopes won—probably because their knowledge of the case comes from *Inherit the Wind*, which dramatically reimagined the trial. In reality, Scopes did eventually get off on a technicality; the Tennessee Supreme Court heard Scopes's appeal and ruled that his fine was excessive. But the court also upheld the constitutionality of the law, which the legislature didn't repeal until 1967.

The Epperson Case: In a 1968 case before the U.S. Supreme Court, high school teacher Susan Epperson challenged the constitutionality of an Arkansas law forbidding the teaching of evolution. The High Court agreed with her, saying that state-school curricula "tailored to the principles or prohibitions of any religious sect or dogma" violated the First Amendment. The ruling lifted the prohibition against teaching evolution but didn't forbid teaching some form of creationism.

Edwards v. Aguillard: By the early 1960s, Biblical literalists began promulgating something called "creation science"—basically, an account of creation from the Book of Genesis rendered in scientific terms. In 1987, the U.S. Supreme Court took up *Edwards v. Aguillard*, a case challenging the constitutionality of a Louisiana law that required schools to teach creation science whenever they taught evolution in the classroom (or vice versa). Proponents of the law argued that it guaranteed teachers' academic freedom. In a seven-to-two ruling, however, the Court decided that the law advanced a particular religious doctrine and therefore violated the First Amendment.

The Dover Trial: In 2005, 11 parents sued the school district and school board in Dover, Pa., for requiring public-school biology teachers to present intelligent design as a scientifically valid alternative to evolution. Without ever mentioning God, intelligent design posits that organisms appeared with complex organs and other biological systems already fully formed, engineered by an unknown, unnamed designer. A host of scientific organizations filed friend-of-the-court briefs calling intelligent design thinly veiled religion, not science. The trial, heard in U.S. district court, attracted nationwide attention and lasted for nearly six weeks. The judge eventually ruled for the plaintiffs, finding that intelligent design is theology and has no place in a science classroom.

EVOLUTION'S DARK SIDE

The new threat of "superbugs" shows why Darwin was right

You don't have to look back over millions of years to see evolution in action. It's happening today, right before your eyes, in hospitals, farms, and athletic facilities across the country. And the consequences could kill you.

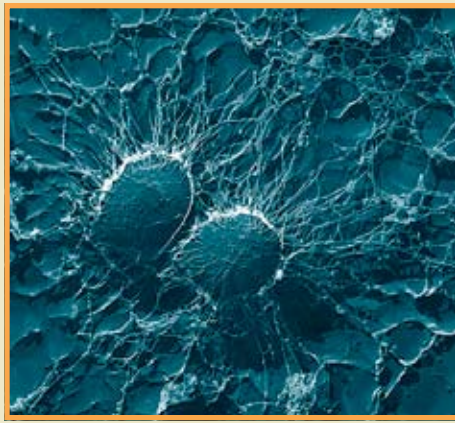
Since the late 1990s, health professionals have become increasingly alarmed at the emergence of drug-resistant bacteria. Immune to the effects of most antibiotics, these so-called "superbugs" can cause serious—sometimes fatal—infections. They present a dire example of Darwin's principle of natural selection at the microbial level.

What does Darwin have to do with drug-resistant infections? Whenever doctors administer an antibiotic, a full-scale war begins to rage inside the patient's body. The drug attacks specific biochemical processes within the bacteria, disrupting their metabolism. But a few bacteria might escape the attack because their genetic code dictates a slightly different biochemical process. Or spontaneous mutations might occur within the bacterial population, subtly changing a bug's biochemistry and making it tougher. Following Darwin's principle of survival of the fittest, these bugs survive and pass on their genes to the next generation. Since bacteria have relatively short life spans and reproduce rapidly, the evolutionary process doesn't take long. One recent case study traced 35 distinct mutations in a methicillin-resistant *Staphylococcus aureus* (MRSA) infection over a 12-week period that made successive generations of the bugs harder and harder to kill. The patient eventually died.

Such bacterial evolution has been happening ever since the 1930s and '40s, when science introduced sulfa drugs and penicillin. But it has escalated rapidly in recent years due to several factors: doctors over-prescribing antibiotics during cold and flu season (antibiotics don't do anything to viruses); farmers using antibiotics in cattle, pigs, chickens, and other animals to stimulate growth; and people not taking all of their prescribed antibiotics as directed.

According to data from the Centers for Disease Control and Prevention, an estimated 63,000 hospital patients died in 2002 from drug-resistant bacterial infections. Tens of thousands more require longer hospital stays or more expensive and extreme treatments. And the problem isn't confined to hospitals. Several professional sports teams, including the St. Louis Rams and the Cleveland Browns, have battled persistent, drug-resistant infections among their athletes—perhaps exacerbated by artificial turf, which tends to harbor blood, sweat, and other body fluids while causing rug burns and scrapes that give bacteria an entrance point.

