A STUDY GUIDE FOR

THE EVOLUTION DIALOGUES

SCIENCE, CHRISTIANITY, AND THE QUEST FOR UNDERSTANDING

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

PREFACE AND ACKNOWLEDGEMENTS

As you will notice, this study guide is arranged parallel to the book *The Evolution Dialogues*, keeping in mind that people will vary in their focus of the material. The four odd-numbered chapters can be used together as an introduction to the nature of science and evolutionary theory. The four even-numbered chapters can be used as an introduction to the history of Christian interaction with evolutionary theory. The chapters also work thematically in pairs. Chapters 1 and 2 both focus on 18th and 19th century developments, Chapters 3 and 4 on the theory of evolution, Chapters 5 and 6 deal with defining science and Christianity, and Chapters 7 and 8 address contemporary understandings of evolution. In some cases, a single chapter might be most useful, such as Chapter 8 for use with readers who have previously assumed that there is only one possible stance a Christian can take toward evolutionary theory.

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We would love to hear about your experience with using this study guide. Please feel free to send feedback to jhuls@aaas.org

THE EVOLUTION DIALOGUES: Science, Christianity, and the Quest for Understanding

STUDY GUIDE

Introduction

Why do some American Christians feel that evolution is a threat to their faith? The dynamic between science and religion has not always been one of conflict as it is often portrayed today. Unfortunately, there is today much misunderstanding about what biological evolution is, what science is, and the variety of views people of faith have exhibited in their interpretations of the evolutionary sciences.

Through this study you should gain an understanding of the origin, development, and current state of evolutionary theory, the science that produces it, and the history of nature that results from the application of modern evolutionary theory. We also present the cultural contexts in which the original theory appeared, the initial Christian reactions, how Christians have understood religious knowledge as compared with scientific knowledge, and the many ways Christians today do actually respond to evolutionary theory.

An understanding of these issues is important because the quality of public science education and the constitutional provision for religious liberty guaranteed in the First Amendment are at stake. Christians and non-Christians alike benefit from such fruits of science as better understanding of energy, medicine, and ecology. These benefits can be lost if science education is undermined either by those who claim that science is the only source of knowledge or by those who claim that scientific knowledge is only legitimate if it conforms to a particular set of religious doctrines.

CHAPTER ONE: SCIENCE IN DARWIN'S TIME

Discover in this chapter: *The scientific context in which Darwin was working.* Evidence for an old earth, extinction, and change in nature over time had emerged before Darwin formulated his theory. This new information required a comprehensive theory that could explain the Earth's natural history.

Terms to understand: **Evolution**
Natural selection
Adaptation

A period of unprecedented scientific discovery

The late eighteenth century found many people in the western world swept into a spirit of scientific discovery. As fossils were uncovered in Russia, Europe and North America, these strange remains raised questions about what had become of the creatures they had once been. Overseas travel brought about the discovery of new plants and animals, land surveyors studied the layers of rock visible at the Earth's surface. Through such endeavors, people sought to discover the natural causes used by God to create and manage the world.

Finding evidence of extinction

Exemplifying this time of discovery, zoologist Georges Cuvier made an important contribution to science by focusing on empirical evidence (repeated observations from nature) rather than speculation. During his time, a viewpoint dating back to ancient Greece, called the "great chain of being" was still popular. According to this understanding, all living things fall into a hierarchy that ascends from the simplest organism to the most complex, with human beings being at the top. It also assumed that each species in the chain had its own ideal structure and function, had always existed on Earth and would continue to exist for all time. But after comparing mammoth fossils on different continents, Cuvier declared that they belonged to a distinct species and also noted that no living mammoth had ever been found. The species was presumably extinct. This new idea of extinction helped to break the ancient "great chain."

Rethinking the age of the Earth

Before the nineteenth century, Earth was commonly held to be only a few thousand years old. This was based largely on the record of events and lineages recorded in the Bible. But closer attention to features of the Earth's surface began to change the estimated age of the Earth. In 1785, Geologist James Hutton proposed that the Earth was actually millions of years old. He noticed on his farmland that the effects of natural processes were gradual and took place over long periods of time. Fellow geologist and naturalist, Charles Lyell strongly supported Hutton's ideas. Lyell carefully observed rock walls and cliffs made of layers of sedimentary rock (formed by bits of older rock, shell, decomposed organisms and salt compressed together under a body of water) and igneous rock (made of crystals and formed at very high temperatures from molten rock). In 1830,

Lyell published his theory that the appearance of the Earth results from small gradual changes, produced by wind, rain, freezing, thawing, earthquakes, volcanoes, and storms.

Pondering the succession of life

Each layer of rock also contained different assortments of plant and animal fossils. Toward the surface, layers tended to contain more complex organisms. Based on this evidence, Georges Cuvier concluded that natural disasters had wiped out certain life forms, which were then somehow replaced. But years later, and building on the work of others, Jean-Baptiste Lamarck came up with a different theory. He speculated that as an organism's needs changed in response to environmental changes such as colder climate, drought and food shortage, it would change how it used its body. Parts would shrink or grow depending on how much they were used. Lamarck didn't believe in extinction but rather in **transmutation**, or the change from less perfect into more perfect.

Darwin makes his contribution

People now grappled with the possibility of a world that was not stable but had undergone a long history of change. Into this era Charles Darwin was born**.** In 1831, aboard the HMS Beagle, Darwin traveled to South America, New Zealand, and Australia, stopping at various islands along the way. Most important was Darwin's experience on a cluster of volcanic islands off the west coast of South America called the Galapagos Islands. The fact that the animal population on each island varied slightly especially interested Darwin. He had been reading works of Lyell on the gradual changes in the appearance of the Earth and likewise began to think that natural forces might also have created the rich variety of life that he saw along his journey. But how? After returning from his sea voyage, Darwin also read *An Essay on the Principle of Population* by clergyman Thomas Malthus who noted that humans (and other breeding forms of life) create more offspring than can survive given available resources. Starvation, plague, inter-species violence kept populations in check. Darwin concluded that individuals with traits more **adaptive** in their particular environment would be more successful. They would be the ones to survive the competition for resources long enough to produce offspring and to pass on their more adaptive characteristics to those offspring. For example, Darwin studied birds on the islands and found that beak length and shape varied according to the seeds a particular island provided. Because of similarities among birds, Darwin judged that they had had a common ancestor but eventually, due to the emergence and prevailing of characteristics most fitting for eating particular seeds, the birds of each island diverged into separate species. Darwin called this process **"natural selection."** He himself acknowledged that he did not invent the idea of **evolution**, but he did discover the mechanism of natural selection, which could be studied as a natural process with testable predictions.

CHAPTER ONE DISCUSSION QUESTIONS

From Angela's story: Have you ever encountered anyone like Lenny? In what ways have your beliefs been challenged by others? In what ways has your education challenged your beliefs? How have you responded in these situations?

1. What long-held beliefs about the world and the way it works were challenged in the early 18th century? How were they challenged?

2. What role did the gathering of observations from nature play?

3. What are some known changes in the environment in recent times? How might these affect the ability of different organisms to thrive and reproduce?

4. Describe Darwin's theory of natural selection and explain how it differed from already existing ideas about evolution.

5. Why might Darwin have refrained from publishing his ideas for 21 years? What might you have done in his situation?

6. A biographer of James Hutton wrote of the old Earth theory that "it would be akin to being told today that the sun is not really the source of the Earth's heat and light, or that there actually is complex life on the moon." How would you respond to hearing such things on the news tonight?

