RESOLVING A CREATION CONTROVERSY

A MATTER *of* DAYS

SECOND EXPANDED EDITION

HUGH ROSS

FOREWORD BY WALTER C. KAISER JR.

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“Dr. Ross endeavors to literally interpret Scriptures and the latest scientific data to show how they are in agreement. Even if you disagree with his conclusions, you will benefit from reading this book. I highly recommend it.”

—John Ankerberg, host, *The John Ankerberg Show*

“This book is an in-depth treatment of the creation events, giving deep insights in both the meaning of the biblical text and the latest scientific data. An honest treatment worth reading by anyone interested in the beginning. A must-read.”

—Rogier A. Windhorst, professor of astronomy, Arizona State University

“In *A Matter of Days*, Hugh Ross shows that a creation date of billions of years ago is not incompatible with a staunch belief in the inspiration and inerrancy of the Bible. He also explains why scientific arguments for young-earth creationism do not hold up. Ross’ call for Christian theologians and scientists of differing viewpoints to work together to resolve their differences amicably is especially appealing.”

—Robert M. Bowman Jr., executive director, Institute for Religious Research

“Since God is not the author of confusion, it follows that any apparent discord between faith and science lies in the limits of human understanding. *A Matter of Days* urges us to challenge those limits. Ross’ clear and ably reasoned work pushes us to better com- prehend the inner workings of creation.”

—Brock Thoene, novelist, coauthor of *First Light*, amateur astronomer

“The issues of the age of creation and the length of creation days are currently painful points of contention within the evangelical church. It need not be so. In fact, these and related issues can be very effectively used in evangelism. In *A Matter of Days*, astrono- mer and evangelist Hugh Ross discusses the problem

and the arguments on both sides of this controversy with biblical and scientific integrity, while appealing for calm on all sides. He ends with a proposal for resolving the controversy in a way that could bring peace to the church and glory to God. I strongly encourage all who are interested in issues relating to science and the Bible to read this book and to pray, as I do, for such a peaceful resolution."

—Kyle Cudworth, professor of astronomy, University of Chicago
and Director of Yerkes Observatory

HUGH ROSS

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RESOLVING A CREATION CONTROVERSY



Covina, CA

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In loving memory of Alice Coles, the Arkansas grandma

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Hugh Ross
2015

Foreword

If you are unfamiliar with any of Hugh Ross' previous contributions to the discussion of the harmony that exists between science and Scripture, this second expanded edition of *A Matter of Days* you hold in your hands will be an unexpected treat. In addition to his outstanding accomplishments in astrophysics, Hugh has been an excellent guide for the evangelical community by showing how Christians can and ought to engage each other and the scientific community with grace, humility, and excellence in the fields of biblical scholarship and cutting-edge scientific research.

It seems too late in the "day" for the Christian church to be so vigorously engaged in the "creation-day/age" controversy that is all-too-often filled with declamations and invective. Such discussion threatens to tear apart the body of Christ. Hugh reminds his readers that nearly forty years of serious attempts to reconcile this dispute have not succeeded. One would have thought that by now the focus of the joint efforts of the Christian community would have been to engage the secular scientific world and their mechanistic conclusions that the universe, mortals, and all that exists on the planet came about without the creative word or hand of God. Sadly, however, too many in the Christian academic community have exhausted their efforts in condemning fellow believers for not agreeing that the universe is very young, and that the "days" in Genesis 1 are 24-hour days.

The fact that most Christians in both young-earth and old-earth groups agree that there was an absolute beginning for the creation of the universe, and that each aspect of the created order came about as a result of the spoken word of God does not seem to attract much attention. This impasse over the timing of creation impedes the witness of the gospel to a watching world that should know we are believers in Christ by the affection we have for each other. How, then, will the world know that we are Christ's disciples if we fail to show the love for each other that our Lord enjoined us to exhibit?

Several serious attempts to resolve these matters have occurred in recent decades, including the International Council on Biblical Inerrancy (ICBI), which commenced in 1977. Two position papers (on the creation days) presented opposing conclusions, and the group (of mostly evangelical theologians and some scientists) concluded that adherence to six consecutive 24-hour creation

days was not essential to maintain belief in biblical inerrancy. All but one scholar—the one who presented the 24-hour creation day position—agreed to sign a statement to that effect. In an effort to achieve unity, the council revised its statement of affirmations and denials and said that only a finite date for creation—without any assertion about cosmic or geological ages—would be sufficient for signing the inerrancy statement.

In the late 1990s, the Presbyterian Church in America (PCA) formed a committee to consider the duration of the Genesis days. After two years of study they produced a 92-page report outlining four different views on the days of creation that were judged to be acceptable positions for the denomination. Later, Westminster Theological Seminary faced the same challenge. They, too, formed a study committee that ultimately concurred with the PCA report.

More recently, a different kind of council watched old-earth astronomer Hugh Ross and young-earth astronomer Danny Faulkner debate on *The John Ankerberg Show*. They debated in 2009 on television before a panel of thirteen Christian astronomers who then wrote and signed a one-page evaluation. Their analysis contained no rancor whatsoever and they concluded that Earth was old.

Despite such efforts at reconciliation, the issue remains a thorn in the Christian community's side. Therefore Dr. Ross proposes a test of the two models: 24-hour creation and day-age creation. Hugh has singled out 18 testable items that each view predicts. Thus, whereas councils, studies, and debates have failed to bring tranquility to the Christian community, much less be a witness to a watching scientific world, perhaps the testing of these models for their accuracy might help effect what other attempts have failed to produce.

It is a personal pleasure to commend Hugh's second edition of this work to both the scientific and Christian communities. Hugh is certainly one of the gifts God has given to the church and to the world. May the evidence he has accumulated for this book be an example of the promise of an even larger body of excellent work emerging from Christian scholars!

—Walter C. Kaiser Jr., president emeritus
Gordon-Conwell Theological Seminary

Introduction

The Dawn of a New Day

Two passions motivate the writing of this book: the study of God's Word (the Bible) and the study of His creation (science). Sadly, even though zeal for motivating others toward these lifelong endeavors consumes most of my time and energy, I've met unimaginable and disheartening opposition along the way.

Debates over the age of the universe and earth and the length of the Genesis creation days have—for the past several decades—deeply divided the evangelical Christian community. Instead of dissipating with each new discovery, the confusion and conflict increase. This impediment to Christian unity appears to be heightening into a storm of ferocious fury.

One might suppose the worst resistance to an evangelical scientific message would come from non-Christian scientists. Such is not the case. The most stinging attacks come from within the body of Christ, from God-loving members of the church who suppose that the facts of nature—unless interpreted through a particular view—cannot possibly line up with the truths of Scripture. For this reason they call me a compromiser and, worse, a heretic. That anyone could believe such a charge breaks my heart. So does the accusation that I don't care about the salvation of nonbelievers.

What could generate such tension and divisiveness? One simple word: "day." For some Christians (young-earth adherents), a "day" of creation means a 24-hour period. From this perspective, the creation week described in Genesis consists of six days—a total of 144 hours. For other Christians (old-earth proponents), the six days equate to six long, finite periods of time—ages or epochs of millions of years each.