In addition to instituting thorough, aggressive sterilization procedures in hospitals, training facilities, and elsewhere, infectious-disease specialists are trying to better understand the mechanism of drug resistance and develop next-generation antibiotics. They know the search will never end, because evolution through natural selection never stops.



Staphylococcus aureus (50,000x magnification)

EXTINCT ANIMAL HALL OF FAME

Dodo—Now a symbol of the need for preserving threatened species, the dodo was first spotted by Portuguese sailors on the island of Mauritius, off the coast of Africa, in the early 1500s. A large, flightless bird related to pigeons and doves, the dodo nested on the ground and, according to the Dutch, was not very tasty. However, the pigs and cats brought by the explorers apparently disagreed. The introduction of these and other non-native species, coupled with human habitat destruction, led to the dodo's disappearance in the mid-17th century.

Giant Deer—Also known as the Irish elk because of the many specimens retrieved from Irish peat bogs, the giant deer more than lived up to its name. Standing seven feet tall with antlers that could span up to 12 feet, it roamed from Europe to Siberia during the Late Pleistocene era. Possibly surviving to as late as 500 BC, the deer may have disappeared due to climate change and early humans' taste for giant venison.

Megatherium—Picture the three-toed sloth. Now, multiply its weight by a thousandfold and imagine our slow-moving friend standing 20 feet high. Welcome to the age of megafauna, when mammalian dominance was asserted by way of epic proportions. The megatherium, a giant ground sloth, lived in South America until about 10,000 years ago. As with many of its megafauna brethren, human hunting and climate change contributed to its extinction.

Aurochs—The ancestor of modern cattle, aurochs ranged from North Africa through Asia and Western Europe. Featured in the famous cave paintings at Lascaux, France, aurochs were much larger and more aggressive than their descendants, although humans began domesticating them nearly 8,000 years ago in Mesopotamia and the Caucasus. The last of the wild aurochs was killed in Poland in 1627, but attempts have been made to breed back a modern version, with debatable success.

Quagga—This subspecies of the African plains zebra was famed for its strange appearance: with stripes on the upper half of its body and plain brown hindquarters, it looked to be half horse, half zebra. Once numerous in South Africa, the last living quagga died at an Amsterdam zoo in 1883. Later DNA studies—the first to be done on an extinct animal—revealed that quaggas had diverged from other plains zebras about 200,000 years ago, but did not constitute a separate species.

Plesiosaurs—Although abundant during the age of the dinosaurs, these Mesozoic creatures were actually marine reptiles not dinosaurs. Distinguished by their small heads, long necks, large midsections, and four flippers, they had few natural predators. Despite persistent rumors of the Loch Ness monster and other modern incarnations, plesiosaurs died out during the K-T extinction.

Booklet written and edited by Joseph D. Younger and Elizabeth Stocum.

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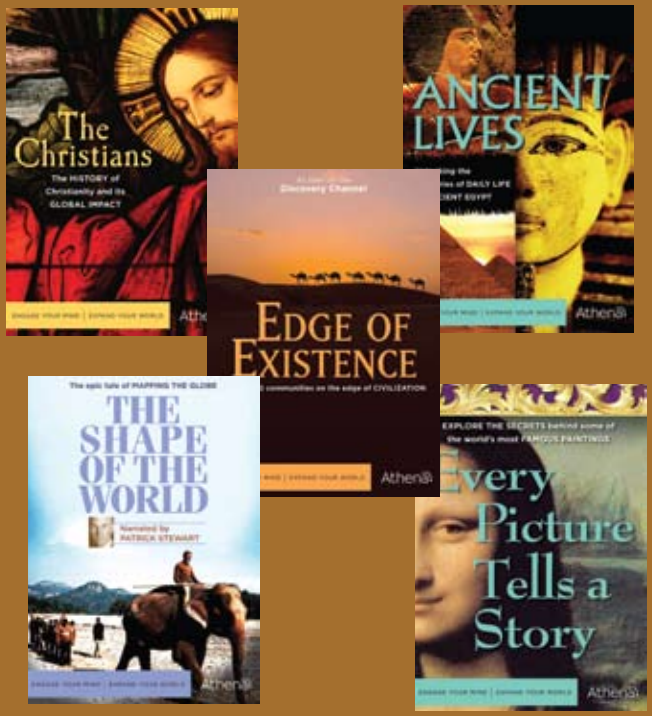

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