7. As a child, how did you first imagine the beginning of the world?

8. What, for you, is the meaning of the word "creation"?

9. Share what you hope to gain from this study of *The Evolution Dialogues*.

ACTIVITY-In group: Reflect on your own position regarding the theory of evolution. Write down some questions you have as you begin this study. Share and discuss them with the group.

CHAPTER TWO: CHRISTIANITY IN DARWIN'S TIME

Discover in this chapter: *The religious context in which Darwin was working and the ways in which Christians sought knowledge.* Science was commonly used as a way to try to understand God. Some Christians believed that seeking scientific knowledge was a means of giving praise to God.

Terms to understand: **Natural theology**
Special creation
Empirical evidence

The seamless blending of all knowledge

In the 18th and 19th centuries, the world was widely believed to have been created in 4004 B.C. This date was first proposed in 1650, by James Ussher, Archbishop of Armagh, in his book *Annals of the World*. To construct this timeline he used many documents, including the Bible, and careful reasoning. To calculate the year of creation, Ussher started with known dates of the reign of Nebuchadnezzar II and subtracted the life spans of the patriarchs as stated in the Bible. The Bible also mentioned that the fruit in the Garden of Eden was ripe, which led Ussher to conclude that creation occurred in autumn. He assumed that the first day of creation would have been a Sunday for God rested on the seventh day and Saturday is the Hebrew day of rest. With astronomical tables and the assumption that God's creation would correspond with an astronomical beginning, Ussher pinpointed the closest Sunday in 4004 B.C. to the equinox, which led him to the specific date of October 23. In line with the scholars of his time, Ussher combined evidence from the Bible, nature, and history to understand the world.

The world as inferred from the Bible

Most Europeans at the start of the nineteenth century understood the Bible as inspired by God and as literally true in every respect. They gathered that God worked alone to direct creation, was actively involved in it, and created each living thing in its ideal form or "kind" (**special creation**). The book of Genesis implied that human beings held a unique place in creation because they were made last, given dominion over the Earth and its creatures, and created in God's image. Christians had also adopted the "great chain of being" concept from the philosophers of ancient Greece and Christian scholars elaborated on the metaphor, extending the chain to God and placing angels between humans and the creator. The many links to the chain, each slightly different from the next in a hierarchy, gave evidence of God's perfect design and power.

Natural philosophy and natural theology

Up to the 1800s, those who sought to uncover the underlying truth of nature with reasoning, observation, and experimentation were called **natural philosophers**. For Christians, this pursuit of knowledge was a way to know and glorify God. At the time, the Bible and nature were thought of as two sources of distinct but non-contradictory truth. According to Bishop Augustine of Hippo, in the 5th century, any conflict between the books was due to misunderstanding and he rejected the idea that the Bible was truer

than a careful study of nature. The idea that truth is found in both places was advocated later by many great thinkers including Francis Bacon, Galileo Galilei, and William Paley. For many in the 18th century evidence of order in the universe was evidence for the existence of God. This came to be called the **argument from design** and was an example of **natural theology.** Some theologians noted however, that this position did not contribute to the understanding of God's ultimate purpose and that argument from design did not convince most nonbelievers. Some also wondered how disease and natural disaster could reflect God's design and good intentions. But despite such concerns, natural theology had a vast influence on scientific scholarship well into the nineteenth century by encouraging the study of nature.

An evolving sense of history

In the eighteenth and nineteenth centuries, historians and theologians began to apply historical analysis to the Bible, with special attention to context, which included authorship, audience, and literary form of expression. A sense that the Bible was not told from one point of view but from a variety of perspectives reinforced the ancient view that the Bible's truth could not always be a literal one. Instead, it conveyed a complex truth having to do with salvation, rather than nature. This was not easily accepted by many clergy and laity. Free thinkers, rationalists, and atheists who already doubted the authority of the Bible used this research to advance their points of view, adding to religious unease and cultural debate. At about the same time, geologists were moving away from the 6,000 year-old Earth theory, toward the idea of a much older Earth. This raised new questions for religious thinkers. How should they interpret the days in the first chapter of Genesis? Possibly each day symbolized an entire epoch (**day-age theory**); or maybe there had been a vast gap of time between an initial creation referred to in Genesis 1:1 and the six-day creation described in the rest of the chapter (**gap theory**).

With increasing discoveries of fossils, the notion of a fixed "great chain of being" was challenged. Instead of an ascending ladder-like chain, life appeared to be more of a tree that had many clipped or extinct branches. Geologists were divided about the fate of these extinct species. Some held that major events, in particular Noah's flood, had formed the Earth's geology and wiped out earlier species. According to the others, natural processes in operation over large spans of time created small and gradual changes.

While Christians reevaluated Genesis, one of the most important convictions of the nineteenth century emerged. It was that science was to be pursued on the basis of **empirical evidence**, or on what can be learned by observing the natural world. This idea reflected a growing belief that theology and science were concerned with different and separate domains.

Darwin's religious views

Throughout his life, Charles Darwin was enthralled by nature, both by its majesty and its detail. His feelings could have been considered religious, yet he did not subscribe to Christian teachings on revelation, redemption, and salvation. Part of Darwin's trouble with the concept of a God who created and was at work in the world came from the great amount of death and waste that he knew occurred through natural selection. Personal concerns, including the death of his young and favored daughter, also fueled his doubts about God.

Darwin could not believe that the world was a result of the evolutionary process alone, but he could not trust the human mind to grasp the true nature of existence. Darwin once wrote, “I feel most deeply that the whole subject is too profound for the human intellect. A dog might as well speculate on the mind of Newton. Let each man hope and believe what he can.” While he never denied the existence of God, Darwin could never fully embrace God either. As he grew older he concluded that “agnostic would be the most correct description of my state of mind.”

CHAPTER TWO DISCUSSION QUESTIONS

From Angela's story: What do you think of Dr. Phil Compton's use of the line from Psalm 104 "You have set the Earth upon its foundations, so that it never shall move at any time"? How does this contradict with what we actually know about the Earth? Can you think of a time when you have found a literal interpretation of the Bible inadequate?

1. In the seventeenth century, scholars used the Bible, history and nature to understand the world. How did the joint use of these sources aid the pursuit of knowledge and what limitations or concerns were encountered?

2. On what do you depend for knowledge of the world around you? What are the advantages and limitations of these sources?

3. In what ways could science be regarded religiously?

4. Do certain aspects of nature help you with your understanding of God? Why or why not? If so, which aspects? Does your understanding of God influence what you expect the world to be like?

5. What is the difference between agnosticism and atheism? How do you respond to Darwin's struggle over identifying God's role in the processes of nature?

6. Do you believe science can draw people away from belief in God? Why or why not?

7. What is a human being? Answer this question first without reference to religion and then from your religious perspective. Are your answers related? If so, how? What sources or evidence do you draw upon for each of your answers?

8. The abilities to use language and think symbolically (behaviors unique to *Homo sapiens*) are in some way related to our ability to be religious people. How can the human mind be understood religiously? How might human intelligence lead to religiosity?

9. What does it mean that we humans are the ones telling the stories of science? What might it mean that we humans are the ones telling the stories of religion? What limitations might be expected of the human understanding of science and of religion?