I founded the evangelistic organization Reasons to Believe, in part, because of my concern for those who cannot reconcile the young-earth concept with their scientific observations. I write this book to show how the record of nature affirms Scripture's truthfulness and how the Bible affirms the trustworthiness of nature's record. Powerful evidence exists that can draw thinking people toward a relationship with the Creator and Sustainer of the universe, Jesus Christ. This book reveals much of that evidence, giving intellectually satisfying reasons to believe. Christians will want to read it in order to develop an effective and

comprehensive set of biblical and scientific tools to help them respond to objections to the faith.

But there is perhaps a greater reason to read this book, and it is my main purpose for writing and speaking on this topic so often—to bring reconciliation, as much as possible, to the church. For too many years this storm of controversy over the length of the creation days has raged within the body of believers. Though belief about the age of creation or the length of a day has little bearing on the essential teachings about God's redemptive provision for repentant human beings, divisiveness hinders the Christian example of love for one another (1 John 4:7–12). Anger over this issue thwarts evangelism and does not accomplish the purposes of God (James 1:19–20).

An urgent need exists within the church for the dawn of a bright new day. This awakening can come through awareness of the issues involved in the controversy. Looking at how they were dealt with in the past, the theological and scientific concerns, better interpretations, and some suggestions for how the body of Christ can address them in the future can help the reconciliation process. Objective testing of soon-to-be-fulfilled scientific predictions from both the young- and old-earth positions offers even stronger hope for unity. Peace could reign in just a matter of days.

Chapter 1

Flash Point

Sticks and stones may break bones, but words do more damage than most people can imagine. Especially name-calling. “You’re dangerous!” “Deceived.” “A false prophet.” “A compromiser!” Charges like these by young-earth leaders, both spoken and implied, are intended to discredit, harm, and crush old-earth advocates, including me.[1]

Because I’m both an astronomer and a pastor, one who prefers to build bridges rather than burn them, I’ve been reluctant to participate in public debates with young-earth proponents. Yet in 1999 I consented to a nationally televised debate on the age of the earth and the length of the Genesis creation days with young-earth speaker Kent Hovind on *The John Ankerberg Show*. Ankerberg invited Hovind and me to dinner the night prior to the debate to remind us (as he had on several previous occasions) that we’d been selected for this public exchange because of our reputation as “gentlemen.” Ankerberg expected considerate behavior. I thought Hovind and I both understood and agreed. But during the debate, in spite of Ankerberg’s many remonstrances, Hovind let go of common courtesy, and I struggled to retain composure in the face of outrageous innuendos.[2]

Hovind is not the only Christian to call me (and other old-earth proponents) derogatory names. Nor is the problem new. Young-earth creationist Russell Akridge, addressing the 1982 Annual Creation Convention, berated astrophysicists and astronomers as “high priests of this decades-old cult” of the “big bang myth” and as “persuasive speakers [who] have deceived an unsuspecting public.”[3] Making this kind of offensive claim against the worldwide community of secular astrophysicists and astronomers only drives resistance to Christians and Christian teachings deeper. Given scientists’ tendency toward independence and nonconformity, the suggestion that millions of them would band together to carry out a plot to mislead the public seems unimaginable. Indeed, as young-earth creation scientists themselves admit (see chapter 17), they know of no modern-day scientist who, independent of a particular Bible interpretation, has ever concluded that the universe or Earth is less than millions of years old. The controversy over the age of the universe and

Earth is strictly an internecine debate among evangelical Christians, Jews, and Muslims. Another explanation must exist for scientists' strong and united confidence in an ancient universe and Earth (both billions of years old).

Insults such as the ones described have generated hostility, to say the least. They shut down communication. And they hinder the witness of many scientists who love God and want to impact the world for Jesus Christ.

Personal Encounter

I came to trust in Jesus as my Savior after a two-year personal study of the Bible that convinced me that Scripture is free of contradiction and error—doctrinally, historically, and scientifically. But as a young man, I couldn't find a church or Christian group (within walking or bicycling distance from my Canadian university) that upheld biblical inerrancy. Upon coming to the United States, I was overjoyed to meet many Christians, even fellow scientists, who were convinced that the Bible is completely trustworthy. Some showed great interest in my personal journey toward faith, especially in the study that led me, as an astronomer, to give my life to Christ. Within a couple of years, I was invited to speak on science and the Bible at a Christian conference.

After my first message, a group of angry men in crisp business suits headed my way. One of them waved the pamphlet *What Is Christianity?* in my face.[4] He said, "I thought you were a genuine Christian, based on what you wrote here, but your other booklet forced me to change my mind." The disturbing words in that "other booklet," *Genesis One: A Scientific Perspective*, implied that the universe is billions of years old.[5] So he and his friends concluded, "You cannot possibly be a Bible-believing Christian!" My wife, Kathy, stood by my side, too stunned to even speak.

This was my first exposure to the raging storm of the creation-day controversy. I offended those men by failing to mention the creation timescale "problem" in my talk. Yet, up to that moment, I was barely aware that such a problem existed. The solidity of the scientific evidence for both Earth's origin (a few billion years ago) and the universe's beginning (a few more billion years ago) raised not a moment's doubt about the necessity of a Creator. Nor did it cause me concern when I first read the Genesis 1 creation account. It honestly did not register with me that anyone could or would see a need to propose that the earth and universe are only a few thousands of years old or that the Genesis days are consecutive calendar days. The truthfulness of the text and the necessity of divine intervention faced no threat from the facts about Earth's or the universe's age.

Battered by Words

Many Christians, including scientists and others who value science, have been displaced or alienated by this storm. Evangelical leaders who believe the Bible is true and that the universe and Earth are as old as the stars and rocks proclaim are often denounced as men and women whose lives and work "do not lead to soul-winning or spiritual growth, but to apostasy."[6] These are serious charges. Moreover, lists of the accused have been published, including biologist Pattle Pun and his colleagues at Wheaton College, most of the authors and officers of the American Scientific Affiliation, Gleason Archer, Charles Hodge, Benjamin Warfield, former young-earth creationist Dan Wonderly, Charles Hummel, and Hugh Ross. (Yes, my name shows up on the lists, too.)[7] Such lists, and the attitudes that generate them, cause many Christians to become distrustful and even disdainful of scientists. Without malice aforethought, they begin treating science as an enemy of the faith.

This polarization is not new. For the past 200 years, the scientific and religious worlds have thundered at each other in a series of battles over God. Traditionally, conflict focused on crucial questions:

- Does God exist?
- If He does, is He the God of the Bible?
- If He is the God of the Bible, how involved was He in forming the universe, Earth, life, and the human race?
- Is the Bible reliable, free of contradiction and error?

In the past 40 years, however, the debate has veered from these core issues. Now the hurricane of controversy whirls around a peripheral point—the age of the universe and of Earth.