ACTIVITY-In group: Write down three things you believe, but cannot prove. Write down something you believed and then discovered was not true. Share these and discuss with the group where our beliefs come from and what factors may alter them.

CHAPTER THREE: THE THEORY OF EVOLUTION

Discover in this chapter: *The theory of evolution as descent with modification*. Life on Earth has changed and continues to change.

Terms to understand: **Mutation**
Microevolution
Macroevolution

Evolution in action

Charles Darwin originally called evolution "descent with modification." Life on Earth has changed, and continues to change over time. Evidence also supports the conclusion that all species are related to each other through a common ancestor. Through evolution, each species has become distinct as a result of tiny, incremental changes to traits that accumulate down through lines of descendants over millions of years. Eventually the total change is so great that a new species emerges.

Natural selection

Natural selection is not random. However, the introduction of tiny changes, or **mutations**, to DNA is. Some of these mutations create changes in traits resulting in increased reproductive success. These are the changes that endure through generations. A well-adapted species may change very little over millennia as long as the environment doesn't change. New mutations will still appear, but rarely result in reproductive advantage if the environment remains stable.

In a changing environment, a species will evolve more rapidly. **Adaptations** that worked before may cease to be advantageous. New mutations may produce changes in traits that better suit them to the new environment, and these genetic changes will spread through populations. This helps explain why strains of the HIV virus are evolving so quickly—anti-AIDS medications create changing environments, which stimulates rapid evolution of the virus.

Other evolutionary mechanisms

In addition to natural selection, evolution is driven by **sexual selection**. In many species males compete for the attention of prospective mates with dominance displays, complex calls, brilliant colors, and other physical shows. Females prefer to mate with the most impressive male, and these males thus transfer more DNA to the next generation. In this way, even genes for traits that do not benefit survival, such as the peacock's enormous tail, can spread through a population. Another mechanism is called **genetic drift,** in which the genetic structure of a population changes randomly over time. Genetic drift is most common in small, isolated populations where the gene pool is small enough that chance events can change it considerably; genes may be lost or their frequencies increased apart from selective advantage.

Microevolution and macroevolution

Microevolution is the small-scale, easily observable change over time that occurs within a species. An example of this is the variety of dog breeds that have descended from a common canine ancestor. Microevolution takes place in a relatively short time-frame as with the finches on the Galapagos Islands. During times of drought, finches with bigger beaks become more numerous because they can crack open a larger range of seeds, giving them an advantage over finches with smaller beaks. This change is observable over only a few generations.

Macroevolution refers to the production of entirely new species. Through mutation, natural selection, and genetic drift a population of an existing species acquires enough new characteristics that it is unable to reproduce with the original species. Macroevolution is not different than microevolution; rather, it is the accumulation of many microevolutionary changes. The definition of what is or is not a species is essentially a human construct. The simplest definition of "species" is a group of organisms that commonly reproduces in the wild. This definition obviously does not apply to asexually reproducing organisms like bacteria. The number of existing species that has been formally discovered is only 1.8 million. It is estimated that there are at least 4 million species, all of which are understood to have descended from one or a few single-celled organisms that were on Earth around 3.8 billion years ago.

Evidence for evolution

Darwin's "descent with modification" theory strongly suggested that all forms of life were related to one another. Today discoveries in chemistry and molecular biology continue to support this conclusion. The physical bodies of all living things are constructed from the same basic cells, which are comprised of the same basic molecules. These cells are more similar across species than they are different.

Homologies offer more evidence for relatedness. These are anatomical structures that are similar across species. The forelimbs of frogs, lizards, rabbits and birds share the same bone arrangements even though each species uses its limbs differently.

Evidence for evolution also comes from **transitional fossils,** which record in stone the change within species, across species and across lines that separate one type of body plan from another. Enough fossils have been found to document the line that descends from early land mammals to whales and from dinosaurs to birds. Fossils also support Darwin's theory in another way. According to the theory of evolution, the earliest, most primitive organisms should be found in the deepest geological layers and the variety and complexity of fossil organisms should increase with each subsequent layer toward the surface of the Earth. And that is what has been found.

If species are related to each other, then similar species should be found close by in time and space, and fossils should bear more similarity to living species from their region than to species in similar habitat elsewhere. This is usually the case, but sometimes the habitat of a living species offers no fossils of related species. In these cases, evolutionary theory predicts that the species have migrated into the territory, and this is what scientists find.

The theory of evolution assumes an ancient Earth. Darwin was very concerned about the 20 million-year-old Earth hypothesis of his day because this did not seem to be a long enough span for the evolutionary process to have produced the diverse life on

Earth. This estimate was calculated by assuming that the Earth was cooling from an original molten state and by measuring the rate at which heat escaped it. What wasn't known at the time was that as the Earth cooled, new heat was being generated through radioactivity. When the effects of radioactivity were considered, scientists calculated that Earth was more than 4 billion years old. This is a much more adequate timeframe for evolution.

Focus on current research

Today, because there is so much evidence to back it, biological evolution is widely accepted by scientists as the best explanation for the variety of life on Earth. However, they still debate the details and there is active and exciting research on a number of questions relating to evolution. These questions include:

When did various species first evolve? New fossil discoveries and DNA findings are allowing scientists to draw more precise "family trees" (or phylogenies") that show when species emerged and how they relate to each other.

How much is the evolution of one species related to the evolution of another? For example, how do plants co-evolve with the birds and insects that feed from them and pollinate them, and vice versa?

How did life originate? Researchers are looking at ways that organic molecules might, under the right conditions, combine into protein and amino acids and replicate to create the first living organisms.

CHAPTER THREE DISCUSSION QUESTIONS

From Angela's story: In chapter 3, Angela and Dr. Laurel Dunbar wrestle with the implications of the struggle for survival within nature. What are your thoughts on why "death and destruction coexist with life and beauty"?

1. Why is the study of evolution important?

2. How does science explain a phenomenon such as pelvic bones in snakes or gills on a human embryo? Are there other mysteries of animal anatomy?

3. How was the estimate of 20 million years for the age of the Earth developed? Why did the estimate change?

4. What are the mechanisms of evolutionary change? Do you think there are limits to how much change they can produce? Why or why not?

5. Discuss the various roles fossils play in providing evidence for the theory of evolution.

6. Discuss how the study of genetics gives evidence for evolution. How about the study of geology?

7. Discuss the resistance of the HIV virus to anti-AIDS medicine as an example of evolutionary change.

8. Could it be true that organisms are never completely adapted? Explain.

9. Why might it sometimes be difficult to define what exactly a species is? If it were up to you, how would you differentiate the organisms that fill the Earth? Why is it important to do so?

10. Think about the talents of a great composer or painter. How might science answer *how* talents develop and faith answer *why*? Do you feel that this dichotomy is useful or limiting?

11. What is astrobiology? How might future discoveries in the field challenge religious views?

ACTIVITY-In group: Divide into two groups and create two lists. *The first list:* Write down what first came to mind when hearing the name Charles Darwin prior to this study. *The second list*: Write down the new things you've learned about Darwin during this study so far. Compare these lists between the groups.

CHAPTER FOUR: INITIAL RESPONSES TO DARWIN'S THEORY

Discover in this chapter: *The variety of ways in which people responded to the theory of evolution*. In a continuously changing world, the purpose of humanity and its relationship to God was less clear-cut. Still, many people, including many Christians, gave the theory their support. However, misuse of the theory encouraged confusion and mistrust, especially in the case of the eugenics movement.

Terms to understand: **Theistic evolution**
Eugenics
Fundamentalist Christianity

A topic of personal interest

Charles Darwin published *On the Origin of Species* in 1859. The book was met with intense interest particularly because it affected people on a very personal level. For some, the book seemed to challenge the idea of God as creator by portraying the history of life as a series of random evolutionary events. Evolution raised the question of whether morality grew from a special relationship with God or was simply an evolved behavior that aided in survival. Responses to Darwin's ideas ranged from outright rejection to unqualified support.

Rejection

The Origin of Species was rejected for numerous reasons. For one, many people believed that apparent change was part of the plan of a divine creator but Darwin's theory seemed to contradict this. It was also argued that the theory lacked sufficient evidence and that it separated science from its appropriate role of illuminating God's work. Some people rejected the book because it conflicted with a literal reading of the creation account in Genesis as well as for its proposal that humans descended from apelike creatures, which many found degrading.

Qualified support

Some of Darwin's colleagues offered only limited support. Charles Lyell, though he pioneered the old Earth theory, could not believe that humans had evolved. He preferred to let the question of human origins remain a mystery. Similarly, Alfred Russel Wallace, the other originator of the theory of natural selection, felt that it did not apply to humans.

Enthusiastic support

Despite all this, Darwin found full support as well. Thomas Henry Huxley, a biologist, believed that humans had evolved although because of their intellect, they were no longer subject to evolution. Huxley was an ardent promoter of *The Origin of* Species and actively defended the theory. Huxley also coined the term **agnostic** to describe those who believed the question of God's existence is unanswerable.

Key support from the Christian community came from Reverend Charles Kingsley who was open to scientific information, believing that it could help his religious understanding. He thought of God as being in all of nature, not only the beautiful facets. He did not see a God who created the world as clashing with a God who worked though the evolutionary process to do so. He wrote to Darwin that he believed it could be just as grand for God to work through evolution as to directly create through intervention in natural processes. Darwin considered Kingsley's support so vital that he included the letter in later editions of his book.

Evolution of scientific and public opinion

Scientists began to examine Darwin's ideas in detail. A main concern was whether the Earth was old enough to uphold evolutionary history. Another had to do with the many gaps in the fossil record. These concerns were eventually overcome by new evidence from the fields of geology and paleontology, and in the space of about 15 years, the vast majority of scientists came to accept the theory of evolution.

However, Darwin's mechanism of natural selection did not gain full scientific acceptance until well into the twentieth century. The problem was heredity. In Darwin's day, it was hypothesized that traits of parents blended in their children. This was a problem for natural selection because it meant that favorable traits that surfaced though mutation would dilute in following generations. Eventually however, the hereditary principles discovered by Gregor Mendel explained how new traits could carry on in a species.

Surprisingly, natural selection was not publicly controversial even before the discoveries that made it plausible. One significant theory suggests it was because natural selection could be used to justify nonscientific and even contradictory views about society. For example, Andrew Carnegie and other entrepreneurs of the era profited from the laissez faire economic philosophy that grew from a "survival of the fittest" ideology. This expression was not originally used by Darwin but was coined by philosopher Herbert Spencer. It allowed the privileged to brush off the poor and uneducated as "unfit." Yet many of these same people were leading philanthropists who funded institutions such as public libraries and colleges for individual improvement within the public domain.

Evolving Christian responses

Endorsement by the scientific community caused some religious theorists to look at evolution as an instrument of God. In the late nineteenth century Pope Leo XIII acknowledged the ancient Christian principle that earlier scriptural interpretations could be mistaken in the light of new scientific knowledge. Roman Catholics came to accept that the human body may have evolved from animal ancestors, but they also affirmed that the soul was later directly created and infused into the body by God. In the United States, some people were using the theory of evolution to justify policies to protect or improve the fitness of humanity. The eugenics movement sought both to encourage the mating of the most fit and discourage mating of those identified as less fit or unfit. Too often were various ethnic communities placed into this latter group including many Catholic immigrants from eastern and southern Europe. This was a distorted social interpretation

of evolutionary science but many Catholics were offended by the eugenics movement and therefore tended to reject evolution.

In the United States, there was no official resistance to evolution by mainline denominations. Even a number of evangelical thinkers of the early twentieth century expressed ideas about how their doctrinal positions could accommodate evolution. B.B. Warfield, an evangelical Biblical scholar, felt that evolutionary processes occurred though natural laws, which were the expression of God's will.

The response from other religions

Neither Judaism, Islam, nor the major Asian religions expressed concern about evolution. Judaism traditionally reads its scriptures though *Midrash*, a process of interpretation by religious scholars sometimes using current science. Islam's Koran contains many references to the natural world, which is therefore considered real, important, and good. Given this perspective, the study of nature flourished in early Islam. Later, Islam was influenced by skepticism that God and God's creation could not be known at all and scientific and theological speculation was disdained. So when Darwin's theory arose, it did not register significantly within Islam. Asian religions such as Daoism and Buddhism are non-monotheistic and do not assume one all-powerful God. Darwin's theory did not challenge their religious views of nature as it did within Christianity.

Build-up toward backlash

By the early twentieth century, scientific evolution was taught in most United States high school and college biology classes. Then several factors merged to create a backlash. The rise of fundamentalist Christianity was one of them. The main concerns of "The Fundamentals" were to identify the basic tenets shared by all Christians. One of these was the authority of the Bible. Some took such authority to mean that every word in the Bible was to be taken on face value as true. From this perspective, the "days" of creation were to be understood as 24-hours long. Non-religious changes also contributed to the backlash. The rise of industrialism the aftermath of the Civil War, the influx of non-protestant immigrants, women's suffrage, and the rights of former slaves all challenged the stability of traditional society with uncertainty and made it more difficult for many people to feel comfortable with a theory in which change and contingency were central.

Perhaps the greatest factor triggering the backlash in the United States was the rapid increase in the number of children receiving public secondary education. What children learned about evolution became a real concern for many parents who were either fundamentalist or opposed to "survival of the fittest" social policies or both.

Evolution on trial

The first law to criminalize the teaching of evolution was approved in 1925 in Tennessee. This set off a course of events that culminated in what is known as the **Scopes Monkey Trial**. John Scopes taught briefly from a text that included lessons on evolution while serving as a substitute biology teacher. He was brought to trial and defended by the American Civil Liberties Union (ACLU) but lost and was fined $100. The case was later dismissed by the Tennessee Supreme Court on a technicality but the law stood for more

than forty years, and four other states subsequently passed laws banning the teaching of evolution in public schools.

Anti-evolutionists were also successful in suppressing the teaching of human evolution in many school districts. By mid-century, the subject of evolution had dropped almost entirely out of public school textbooks.

CHAPTER FOUR DISCUSSION QUESTIONS

From Angela's story: How did you react to Dr. Phil's comment that "among scientists, you will find Christians, including evangelical Christians, along with scientists of other persuasions, who have endorsed Darwin's original theory of evolution and who have pointed out problems and gaps that need to be resolved. Scientists of all stripes have refined the theory through further discovery and research." What does this say about the nature of science? What does this say about the relationship between science and religion?

1. Why were Darwin's ideas considered dangerous in his time?

2. Why are people sometimes still uncomfortable with evolutionary theory today? Have the reasons changed since Darwin's time?