Scientific discoveries keep the tumult in the public eye. Ours is the first generation ever to measure the size, age, and historical development of the universe. Astronomers now have produced stunningly detailed images of the universe when it was just 0.003 percent of its present age.[8] The polarization signals in these images reveal the physical state of the universe a mere ten billionth of a trillionth of a trillionth of a second (10^{-34} seconds) after the cosmic creation event.[9] Sadly (and ironically), news of these astounding detections raises anxiety rather than excitement in the evangelical community. Why?

Though it spectacularly affirms biblical cosmology (see chapter 13), such data threaten belief in a *recent* creation date for the universe.

Many Christians are raised believing that to be true to God's Word means to accept that the universe, Earth, and life were created in six 24-hour days, only a few thousand years ago. Most people lack the theological and scientific tools to think through the implications of this teaching. In an attempt to stay out of the storm, they remain distressed and confused. Yet a personal, internal storm threatens to break out: scientific facts versus scriptural integrity, the natural record versus the written words of the Bible. These people love Jesus but long for simplicity—a cosmos not so mind-boggling, vast, and complex, with answers untainted by the presumed corruption of scientific and theological research.

In their bewilderment and longing, some of these Christians stay away from science, never even considering it as a tool for sharing their faith with those who don't know Jesus. They steer clear of organizations that use science to reach people for Christ. Thus, their faith can't be strengthened and supported by scientific evidences. Even more alarming, many skeptics who need solid evidence to resolve their doubts remain untouched by the claims of Christ. Such people (educators, politicians, community leaders, and others) perceive evangelical Christians as nonthinkers or even as antiscience or antireason. Because the creation-day issue has divided many believers, young- and old-earth creationists often focus more energy on defending their respective positions than on reaching out to those who don't yet believe the Bible is true.

Distortions Deluge Society

The young-earth viewpoint and the desire to avoid science have inoculated a large segment of society from taking seriously the call to faith in Christ. Thus, because of a belief in a universe and Earth only thousands of years old, the groundwork has been laid to discount the Bible's credibility and remove "religious notions" from public education and the public arena.

Worse yet, courts in North America have come to perceive the length of creation days as a central issue of Christianity. Some leaders who don't want creation taught in public schools are delighted that a majority of evangelical Christians accept a young universe and a young Earth. They exploit this belief to win their court cases, keeping creation teaching out of public institutions. Of greater importance, they believe that by discrediting Genesis they can demonstrate a flawed Bible. This "faulty creation message" is used to discredit the deity of Christ, the inerrancy of Scripture, the sanctity of life, doctrines on heaven and hell, and so forth. If the creation account is implausible, what basis remains to believe anything else the Bible declares?

An example of this line of reasoning is articulated in the book *Steve Allen on the Bible, Religion, and Morality*:

> The fundamentalist argument against the scientific assertion of the great age of our planet—to the effect that God created the earth only about 6,000 years ago, including fossils embedded in rocks—is unworthy of serious discussion.…It is now recognized by every intelligent and informed person that the two [Genesis and science] cannot be reconciled. …Nor should we be guilty of the error of assuming that the problem relates only to Genesis. It touches the New Testament as well.[10]

Many educators use the age of the universe to marginalize, patronize, and abuse the Christian community with statements such as these: "If you are a Creationist, the Bible—not nature—dictates what you believe."[11] "The spurious stories in Genesis are simply absurd. Yet, they do represent a conceptual framework from the undisciplined imagination of a prescientific age."[12] "The biblical story of creation has great poetic beauty and metaphorical power."[13] These comments expose the widely held assumption that all evangelical Christians reject the integrity of science and accept young-universe creationism. (The term *creationist*, for example, is rarely qualified, though one can be a creationist without adhering to a young-universe view.)

Atheist Michael Ruse goes even further: "There are degrees of being wrong. The Creationists are at the bottom of the scale. They pull every trick in the book to justify their position. Indeed, at times they verge right over into the downright dishonest.…Their arguments are rotten, through and through."[14]

A Destructive Controversy

Few Christians comprehend the devastation wreaked by the creation-day issue. Many people dismiss the Bible because of it. The sad irony is that the creation date need not be a difficulty. (See "What the Fuss Is *Not* About.")

The Bible never states that the world is only several thousands of years old. It does not add up the years of the genealogies in Genesis 5 and 11 to infer a conclusion about humanity's antiquity. In this respect the Bible appears to place little importance on the questions of the *when* of creation.

More than twenty lengthy creation-related passages within Scripture (see table 6) emphasize most strongly the *who* of creation. To a significant degree, they explain the *how* of creation. And to a much lesser degree, they discuss the *when* of creation. In other words, the Bible itself places far more importance on

the factual nature of the creation events than on the length of the Genesis 1 creation days.

The Bible's central teaching about how men, women, and children may receive redemption from sin and enter into a relationship with God makes this order of emphasis entirely appropriate. Misidentifying God or His key attributes could destroy the possibility of a person's relationship with Him. Misunderstanding God's strengths, capabilities, and past works can impair the trust required to build intimacy. But misidentifying the timing of God's past works in the cosmos has little or no bearing on that closeness. Nor does it bear upon the Bible's authority. Yet this one doctrinal point stands at the center of the tempest.

Young-universe Christians claim that the Bible can *only* be interpreted as teaching that all creation took place in six consecutive 24-hour days about 10,000 (10^4) years ago. Old-universe Christians say the text allows ample room, with no compromise of inerrancy, for creation days of longer duration and even for a cosmic origin date of just over 10 billion (10^{10}) years ago.

What the Fuss Is *Not* About

Some Christians fear that believing in a billions-of-years-old Earth and universe means they must accept an evolutionary history for the human species. From their perspective, the old-earth view implies a denial of Adam and Eve as literal historical persons from whom the human race descended. But this is an inaccurate notion.

Years ago, at a conference on the Genesis creation accounts, I shared the speakers platform with three old-earth creationists and one young-earth creationist. Someone from the audience asked the panel, "Did God literally create Eve out of a rib of Adam, as described in Genesis 2:21–22?"[15]

To everyone's surprise, each of the old-earthers—despite significant differences among us in our interpretation of Genesis—expressed belief in God's direct creation of Eve (and Adam) within the past 100,000 years. Each of us appealed directly to the Bible for support, upheld biblical inerrancy and supernaturalism, and in no way capitulated to naturalistic evolutionary theory.

Meanwhile, nontheists demand far more time for natural processes alone to produce the cosmos, Earth, and life. In the 1930s, mathematician Sir Arthur Eddington rejected big bang cosmology so as to "allow evolution an infinite time

to get started."[16] In the 1980s, biochemist Harold Morowitz demonstrated that if all the chemical bonds in the simplest known independent life-form were broken, then under ideal naturalistic conditions it would take $10^{100,000,000,000}$ years for those atoms to reassemble into that life-form.[17] Today, physicists like Stephen Hawking, Lawrence Krauss, Leonard Mlodinow, and Victor Stenger are speculating about spacetime constructs that would conceive of the universe as a component of a multiverse that would be of near infinite age.[18]

So, young-earth creationists differ from old-earth creationists by only six zeros, while at least a hundred billion zeros separate naturalists from those who believe in the Creator. In the past I've called this difference between young- and old-earth proponents trivial, referring only to mathematical terms. This perspective in no way suggests a trivial difference in other respects. My intent was to indicate that young- and old-earth creationists are mathematically much closer to one another than they are to any form of naturalism. Thus, the controversy seems largely unnecessary.