3. Consider the impact on religion of information obtained though scientific research. How might it aid or hinder religious views?

4. Given the Christian belief that God is the Creator of all life, can Christians still accept the theory of evolution?

5. Is there a difference between the possibility of a God who creates all life and the possibility of a God who uses the evolutionary process to do so?

6. How does your exploration of the "mysteries of faith" compare to a scientist's exploration of the mysteries of the natural world?

7. Can you use your religious beliefs together with your scientific knowledge to imagine God's intentions for life on Earth? What might they be?

8. Evolution raises the question of whether human morality stems from a relationship with God or evolved as a behavior helpful to survival. How do you deal with this apparent dilemma?

9. The mechanism of natural selection has at times been greatly misinterpreted especially in the case of the eugenics movement. Describe the erroneous "logic" in the eugenics argument.

10. What fact or issue most surprised you in this chapter? Why?

ACTIVITY-In group: Identify and present the creation stories from other cultures and religions. Discuss the differences and similarities. Select a particular story and examine some of ways in which a person could interpret the story if they accept the theory of evolution.

CHAPTER FIVE: THE SCIENCE BEHIND EVOLUTION

Discover in this chapter: *What science is and is not*. The scientific method uses observation and logic to develop testable hypotheses. Scientific theories encompass many tested hypotheses and are continually refined as new data is discovered. No aspect of science can address supernatural questions.

Terms to understand: **Hypothesis**
Theory
Scientific method
Ontological naturalism

What science is

Science is a process through which to understand the natural world. It explains physical occurrences though observations and logical inferences from those observations. These inferences are then tested against new observations. Our ancestors discovered much about nature though trial and error. They observed that particular effects consistently arise from particular causes. For example, they learned that water flows downhill and that cooked food is often easier to chew. The desire to understand drove humans to seek more knowledge and to join separate insights into more general explanations of how things function. Over time, certain methods were recognized to produce dependable insights and have become the form of practice we now call science.

Levels of scientific knowledge

Science begins with data gathered through observations of the natural world. Observations that have been confirmed again and again are referred to as **facts** (e.g. the Sun is 93 million miles from Earth). Yet some facts remain conditional due to the potential for discovering new evidence. **Hypotheses** are tentative proposals used to explain data and are tested through further observations or experiments. Hypotheses may be falsified by conflicting data or supported by consistent data, but an hypothesis can never be absolutely confirmed or proved.

A scientific **theory** is an explanation of how nature works that encompasses many tested hypotheses. A theory explains diverse observations, presents testable predictions and has not been contradicted by reliable evidence. At the same time, scientific theories are not "provable" in the sense that mathematicians use the word. Developing reliable theories is a main goal of science.

When new findings occur, they are presented to the scientific community who judges the reliability of the findings and their significance for hypotheses and theories. Skepticism is the main approach scientists take toward evaluating each other's work. They often repeat each other's experiments to see if they get the same results and will conduct new experiments to challenge the new ideas. Even well-documented theories may produce observations that are not easily explained by the theory. These observations may stimulate the proposal of new hypotheses and new tests, which often result in modifying the original theory or in abandoning it in favor of another perhaps newer theory.

The construction of knowledge about evolution
In *The Origin of Species*, Darwin presented data on pigeons based on his own observations, visits to pigeon breeders, and correspondence with them. This data led him to hypothesize that in spite of the differences between breeds of pigeons, all were descended from the rock dove and were in fact a single species. To test his hypothesis, Darwin collected more data and found more facts supporting it. For example, he determined that mating two pigeons from different breeds produced offspring that could also reproduce. Darwin combined tested hypotheses about pigeons with other tested hypotheses to form his theory of evolution.

Certainty & uncertainty
Scientists must remain flexible, open to new ideas, and must always strive toward improved understanding. Throughout the history of science, there are many examples of theories that were at first opposed to by the scientific community and that are now acknowledged as reliable explanations of nature. Quantum theory, which explains the behavior of matter and energy in the subatomic world, was once described as "weird science" but it has prevailed because it best fits the variety of experimental evidence gathered over the years. It also clearly explained a range of observations that conflicted with previous theories and successfully predicted further data. This is also the case for the theory of evolution.

Non-scientific interpretations of science
Scientists work to prevent their own motives or bias from affecting their analysis of data. However, everyone has an individual worldview. Many worldviews are informed by science's discoveries about the universe and nature, but worldviews can also negatively impact science. In some cases, worldviews are inflexible, obscuring what science has discovered and preventing a deeper understanding of nature. In other cases, people claim scientific support for aspects of their worldview that are not scientific. For example, Earth is 4.6 billion years old, which is long enough for humans to have evolved through natural selection, but some people claim that humans are the aim or goal of evolution of life on Earth. This is a non-scientific conclusion because intention cannot be revealed through the scientific method. Worldviews also intrude on science when a person declares that science supports atheism or theism. Claims of this sort confuse the definition of science by giving the impression that science answers religious questions. Philosophical interpretation of science has its place, but it is not within science.

What science is not
According to **ontological naturalism**, only the natural world exists. People who believe this are often called **material reductionists** because they reduce analysis of the world to material processes and deny the possibility of other sources of insight. Often, materialist views are presented as science, yet in reality, their subjective nature puts them outside of science. Science is not the only way of gaining knowledge. It is *a* way of gaining knowledge based on information obtained by human interaction with the natural world.

CHAPTER FIVE DISCUSSION QUESTIONS

From Angela's story: Have you or someone you've known ever held beliefs like those of Angela's father? How do you go about a conversation on an issue such as evolution? What are some important things to understand about evolution before trying to do so? How can microevolution (for example, selective breeding to improve a line of cattle) help us understand macroevolution (for example, the relatedness of cows and whales)?

1. What are the different levels of scientific knowledge? How does one level depend upon another? Can "good science" exist if any of the components of the scientific method are missing?

2. People popularly ask science to "prove" something. Why is science about explanation rather than proof? Ho is proof used in other non-scientific contexts?

3. How did Darwin use the scientific method to come up with his theory of evolution?

4. Discuss the danger of personally ideology disguised as science.

5. Can science address the question of meaning?

6. Can science give us answers to questions raised by faith? If not, why not? If so, how?

7. Compare the extent to which knowledge changes over time both in science and in religion.

8. Is it correct to say that a person "believes" in science or evolution? Why or why not?

9. How is the study of science important to the future of the nation and the world?

ACTIVITY-At home: Visit your library or a website such as www.literature.org . Take some time to read Chapter 15-Recapitulation and Conclusion from Darwin's *On The Origin of Species.* Pay special attention to the last passage.

CHAPTER SIX: CHRISTIAN WORLDVIEWS

Discover in this chapter: *What religion is and is not.* Christian knowledge is gained through revelation, tradition, reason, and experience. Religion begins with faith and deals with the question of what things mean.

Terms to understand: **Biblical inerrancy**
Biblical infallibility

Foundations of Christianity

The foundation of Christian belief is a set of writings called the Bible. The writings were penned by a variety of authors over a long period of time and then formally assembled during the first centuries of Christianity. The Bible includes the Hebrew Scriptures, accounts of Jesus' life (the Gospels), theology, personal correspondence, and the history of early Christian communities.

Revelation is a crucial source of Christian knowledge. It is functionally comparable to eastern religions' **enlightenment**. Christians also find knowledge through their **traditions,** which include biblical interpretations, theology, church government, and religious practices. Tradition is a product of another important source of knowledge called **reason**. The value of reason has been debated by Christians. Some feel that God has already revealed all that is necessary through the Bible. Others feel that reason is a gift from God that leads to a deeper understanding of faith. **Experience** is yet another source of Christian knowledge. It takes place in several contexts including the living of everyday life, the application of reason to observations of the world—as in the study of science, and religious experiences, which are often described as a strong sense of the presence of God. These sources of Christian knowledge are dependant on each other and each rests on some amount of faith or assumption.

The Christian Story

The story of Jesus is well known to Christians through the writings included in the Gospel books, Matthew, Mark, Luke, and John. In these writings, Jesus is described as being born in modest conditions to a Jewish family from Nazareth and of having peasant origins but noble roots. As an adult, Jesus became known as a rabbi and healer who preached of God's love for every person and of God's call for people to love God and each other. He also condemned laws and rituals that he believed hindered this expression of love. For this he was seen as a threat to social order and was arrested, tried, and crucified. As described in the Gospels, three days later, Jesus appeared in the flesh to his disciples and after forty days was taken up to be with God. Christians believe that faith in Jesus, who reveals God, is the foundation for a meaningful existence.

Christian Belief and History

What is documented historically is that the disciples of Jesus declared him to be the **Messiah** (**Christ** in Greek), God's chosen one. Through the disciples' work, Christianity spread among Jews and non-Jews in the Greco-Roman world. Today it is the world's largest religion with about 2 billion followers from all over the world. Despite

disagreement on various theological points, most Christians believe that their call is to love God and empathize with others, following the example of Jesus, whom they revere as savior, in order to live in communion with God and other people. Christians believe that nothing, not even death, can separate them from eternal unity with God through Jesus.

Christians acknowledge that they often do not act in ways that follow Jesus' example. But they believe that they are still loved by God and that if they repent their wrongdoings, God forgives them and the relationship is restored. Jesus' crucifixion is viewed as the ultimate revolt against God. His resurrection, however, is the confirming sign that communion with God is possible even after such rebellion.

Christians have organized themselves into major groupings such as Eastern Orthodox, Roman Catholic, and Protestant. Further subdivisions, or denominations, number in the hundreds: Anglican, Baptist, Presbyterian, Methodist and such. In addition, there are many local Christian communities that operate outside formal denominational structures. Each denomination or traditional group may have its own set of teachings, its own creeds, and its own distinctive worship practices. However, the object of all Christian activity is to understand God's will and to be faithful to it.

Contexts of knowing

Revelation, tradition, reason, and experience have an impact on how Scripture is interpreted. Different emphases lead to different interpretations; therefore all claims to Christian knowledge must be expressed with great humility. Most religions agree that the focus of religion is on what things *mean* rather than on what they *are*.

Different contexts of knowing entail different forms of knowledge. For example, take water boiling on a stove. A scientific explanation would involve gas laws, thermodynamics, and water chemistry. In another context it might be explained by the action of a man filling a kettle and placing it on a lit stove burner. Yet another perspective might explain the occurrence by the man's wife's desire for tea and their personal relationship. None of the explanations trump the other. Each is appropriate to its context.

Defining religion

Religion is the pursuit of answers to large questions about life's purpose, ways to conduct oneself, the meaning of suffering, personal status after death, and the nature of the divine. Through religion, humans seek to understand the depths of reality beyond scientific exploration.

Every civilization throughout history has displayed some form of religiosity, which implies its essential connection with human nature. One scientific explanation of religion is that it is an adaptive cultural form, which enhances survival on a group level. But some people find a biological explanation inadequate. For them the universal urge toward religion, even if it can be explained biologically, implies the reality of the depth for which it reaches. According to Huston Smith, a scholar of world religions, "Built into the human makeup is a longing for a 'more' that the world of everyday cannot requite. This outreach strongly suggests the existence of the something that life reaches for in the way the wings of birds point to the reality of air."

Faith as the starting point

Christians believe in some things for which there is no proof. But all knowledge systems depend on faith of some kind. Any system of knowledge is built through shared assumptions, judgments, and experiences of many people over time. Today people generally accept the principles of genetic science without having ever seen any DNA. Though religious doctrines are often tested against cultural circumstances, there is not an intentional testing of doctrine. It is this stance toward testing that is the largest difference between science and religion. This difference may be central to those historical moments that are viewed as conflicts between science and religion.

Contested knowledge

The dynamic relationship between revelation, tradition, reason, and experience is cause for much diversity within Christianity. And with diversity there is often disagreement. Central to these controversies is the attempt to define, for the purposes of scripture, the word "literal." Some Christians hold to **biblical inerrancy,** the view that the Bible is without error in every detail. The word "day" means literally, a 24-hour time span. Yet others believe in **biblical infallibility,** the belief that the Bible is correct in what it teaches. For these people, the Bible can include allegory, metaphor, and parable.

CHAPETER SIX DISCUSSION QUESTIONS

From Angela's story: How do you respond to Dr. Phil's questions, "So what if we are able to explain how the love of God is mediated in the evolved brain? What does it say about the truth of that love?" Can you think of other questions that science and religion approach differently yet where the answers do not contradict?

1. Consider revelation, tradition, reason, and experience. How do you feel that they are related?

2. What assumptions must be made in gaining religious knowledge? In scientific understanding? Is there a difference between assumptions and faith?

3. Identify the types of knowledge required for religious understanding. What role does faith play?

4. Discuss the difference between philosophy and science. In what ways can the two be confused?

5. What reasons might some Christians give for not believing that all organisms share a common ancestor?

6. Discuss how a career in science can be fitting for a Christian.

7. Does the diversity of Christian denominations hinder or benefit Christianity as a whole? How?

8. In which ways does the creation account in Genesis agree with what science has been able to demonstrate about the origin of the universe, Earth, life, and humankind?

9. Is it possible to read texts originating from different times, cultural contexts or languages without interpreting them? If so, how? If not why not?

10. How does your faith tradition define the words "inerrant" and "infallible" with respect to the Bible? How are the definitions similar to each other? How do they differ?

11. How does your faith tradition approach sacred texts? How does this approach interact with other ways of knowing, such as science?

ACTIVITY-In group: Break into groups of three or four people. In each group, come up with a definition of "religion" that everyone agrees upon. As each group presents their definition, identify what was easy about this activity, what was difficult, and the ways in which the definition may have changed during the process of this discussion.

CHAPTER SEVEN: THE WORLD AS EXPLAINED BY EVOLUTION

Discover in this chapter: *The world and humanity as explained by evolution.*

Terms to understand: **Big Bang Theory**
Cultural Evolution

Diversity beyond measure

To date, scientists have discovered and formally described around 1.8 million species, but most estimate the actual total to be between 4 million and 15 million. Even the large mammals have not been fully counted; a new species of the mangabey monkey, *Lophocebus kipunjji*, was discovered in Tanzania as recently as 2005.

One big family

Scientists now know how to decode DNA and this has revealed that the order of the molecules called "base pairs" strung along the DNA is remarkably similar between species. The base pair sequence of human DNA is about 99 percent identical to chimpanzees and about 85 percent identical to mice. The observable differences in the physical and behavioral appearance of humans, chimpanzees, and mice are due to the relatively few genes that are different as well as to the different ways that the shared genes interact and express themselves.