The emotionalism associated with the young-earth versus old-earth debate also seems unnecessary. I admit that my own attitudes need continual growth and change, especially when I encounter personal insults and injuries. So do my communication abilities. Defensiveness and hyperbole only contribute to the problem. Remembering the factual basis for my position helps me maintain a sense of objectivity:

- Science is an attempt to interpret the facts of nature.
- Christian theology is an attempt to interpret the words of the Bible.
- According to that theology, God created the universe and is responsible for the words of the Bible.
- Since the Bible repeatedly declares that God cannot lie, no contradiction can exist between the words of the Bible and the facts of nature.
- In the past, both the facts of nature and the Bible's words have been misinterpreted and such misinterpretations have been identified and corrected.
- Therefore, any conflict between scientific findings and Christian theology must be attributed to human misunderstanding or misinterpretation.
- Such conflicts need not cast doubt on the integrity of the Christian faith or raise suspicion toward all science and scientists.
- Such conflicts indicate that further research is needed.

Additional research will help resolve conflicts. Yet, with so many storm clouds swirling, can anyone hope for a peaceful end to the tumult? I can and I do. The desire for reconciliation motivated this book. It impels me to address the controversy. I write these pages with the hope that I can contribute to the peacemaking process by presenting sound reasoning that challenges unbelief and nurtures faith.

I'm persuaded that more than enough evidence is now available to resolve the conflicts between science and faith—young-earth and old-earth perspectives. No compromise of integrity is required by either side, not by the Christian who upholds the inerrancy of God's Word nor by the scientist who trusts in the established facts of nature.

A first and essential step toward resolution is to trace the historical growth and development of the creation-day controversy. Acrimony didn't arise overnight. Though the date for creation has been debated since the birth of the Christian church, that discussion remained open and friendly for over 1,500 years. Then, beginning just a couple of centuries ago, friendly dialogue degenerated into polarization.

Chapter 2

The Gathering Storm

Throughout the Middle Ages, church scholars maintained a tolerant attitude toward differing views and interpretations of the length of creation days. A few Jewish and Christian scholars added up all the years attached to the different genealogies mentioned in the Bible, with dates for "the beginning" ranging from about 5,630 years to about 9,000 years.[1] These scholars didn't necessarily consider their calculations to be reliable methods for dating the origins of creatures or of the planet. Rather, they saw the dates as rough tools for ordering human events relative to one another.

In the mid-seventeenth century, however, two British scholars, John Lightfoot and James Ussher, produced commentaries that seeded the clouds of dissension. In their zeal for exactitude (and personal competition), they inadvertently opened the gates for a drenching dogmatism that divided Christian from Christian, and faith from fact, for centuries to come.

Assumptions Cast Their Pall

In 1642, just 31 years after completion of the King James translation of the Bible, Cambridge University Vice-Chancellor John Lightfoot published his voluminous calculation of the exact date for the creation of the universe: September 17, 3928 BC. He arrived at this conclusion by analyzing the genealogies in Genesis, Exodus, 1 and 2 Kings, and 1 and 2 Chronicles.

Eight years later, Anglican Archbishop of Ireland James Ussher corrected Lightfoot's date. His copious commentary and calculations changed it to October 3, 4004 BC. Ussher's work also derived specific dates for every historical event mentioned in the Bible.[2]

In a final round of academic sparring, Lightfoot adjusted Ussher's date. He concluded that all creation took place the week of October 18–24, 4004 BC, with the creation of Adam occurring on October 23 at 9:00 AM, 45th meridian time. This extraordinarily precise conclusion provoked considerable mirth among both Bible scholars and critics, but its far-reaching effects are nothing to laugh about.[3]

Perhaps it was the heady atmosphere of England's intellectual ascendancy, perhaps it was academic intimidation or ambivalence, but some force ensconced

the 4004 BC date firmly in the minds of millions. Though this date left much room for question and critique, it was accepted as God's own truth, with little challenge for more than a century. Both Lightfoot and Ussher ignored Hebrew scholarship and assumed no generations were omitted from the biblical genealogies. They also assumed the Genesis 1 creation days to be six consecutive 24-hour periods.

From the turn of the eighteenth century onward, the King James Version incorporated Ussher's chronology as margin notes or even as headings in the text of its various editions. Many readers had difficulty distinguishing the commentator's chronology from the inspired passages. Further, the King James translation quickly became *the* translation for the English-speaking world and the dominant text of Protestant Christianity as it spread around the globe. This intertwining of dates and text—and the lack of serious questioning of the dates for so long—helps explain how Ussher's time frame came to be viewed as authoritative by many sincere believers nearly everywhere Protestant Christianity took root.

A Disputed Label

Many young-earth creationists react to being labeled "Ussherites." Though they agree with Ussher that the Genesis creation days are six consecutive 24-hour periods, some deny his assumption that no generations were omitted from the biblical genealogies. (For biblical background, see "A Biblical Calendar" in chapter 20)

Young-earth creationists who believe there are gaps in the genealogies estimate that the universe was created anywhere from 10,000 to 50,000 years ago. From their perspective, the deviation from Ussher's date is significant. But the difference between their dates and Ussher's date and the range of dates affirmed by science is only about 0.0001 percent. For this reason, most scientists see little need to distinguish between Ussherite and non-Ussherite young-earth creationists. From a scientist's perspective, stretching the 6,000 years to 50,000 is inconsequential and does nothing to enhance credibility.

I say nearly everywhere because, though few major objections to Ussher's dates for creation arose in the West during the late 1600s to mid-1700s, attempts to spread the Christian gospel in Asia were stymied because Chinese historical records gave a date for the origin and spread of civilization that preceded

Ussher's date for creation.[4] Sadly, this problem drew little, if any, response from Christians in Europe and the Americas.