Scientists recognize that species with common traits are not always closely related. For example, the horse and the litpotern, a South American hoofed mammal that became extinct more than 10,000 years ago, look very much alike but evidence suggests that they evolved independently through different lineages on disconnected continents. This is referred to as **convergent evolution**.

There are many cases, however, where similar characteristics appear in different species because they are linked through a common line of descent. This explains the similarities between the bone structure of the wings of bats, the forelimbs of gorillas, and the flippers of whales.

Life's origins

Scientists believe that prior to the first DNA-based life there may have been life based on a simpler hereditary mechanism such as RNA. Prior to that, there may have been organic (carbon-containing) molecules formed by the convergence of methane, ammonia, water vapor, hydrogen gases, and other compounds. Such compounds came into existence when the universe was already several billion years old.

The universe itself originated some 13.7 billion years ago when an infinitesimally small and unimaginably compressed and very hot region exploded outward in all directions. **The Big Bang Theory** is the predominant explanation for this origin, based on extensive evidence and astronomical measurements including evidence that the galaxies are receding from one another.

The line between non-life and first life is not clear-cut. A living thing can be defined by three criteria: it is able to acquire and use energy, it has a membrane that

separates itself from its surroundings, and it can reproduce on its own. Under this definition, the first life forms were ocean dwelling, single-celled organisms that appeared between 3.5 and 4 billion years ago.

The arrival of plants & animals

Bacteria capable of photosynthesis emerged about 3.2 billion years ago and almost a billion years later, oxygen-producing bacteria emerged. Rising oxygen levels created a poisonous atmosphere that extinguished many species, but others experienced mutations that were adaptive to the new atmosphere and these species flourished. In addition, the increase in oxygen created the ozone layer. For the first time in Earth's history, its surface was protected from the ultraviolet radiation of the sun. This meant that life finally had the opportunity to evolve up from the water's depths and onto land. As bacteria and soil built up on the Earth's surface, simple plants and fungi emerged and the next couple billion years saw the appearance of eukaryotes, or organisms with a nucleus. Around 1 billion years ago, the first multi-celled animals formed from eukaryotic cells. These included algae and seaweeds and, later, sponges, jellyfish, flatworms, and marine animals with and exoskeleton.

Eventually, about 500 million years ago, the first animals with spines evolved; these were the earliest forms of fish. Reptiles followed and around 230 million years ago, one of the reptilian lineages gave rise to dinosaurs. The first mammals diverged from a line of reptiles and remained small. Birds also branched out of the dinosaur lineage. Around 65 million years ago, due to a major extinction event, the dinosaurs died out. But birds and mammals survived and over the span of millions of years, these remaining populations recovered, diversified, and became abundant.

Human origins

The history of human origins is still incomplete, but scientists agree on the broad outlines. Some time between 5 to 8 million years ago, there was a major fork in the branching evolution of primate species. The chimpanzee lineage evolved from one set of branches. Modern humans evolved out of the other. Species that fit onto this second set of branches are referred to as **hominins**. Our species is the only surviving branch among numerous members of the hominin family that evolved in the last few million years.

The first several million years of human history took place entirely within the continent that is now Africa but by 1.8 million years ago, some populations began to migrate outward. A major group called *Homo neanderthalensis* evolved from those populations, first appearing in Europe and the Middle East more than 200,000 years ago. Many Neanderthal fossils have been recovered, and research indicates that although they resemble early *Homo sapiens* in some respects, they are not ancestors of modern humans. Rather, they represent another line of hominins that overlapped in time and territory with early modern *Homo sapiens*. They were highly adaptable hunter-gatherers and are the earliest hominin known to bury their dead. There is also evidence that they cared for their sick and injured.

Homo sapiens first emerged in Africa around 200,000 years ago. Spear points appeared around 90,000 years ago, ornamental beads around 40,000 to 50,000 years ago, and artistic paintings around 40,000 years ago. The *Homo sapiens* that moved into Europe some 40,000 years ago had the ability to make symbolic artifacts. This set them

apart from their Neanderthal neighbors, who from remaining evidence do not seem to have advanced far in terms of cultural activity. The creative abilities of *Homo sapiens* may have been connected with their acquisition of language. Language permits information to be transmitted between generations so that knowledge, skills, and inventions can be maintained and elaborated on.

As humans emerged, other lineages of plants and animals continued to diversify and evolve—just as they do today. The most prominent witnesses to evolution in today's world are the rapidly evolving diseases such as HIV and tuberculosis, which through exposure to antibiotic medicines are facing selective pressures that cause resistant forms to survive.

The future of evolution

Two insights can be gained from the story of evolution. One is that humans evolved very late in the history of biological evolution. The other is that of the millions of species that have existed on Earth, humans stand apart. In the 4 billion years of life's history, *Homo sapiens* is the only animal that has acquired symbolic behaviors such as language and art. Distinct from other species, humans operate within a framework of **cultural evolution**.

By virtue of their cultural power, humans have unprecedented effects on the existence of other forms of life on the planet. Scientists identify five major extinction periods in the world's history, and many believe that we are now entering another period of mass dying. "The Sixth Great Extinction," could rival any that has occurred in the past. Thousands of species are disappearing each year. For the first time in human history, existing species are lost more quickly than new species evolve.

The contributing factors to this accelerated rate of extinction are all human-caused and many scientists believe a "Sixth Great Extinction" is still avoidable. According to the Earth Policy Institute, "While this may be the first time in history that a single species can precipitate a mass extinction event, it is also the first time in history that a single species can act to prevent it." Humans have the scientific understanding to live harmoniously with the other species of the Earth. They may, however, need something beyond science to find the vision and will to do so.

CHAPTER SEVEN DISCUSSION QUESTIONS:

From Angela's story: Angela poses the question "Have we co-evolved in some way with the rest of creation, or do we stand apart?" How do you answer this question? Does it have to be either/or?

1. Discuss the ways in which humans, in their short life span, can observe the workings of evolution.

2. What evidence supports the conclusion that all life is connected? What does your faith tradition say about life being connected?

3. Is intelligent life inevitable? Why or why not?

4. How are humans related to all living things? How are humans unique?

5. Why might humans have a responsibility for the Earth that other species do not have?

6. To what extent is extinction a normal part of the process of evolution? At what point must we assume an active role to prevent it?

7. Define the word "creation." Has your definition changed throughout the course of this study? How has it changed or why hasn't it?

ACTIVITIES- In group: Have people bring in a photograph or magazine clipping of some aspect of the natural world. Discuss the spiritual significance of these choices. Arrange them as they would appear on the tree of life as it is understood through evolutionary science. Arrange them according to their possible spiritual significance. Discuss the implications of each arrangement.

At home: Visit the website www.tolweb.org to explore the tree of life and its many branches.

CHAPTER EIGHT: CONTEMPORARY STANCES TOWARD EVOLUTION

Discover in this chapter: *Contemporary issues involving evolution.* Creationism and "intelligent design" deal with supernatural questions that cannot be addressed through the scientific method. Science and religion ask and answer different questions, but there is a growing body of scholarship encouraging constructive engagement.
Terms to understand: **"Scientific" creationism**
"Intelligent design"
Evolutionary theology

A touchy subject

Despite the vast amount of scientific evidence supporting evolution and its widespread acceptance by the scientific community, evolutionary theory remains controversial. Throughout the country, school boards, education policymakers, legislators, teachers, parents, and students are caught up in various policy debates over whether and how evolution should be taught.