Rocks and Fossils Raise Questions

Meanwhile, on the science front, research into Earth's crust was getting under way. In the 1780s, Abraham Werner theorized that Earth began as a muddy ball of water and that the solid parts of the planet had precipitated out of the water in a series of successive events.[5] In the 1790s, James Hutton developed the idea that Earth's strata were not precipitates but true sediments and that lava flows (from volcanic activity) were as important as sedimentation.[6] Another geology pioneer, William Smith, learned to correlate fossil remains with rock formations. He was able to demonstrate that a particular stratum should contain specific fossils. He also proposed that the oldest fossil beds would be at the bottom, while the youngest would be at the top.[7]

By the beginning of the 1800s, fossils were recognized as the remains of once-living things, and fossil hunters had begun unearthing fossilized creatures unlike anything they'd ever observed. In 1808, Georges Cuvier and Adolphe Brongniart published the first account of their crustal explorations. They reported finding very different formations next to one another and inferred that these were laid down under very different conditions. This conclusion led them to consider the possibility that a long time interval passed between the laying down of the formations. In addition, they correlated particular fossils with particular strata.[8] Differing with evolutionist Jean-Baptiste Lamarck, Cuvier argued that if evolution were true, researchers should be finding evidence of intermediate fossils (or transitional forms).[9]

During these early days of geological research, estimations of the Earth's age varied. However, in the mid- and late-1800s, Charles Lyell, John Phillips, Lord Kelvin, and John Joly each independently (using sedimentation rates, Earth's cooling rate, and the rate of salt accumulation in the oceans) came to believe that Earth must be at least in the tens of millions of years old.[10]

These geologists were not all Darwinists. Many were devout Christians. They typically proposed that God responded to various cosmic and terrestrial catastrophes (for example, asteroid collisions, volcanoes, floods, ice ages, and so on) with successive acts of creation.[11]

Given the entrenchment of Ussher's chronology, it's not difficult to guess what happened when these findings from the new science of geology came to the attention of certain church leaders. A furious attack arose against the geologic timescales. Geologists were accused of slandering the Bible. Yet most of them

boldly reaffirmed their belief in a sequence of special, supernatural creation events following cosmic or terrestrial catastrophes.[12] They also reminded the world that the Genesis creation account itself portrays a chronological order of creation. Many Christians, however, were not appeased. They saw the geologic timescales as a direct assault against the veracity of the Bible.

A Theological Twist

Even before the downpour of conflict over sedimentary layers was fully unleashed, theology took a sudden turn. The shift was touched off by the publication of a commentary on Genesis by French physician and pastor's (prodigal) son Jean Astruc (1684–1766). He argued that Genesis contains two creation narratives, one in the first chapter and another in the second, each written by a different author and each contradicting the other.[13]

Astruc began with a detailed, though superficial, outline of the Genesis 1 creation events. Unfortunately, his chronology was widely accepted even by those who resisted his interpretation of Genesis 2 and his conclusions about the contradictory order and different authorship of the two passages. Thus, Astruc set the stage for a momentous turning point in biblical theology.

Within a few decades, German theologian Johann Eichhorn, seeing that the discoveries of geologists overthrew both Astruc's widely accepted Genesis 1 chronology and Ussher's firmly fixed timescale, proposed a theological "solution." Eichhorn and his German colleagues theorized that at least some, and perhaps much, of the Old Testament represents a compilation of late, unreliable documents. From their perspective, the Bible's creation accounts were Hebrew renditions of borrowed myths. For championing this proposition, Eichhorn became known as the father of "liberal higher critical" theology. For those who embraced it, liberal higher criticism effectively severed the cord by which faith had been anchored to fact. *Truth* was thrown open to redefinition.[14]

The initial reaction of both scientists and orthodox Christians to this new theological perspective was strongly negative. The majority of both groups held to a belief in the inerrancy of the Bible. But the scientists stuck to their geological timescales, while many other Christians clung to Ussher's creation date and Astruc's simplistic chronology.

Younger Than She Looks

As geologic evidence for Earth's antiquity quickly accumulated, scientists reared on the inviolability of Ussher's creation date faced a serious problem. One such person, British biologist and preacher Philip Gosse acknowledged that

paleontological and physical data do establish an age for Earth far older than a few thousand years. Gosse the scientist was convinced by the physical evidence that Earth is old, yet Gosse the preacher felt constrained to uphold the date he thought his Christian faith required. How was he to maintain his integrity?

In 1857, Gosse published *Omphalos: An Attempt to Untie the Geological Knot*. To solve his dilemma, he proposed that God may have created Earth, and life on Earth, with the appearance of age. That is, Gosse posited that God's creation bore false records of the aging process.[15] For example, he believed God created trees with annual rings for nonexistent years.[16] Gosse's hypothesis that God had imposed a deceptive appearance on Earth's rocks and on living things struck a sour note with many fellow Christians. Though his book generated strong initial interest, it soon fell from favor, only to await revival by a later generation.

Theory Generates Thunderheads

From the mid-1800s until today, one of the biggest obstacles for scientists to overcome in reconciling the natural record with the Bible resulted from a five-year voyage (1831–1836) by British naturalist Charles Darwin. During his journey, Darwin researched the fauna of the Galapagos Islands. Amazed by the diversity of the creatures, he pondered how they might have become differentiated to such a degree. While still working to develop a hypothesis, Darwin came across Thomas Malthus' *An Essay on the Principle of Population*.[17] Thrilled at finding in Malthus' theory a possible explanation for the species differentiation he had observed, Darwin spent the next 20 years constructing his own theory.

In 1859, he presented *The Origin of Species* to the world, proposing that all life-forms evolved through natural selection. He theorized that life progressively changed through the preservation of those individual creatures and characteristics best adapted to outlast others in the competition for survival. Darwin implied in the first edition, and explicitly stated in the second edition, that life had "been originally breathed by the Creator into a few forms or into one."[18] But he also made it clear that while God may have been the Creator of "some one prototype" of life, he believed evolution was responsible for all the succeeding plant and animal species.[19]

Darwin stirred strong and immediate reaction from the Christian community. Four major objections to his theory arose:

- It denied the divine creation of the various species of life.
- It declared life-forms capable of generating new species rather than consistently reproducing after their own kind.
- It implicitly denied the special creation of humanity.
- Its agency of change—natural selection—required vastly more time than Ussher's time frame allowed.

Particularly offensive was the implication that humans descended from lower creatures.

Though many scientists strongly objected to Darwin's views, most (at least within the European scientific community) adopted it with surprising speed, perhaps propelled by the following developments:

- They saw evidence of life-forms changing in response to environmental stress.
- They saw no scientifically supported alternative to Darwin's hypothesis.
- They were aware that at least some theological experts, namely the German liberal higher critics, had conceded nonfactuality in the biblical texts.
- They were irked by church leaders' diatribes against scientists, specifically against geologists and the geologic timescales.

Thus, science and faith became increasingly polarized. The clouds of controversy became fixed and the front refused to move. A severe squall threatened.

Chapter 3

The Clouds Burst

With the publication of Darwin's *The Origin of Species*, the clash of Ussher's 4004 BC creation date with geologists' timescales became a thunderous collision. Typically, scientists rushed to one side, Bible believers to the other. Personal conflicts only heightened the storm's pitch.

Monkey-to-Man Debate

The legendary Wilberforce-Huxley debate of 1860, though remembered as a confrontation between opposing ideologies, was actually more of a personal grudge match.[1] After being humiliated at a Royal Society meeting in England, Britain's foremost biologist, Sir Richard Owen, invited a brilliant orator (Samuel Wilberforce) to debate his nemesis, Thomas Huxley, on the topic of Darwin's book.

Wilberforce (the bishop of Oxford), with limited training in science and inadequate preparation, stumbled into several serious blunders during the debate. Huxley (a young scientist) seized upon and exposed these scientific errors. Backed against a wall, Wilberforce sought a rhetorical victory by asking Huxley on which side of his family he claimed descent from monkeys. Huxley's brilliant reply dealt a blow that continues to reverberate: "I would rather be descended from a poor chattering ape than from a man of great talents who would appeal to prejudice rather than to truth."[2]

Because scientists viewed Wilberforce as a chief proponent of Christian orthodoxy, this rhetorical defeat shattered public opinion of Christians and Christianity. From that day forward, scientists—not all, but many—associated Christians with prejudice, deception, error, ignorance, emotionalism, and blind opposition to scientific pursuits. It is not uncommon for scientists even to this day to discount Christianity simply because of echoes from the Wilberforce-Huxley debate.[3]

Fundamentalism's Gloom

Ussher's 4004 BC creation date became a recognized problem for the Christian faith only when scientific developments of the nineteenth century called that

date into question. As the twentieth century dawned, a movement within the church, as well as further developments in science, brought the age question into the full light of public scrutiny.

Between 1910 and 1915, American laymen Milton and Lyman Stewart financed the publication and distribution of 12 small books titled *The Fundamentals: A Testimony to the Truth*. This set of booklets argued against liberal higher-critical theology and reasserted the literal inerrancy of the Bible. The essays that addressed Genesis, specifically the creation and the fall, asserted the importance of recognizing these events as actual historical occurrences, foundational to everything else in Scripture, but left open the question of the creation days' length. Professor of apologetics and systematic theology James Orr wrote:

> You say there is the "six days" and the question whether those days are meant to be measured by the twenty-four hours of the sun's revolution around the earth—I speak of these things popularly. It is difficult to see how they should be so measured when the sun that is to measure them is not introduced until the fourth day. Do not think that this larger reading of the days is a new speculation. You find Augustine in early times declaring that it is hard or altogether impossible to say of what fashion these days are, and Thomas Aquinas, in the middle ages, leaves the matter an open question. To my mind these narratives in Genesis stand out as a marvel, not for its discordance with science, but for *its agreement with it*. (italics in original)[4]

At a 1919 conference in Philadelphia, the fundamentalist movement took form as an organized effort with the founding of the World's Christian Fundamentals Association (WCFA). Subsequent to this meeting, the group took on the task of delineating what qualifies a person as a true Christian, and they went beyond the five fundamentals.[5] In the matter of origins, belief that God created the universe, Earth, and life was no longer enough. Because the WCFA deemed evolution, specifically Darwinism, as the great evil of the day, they adopted Ussher's chronology as a necessary belief, the only defense they could see against the rising tide of "godless" science.

In less than 10 years, the movement launched by the Stewarts changed from a careful, dispassionate defense of Christian orthodoxy to an overzealous crusade. One newspaper reporter in 1920 characterized the WCFA as those engaged in a "battle royal for the Fundamentals."[6]

Monkey Trial

Fundamentalist attacks on Darwinism, and counterattacks by scientists and others, further escalated after the infamous Scopes trial. In 1925, William Jennings Bryan, three-time presidential candidate and noted "fundamentalist," volunteered to help prosecute a biology teacher who had intentionally defied Tennessee's law against teaching evolution in public schools. Unwittingly, Bryan stepped into a carefully laid trap. Scopes, the teacher, was found guilty (as expected), but H. L. Mencken's scathing newspaper articles of what supposedly happened in the witness chair have long overshadowed the legal victory.

Mencken implied that under defense attorney Clarence Darrow's cross-examination Bryan (an expert witness on Christian fundamentals) was forced to admit that the six consecutive 24-hour periods of biblical creation must be incorrect. According to Mencken (and several respected historians), Darrow compelled Bryan to concede that the Genesis creation days must be longer time periods.[7] In truth, Bryan went into the trial believing that the Bible allowed for long (era) creation days. When Darrow first asked Bryan if he believed the world was created in six days, Bryan answered, "Not six days of 24 hours."[8] Repeatedly badgering Bryan on the point, Darrow desperately tried—and failed—to get him to commit to belief in 24-hour creation days.

Nonetheless, newspaper accounts successfully disparaged Bryan's testimony and reputation. Shocked by Bryan's apparent disgrace, many fundamentalists became convinced that bolting the door on the geologic timescale was their only hope for upholding the Bible as true. They decided to lock belief in a universe only thousands of years old into their doctrinal position on creation. So the five fundamentals of the faith became six.[9]

Molecules-to-Man

After World War II, the Darwinist hypothesis expanded to become the molecules-to-man concept. With naturalistic philosophy now permeating the scientific community, and with Christianity seen as antiscientific, few dared question the notion that biological evolution by strictly natural means applied not just to primitive cells but also to inorganic chemicals. Origin-of-life researchers admitted to being a long way from synthesizing life from naturally occurring inorganic compounds or from observing the production of *any* complex organic molecules from inorganic material either on Earth or in outer space.[10] Nonetheless, they so influenced other scientists and educators that high school

biology texts soon taught molecules-to-man as an established, fact-based theory.[11]

The molecules-to-man theory infuriated the Christian community. Recognizing the influence of this thinly veiled attempt to eliminate God from having anything to do with creating life, people who adhered to the six fundamentals (including 24-hour creation days) became acutely aware of the need to build their case on scientific credibility. Only science could help them gain clout with the educational and political establishments in thwarting the evolutionists' claims.

The Storm Spreads

In 1961, Henry Morris, a civil engineering professor, and John Whitcomb, a theology professor, published *The Genesis Flood*, a lengthy volume that dealt with much more than Noah's story.[12] This treatise on creation, an attempt to defend a creation timescale of only thousands of years, included all the trappings of a scientific text. *The Genesis Flood* sought to raise fundamentalists' intellectual and scientific respectability. Christians could now combat science with science, or so it seemed.

Emboldened by the publication of *The Genesis Flood*, ten fundamentalist scientists banded together in 1963 to form the Creation Research Society (CRS). Within a decade, the CRS boasted 450 members with graduate degrees in science. This rapidly growing group of scientifically trained creationists brought about a spectacular promulgation of recent-creation teaching.

By 1970, the CRS began to splinter because of differences in personalities and objectives, but this splintering only multiplied their impact. The Creation-Science Research Center (C-SRC) formed to specialize in gaining legal recognition for the teaching of "scientific" creationism (that is, young-universe creationism) in schools. By then the teaching of evolution had become legal, as well as predominant, in all states. The Institute for Creation Research (ICR) formed in 1972 to focus on gathering scientific data and "informing" the public, especially through lectures and debates. Since then, several dozen young-earth creationist organizations have proliferated across the United States.

By 1980, nearly every American evangelical church and school had been swayed by young-earth creationist teachings. Their influence spread around the world. Societies along the lines of the CRS and the ICR formed in more than two dozen nations. The impact of their views on creation became so pervasive that this ideology is thought to represent the doctrine of the entire community of Bible-believing Christians. The word *creationist* implies the young-earth

position, though many orthodox Christians who believe in creation (and who deny naturalism and Darwinism) hold differing views regarding its timing.