Most opponents of evolution are religiously motivated Christians. Yet at the same time, many Christians have sought to relate their beliefs to the science of evolution. Views range from those who would change science in order to make it consistent with their theology to those who would modify their religious understanding in order to take account of an evolving universe. In the middle are those who have addressed the issue by separating science and religion into distinct domains.

"Scientific" creationism

In the first half of the 20th century, science became a powerful force in the United States. Many of the leading evolutionary biologists were located in the United States. Those defending evolution gained judicial advantage in 1968 when the Supreme Court ruled it unlawful to ban the teaching of evolution because it conflicted with certain religious views. Such bans were found to be a violation of the constitutional protection against the endorsement of a specific religion by the government.

Those who wanted creationism taught in public schools began to advocate for what they now called **"scientific" creationism**. Supposedly scientific claims were made to support creationist doctrine such as the claim that the fossil record did not support the hypothesis that new species emerged out of lineages of older species. All of these claims were rebutted by scientists as either erroneous or distortions of science.

Nevertheless, advocates of "scientific" creationism lobbied politically for its inclusion in the public school science curriculum, calling for a "balanced treatment," as if it were a valid scientific alternative to evolution. By 1977 more than twenty states were considering bills that would require instruction in "scientific" creationism whenever evolutionary biology was taught. But in 1987, the Supreme Court found that "scientific" creationism was a religious position, not science, and that to require its teaching was a violation of the Constitutional protection against the establishment of a single religion by the government.

"Intelligent design"

By the 1990s, it was clear that the courts would not permit religious doctrine to dictate science content in the classroom. Yet it was also evident that there were no legal obstacles to teaching alternative scientific theories to evolution, if any could be found. Accordingly, some of those who objected to evolution on religious grounds dropped the term "creationism" from their vocabulary. They began to avoid any religious references and to form their arguments in more scholarly and scientific language. They also re-emphasized their focus on state and local school boards rather than legislatures.

What emerged was a position that has come to be known as "**intelligent design" (ID)**. The concept argues that the emergence of the first living things and certain other biological phenomena have not been explained by science and never can be. ID promotes the notion that there must have been some intelligence involved in these events. This was basically a revival of the **God of the Gaps** position: the idea that what has not been explained by natural means constitutes evidence of a supernatural hand at work. William Dembski, mathematician, theologian, and advocate of ID, has proposed a mathematically-inspired form of analysis that he claims can identify "**complex specified information**" in nature. He holds that such information can only be the product of an intelligent agent. This is a contemporary echo of the early nineteenth century **natural theology** argument of William Paley. Paley proposed that just as a watch found on a heath is evidence of a human designer, so a complex phenomenon found in nature is evidence of a supernatural designer.

Another claim of "intelligent design," developed by biochemist Michael Behe, is that some biological structures are "**irreducibly complex**" systems such that the removal of any one of their parts causes them to cease functioning. ID supporters argue that such structures could not have arisen through natural selection and must have resulted from the actions of an intelligent designer.

Rather than calling for the elimination of evolution from the curriculum, ID advocates commonly seek to undermine evolutionary biology by urging that the schools "teach the controversy." The debate over "intelligent design" is not so much about particular scientific findings as it is about the very nature of the scientific endeavor and whether explanations of the history of nature can be made in terms of nature itself without reference to God. One reason that modern science has flourished since the seventeenth century is that it has limited itself to natural explanations alone. Scientific investigation cannot be based upon reference to the mystery of God, but neither does it eliminate that ultimate mystery.

Scientists respond

The scientific arguments against intelligent design are extensive. One main point is that the formation of so-called "irreducibly complex" systems, such as the complex eye, can readily be explained through natural causes alone. Furthermore, the fact that a complex phenomenon has not yet been explained through natural causes is not evidence for the intervention of an intelligent designer.

"Intelligent design" presumes that the actions of a supernatural designer can be detected through scientific inquiry. But supernatural entities by definition operate outside of natural laws and so cannot be investigated using methods of experimentation. Thus,

intelligent design encourages the abandonment of scientific inquiry about natural causes by prematurely declaring an ultimate cause.

Science is full of examples of previously mysterious mechanisms that are now at least partially understood such as what causes disease or what causes tornados. It is the "unknown in nature" that drives scientific inquiry into the depths of nature.

Creation and Evolution as Complementary

Many Christians have no difficulty with evolution. This is because they hold the idea that science and religion constitute different but complementary forms of truth. According to paleontologist Stephen Jay Gould, science and religion are two ways of knowing that do not conflict because of the "lack of overlap between their respective domains of professional expertise—science in the empirical constitution of the universe, and religion in the search for proper ethical values and the spiritual meaning of our lives."

Recently, Christians have been taking more public stances in support of evolutionary theory, for many reasons. One is to affirm that Christianity has historically encouraged scientific pursuits. Another is to show that faith in God as Creator can be consistent with an evolutionary understanding of the history of the universe and of life on Earth. But for some, the most important reason is that evolutionary theory stimulates in positive ways their own evolving understanding of God.

Creation and Evolution as Interactive

There are questions that cannot be addressed if science and religion are kept separate. How exactly would God operate through the details of evolution? If human beings are subject to extinction or to evolutionary transformation, what does it mean to say they are made in the image of God? Different approaches to these questions include **evolutionary theology,** which views God as continuously and intimately engaged in an ongoing creation of the universe through evolutionary processes, and **process theology,** which suggests that God creates the world by enabling it to create itself and that God is affected as the universe evolves. For those who believe that science and Christianity are interactive, the search for constructive conversation between the two is ongoing. All we know for certain is that there are no easy answers to the questions.

CHAPTER EIGHT DISCUSSION QUESTIONS:

From Angela's story: How has Angela responded to what she has learned in her freshman year of college? What conclusions has she drawn? How has she changed? How has she remained the same? What conclusions have you drawn during this study?

1. Do you believe that teaching creationism or "intelligent design" in the public schools is a violation of the Constitution? If so, why? If not, why not?

2. What differences do you see between "intelligent design" and "scientific creationism"?

3. Why might "intelligent design" be attractive to many people?

4. How is the word "theory" used by ID advocates? How is it defined in science?

5. What impact do you believe the "intelligent design" debate has had on students and teachers?

6. Explain the proposal to "teaching the controversy" and give your assessment of it.

7. Would it be sensible to teach atomic theory or the theory of gravity by way of their supposed weaknesses? Why or why not?

8. What have been the strategies of anti-evolutionists since the 1920s?

9. How do you respond to the questions theologian John F. Haught poses below? "Hasn't Darwin's evolutionary science placed in serious doubt the religious sense we inhabit a meaningful universe? Or is it instead possible that what scientific skeptics often take to be the religiously ruinous consequences of Darwinian thought are in fact fresh openings to mysterious sacred depths of reality previously unfathomed? And in these depths will we find only an abyss of absurdity, or perhaps instead the sustaining presence of a truly living and renewing God, one who can command the fullness of our worship and one to whom we might still pray with love and confidence?"

ACTIVITIES-In group: Examine newspapers and magazine articles for stories relating to the public controversy over teaching evolution.
At home: Get the view of a student on what they are or aren't being taught in their high school science classroom. Ask them how they respond to what is being taught and why.