Science Unleashes a Torrent

The science establishment began to treat young-earth creationists as they did flat-Earth proponents. For a while, most scientists presumed the evidences against the young-universe and young-earth hypotheses were so obvious and overwhelming that no rebuttal was necessary. In fact, rebutting such premises was discouraged since it gave undue attention (and the tiniest hint of academic merit) to the young-earth view. But when the science establishment saw the threat of laws intending to force the teaching of creationism, they began to speak out.

America's most influential scientific body, the American Association for the Advancement of Science (AAAS), started publishing articles in its technical journal, *Science*, pointing out the errors and dangers of scientific creationism.[13] Later, the AAAS published a special insert section in its popular-level magazine, *Science 81*, challenging creationism as nonscience.[14] Copies of this insert were distributed to 100,000 members of the National Science Teachers Association.[15] In 1983, the National Center for Science Education (NCSE) was founded to support and coordinate "committees of correspondence." Today, at least one such committee exists in every state of the United States and in most Canadian provinces. The declared purpose of NCSE and these committees is to "keep scientific creationism from being taught as legitimate science."[16]

Since the 1990s, well-known scientists have been publishing book-length exposés of scientific creationism. These disparaging works carry such scornful titles as *Telling Lies for God*[17] and *The Triumph of Evolution: and the Failure of Creationism*.[18]

Deepening Divide

Neither creationists nor evolutionists have seriously sought to resolve this controversy. Rather than try to understand each other and develop dialogue, both groups continue to reinforce animosity by negative perceptions and portrayals of their opponents.

Young-earth creationist leader and author Edward Blick accuses evolutionists of "deliberately bluffing," of making "patently false" statements, of violating rules of logic through "circular reasoning, faulty premises, faulty analogies, and wishful thinking," and of making a farce of scientific laws.[19] Henry Morris, founder and past ICR president, blames evolutionary "uniformitarianism" for

spawning “the vast complex of godless movements.”[20] Evolutionist Thomas Jukes accuses young-earth creationists of using “terrorist tactics.”[21] “The irresponsible misrepresentation of science that is habitually demonstrated by creationists” elicits “justifiable anger,” according to geologist Richard Bambach.[22]

With each side accusing the other of distortion, deceit, and bad science, little hope of reconciliation has been seen or expressed. And both sides enroll a large following. In the 1980s, according to Gallup, 44 percent of Americans held to a 10,000-year-old creation date and 47 percent held to some form of Darwinian evolution. The fact that 74 percent of those surveyed want only their own view taught in public schools demonstrates the degree of tension.[23] Continuing Gallup polls on the subject of evolution and creation taken in June 1993, November 1997, August 1999, February 2001, December 2010, and June 2014 show that “the public has not notably changed its opinion on this question since Gallup started asking it in 1982.”[24]

Appearance-of-Age Theory Resurges

Attempting an end run around the science establishment, some young-earth creationists have revived and slightly altered Gosse’s appearance-of-age concept. Gary North, an influential “reconstructionist” theologian (see “Reconstruction and Presuppositionalism”) makes this statement:

> The Bible’s account of the chronology of creation points to an illusion.… The seeming age of the stars is an illusion.…Either the constancy of the speed of light is an illusion, or the size of the universe is an illusion, or else the physical events that we hypothesize to explain the visible changes in light or radiation are false inferences.[25]

Marvin Lubenow, an ICR associate, concurs with North’s view: “There is no general Bible-science conflict if one recognizes the domain of science to be primarily in the present and involving the investigation of *present-day* phenomena” (italics in original).[26]

Whitcomb, another ICR associate, prefers the term “superficial appearance of history or age.”[27] He says, “There could be no *genuine* creation of any kind without an initial appearance of age inherent in it.…*If God exists!*—then there is no reason why He could not, in full conformity with His character of truth, create a whole universe full-grown” (italics in original).[28]

Both ICR and Answers in Genesis—now the most prominent and vocal advocates of a recently created universe and Earth—rely to some degree on this theory of *apparent* versus *real* age. Morris implies that no tool of science can ever yield real information on the age of the earth: "The compelling Biblical… direct testimony from the Creator is the *only* way to *know* the age of the earth" (italics in original).[29]

Reconstruction and Presuppositionalism

Reconstruction theology, as taught by North and others, combines Puritan beliefs about law, politics, and end times events with theologian Cornelius Van Til's apologetics theory called presuppositionalism. According to some of its advocates, presuppositionalism[30] says all human reasoning and interpretation of scientific evidence must be subordinate to a "biblical" interpretation of reality. Some young-earth creationists adopt an extreme form of presuppositionalism, asserting that any scientific interpretation of the record of nature can be discounted in light of their young-earth interpretation of the words of the Bible.

An Unreal Reality

North rightly observes that a cosmic creation date of only thousands of years implies, in some respect, that the universe is an illusion. Since astronomers have sound reasons for concluding that the cosmos is real (see chapters 14–18), they cannot reasonably adopt young-universe creationism. This disconnect between the real and the apparent extends beyond denial of distant stars and galaxies.

Taken to its logical conclusion, the appearance-of-age hypothesis would imply that we cannot establish the reality of our own or anyone else's past existence. We could have been created just a few hours, or even moments ago, by a Creator who implanted scars, memories, family members, photographs, material possessions, liver spots, and hardening of the arteries to make us look and feel older than we really are. If God built into the universe a testimony of events that never took place, one can say that the Bible is a written testimony of events that never really happened.

Independent young-universe creationist Lambert Dolphin claims that time (t) did not begin until Adam rebelled against God in the garden of Eden.[31] He argues, "The fact that pre-history occurred before t = 0 gives our universe an appearance of great age."[32]

Another independent creationist, Dennis Petersen, replies to questions about

the reality of stars millions of light-years away with this question: “If your God could create sources of star light, do you think He might be able to create the light beams to instantly appear on the Earth?”[33]

Appearance of age provides what may seem to Christians a consoling response to overwhelming scientific evidence for a billions-of-years-old universe and Earth. If ages in the natural realm are indeed illusory, then no amount of scientific evidence means anything against young-earth interpretations of the Bible’s words. Thus, these interpretations remain safe from outside influences. Science—at least the research of nonsectarian institutions—ceases to matter.

A Biblicist Approach to Truth

Advocates of the appearance-of-age view typically hold what may be termed a “biblicist” perspective—belief that the Bible is the only reliable truth source about any subject. In other words, in any research field, from astronomy to zoology, we “must grope in darkness apart from God’s special revelation in Scripture.”[34] Biblicists claim the Bible must be interpreted “literally” (by which they mean concretely), even if that interpretation contradicts observable facts of nature.

Morris takes for granted that a deeply rooted scientific “assumption” provides the *only* basis for taking the Genesis creation days as anything other than 24-hour days. And he’s concerned what that “assumption” could mean. “The road of compromise [on the issue of age, for example], however attractive it seems, is a one-way street, ending in a precipice and then the awful void of ‘rational religion,’ or atheism. Our advice is to stay on the straight road of the pure Word of God.”[35]

North agrees: “For Christians to tamper with the plain meaning of the Bible in order to make it conform to the latest findings of this or that school of evolutionary thought is nothing short of disastrous.”[36]

Morris, North, and others ignore or reject the biblical scholarship and even the sincere faith of those who show that the Hebrew texts allow ample room, or —as I believe—offer evidence, for a different interpretation of the Genesis creation days.

Biblicism has sometimes been confused with the Protestant doctrine of *sola Scriptura*, according to which the Bible is the supreme authoritative source of information on all subjects it addresses.[37] The Bible does not specify, however, such details of nature as the number of human chromosomes or a particular planet’s age, so it does not claim authority in these details. According to Scripture (for example, Psalm 19), the facts of nature constitute a reliable source

of information. (Nature is not called an “authoritative” source because, by definition, authority resides in persons and their words.)

False Dilemma Drives People Away

The outspokenness of young-earth creationists has been effective. Many people who have never looked into the matter for themselves assume that Scripture clearly says God created everything in 144 hours, just 6,000 to 10,000 years ago. Given the scientific implausibility of such a position, many people reject the Bible without seriously considering its message. One physician I know, though hungry for spiritual truth, ignored the Bible and the Christian faith for years because he couldn’t get past some believers’ insistence that the Bible’s first page taught a recent 144-hour cosmic creation.[38]

I have discussed faith issues with people who were convinced that becoming a Christian would require them to reject all knowledge except that found in Scripture. Few had been presented with these core ideas:

- God is the initiator of both the biblical revelation and the created revelation (natural world).
- God renders both the words of the Bible and the facts of nature true and consistent.
- God’s character and attributes are expressed specifically (propositionally) in the Bible and generally (intelligibly) in nature, and neither negates or contradicts the other.

These viewpoints represent obvious but rarely articulated options.

All too often, people are left with the hard choice between believing what they think are the words of the Bible and rejecting what they believe are the facts of nature *or* believing the facts of nature and rejecting the Bible. Tragically, this false dilemma hinders serious consideration of crucial spiritual issues.

A Dogmatic Drenching

With rising hostilities on both sides of the creation-evolution controversy, defense of a recent creation has been growing more dogged. Many churches and Bible colleges now include belief in a young universe and a young Earth in their statement of faith. In some cases, applicants who disagree are denied admission.

In 1992, the ICR published an article in its *Back to Genesis* magazine about the importance of belief in a young earth for determining a person’s role in the

church and in ministry. The article's author, John Morris, concludes:

> I still am uncertain about young-earth creationism being a requirement for church membership; perhaps it would be proper to give new members time to grow and mature under good teaching. But I do know one thing: [Young-earth] Creationism *should* be made a requirement for Christian leadership! No church should sanction a pastor, Sunday school teacher, deacon, elder, or Bible-study leader who knowledgeably and purposefully errs on this crucial doctrine. (italics in original)[39]

The Storm's Aftermath

Whether a written doctrine or not, young-earth creationism as a tenet for Christian acceptance inflicts damage. A young astronomy research assistant and his wife seeking Christian fellowship were asked to leave one church after another, not because of anything they did or said, but simply because, in response to probing, they acknowledged their belief that the universe is billions of years old. A world-renowned astronomer met with similar difficulty. After coming to personal faith in Jesus Christ, he sought a church home where he would not have to hide his identity and views. He visited more than 50 evangelical churches before finding one that upheld the Bible as the error-free Word of God and also tolerated belief in an old universe and Earth.

Is it any wonder that individuals trained in the sciences, especially those with little or no Christian background, seem hesitant to make their way into churches? How painful to be a disciple of Christ or a sincere seeker and yet be turned away as an enemy of the faith. How difficult, too, for the devout fundamentalist, trained as he or she is to stand firm against compromise and worldly thinking, to embrace as brothers or sisters those who believe in an old universe and Earth. According to what the fundamentalist has been taught, such people must deny Scripture's authority. They must be deceived or even evil.

With these dynamics at work, open, friendly dialogue has become virtually impossible. Instead, heated debates, confrontations, public attacks, and watchdog committees keep the storm front in place. Such an impasse thwarts fulfillment of God's purposes for His people. Now is the time to push the clouds away and seek the light of day. Now is the time to make every effort—short of compromising either the words of the Bible or the facts of nature—toward a peaceful resolution. Let's reconsider the assumptions that have propelled a tornado of trouble. Let's acknowledge emotional attachment to our views and, with a sense of humility, move forward with our reconsiderations, trusting God's Spirit to guide us.

Let’s start by going back to the beginning to look at how the church fathers viewed the length of creation days.

Chapter 4

Wisdom of the Ages

Record highs and lows. Weather forecasters often look to the past to put the current climate in perspective. Consistency with the past can sometimes quell controversy and irrelevant speculation. Some young-earth creationist leaders have attempted to use this technique to settle the creation-day debate. They claim that before the advent of modern geology and Darwinism early church scholars consistently taught a 24-hour creation-day interpretation of the Bible.[1] As recently as 2001, Ligon Duncan and David Hall wrote,

> The day-age view [Genesis 1 creation days = six long time periods] first arose when jazz was on the rise in America.…Conversely, the 24-hour view [Genesis 1 creation days = six consecutive 24-hour periods] has been the consensus of the Church since the earliest hymns, chants, and doxologies, and long before Bach and Handel. If ever the Church agreed on anything, it has been on the days of creation. The paradigm shift occurred only recently when naturalistic and/or rationalistic paradigms were enthroned and Scripture was made subservient to them.[2]

A look at what actually occurred in the past may help determine whether modern interpreters have compromised Scripture to accommodate the latest findings of science and whether a recent shift in belief has generated the idea of an old Earth and universe. In the Protestant tradition, the opinions of past church scholars are never accorded the same weight or priority as the special revelation of the Bible or the general revelation of nature. Nevertheless, the historical position of the church carries significant authority where we find clear unanimity, in matters such as the deity of Jesus Christ and the means of redemption from sin.

Genesis 1:1–31, which describes the six creation days (known as the Hexameron), receives more commentary from early church scholars than does any other text in the Bible. However, of the approximately 2,000 surviving pages of the commentary on the Hexameron, only about two pages address the duration of the creation days. Clearly, the early church fathers did not consider

the length of these days a major doctrinal point.

And yet the question remains: did early church scholars clearly and unanimously teach that the universe was only a few thousand years old and that the Genesis 1 creation days were six consecutive 24-hour periods—or did they allow for a variety of views within the church? Evidence points to a diversity of opinions within both the Jewish and Christian traditions, though the range of perspectives may be somewhat limited because many early writings did not survive.

First-Century Jewish Scholars

The earliest scholars to record their thoughts about the Hexameron were Jewish—Philo (c. 13 BC–between AD 45 and 50) and Josephus (c. AD 37–c. 100).

Philo expressed the notion that God created everything instantaneously and that the six days are figurative, a metaphor for order and completeness. "He [Moses] says that in six days the world was created, not that its Maker required a length of time for His work, for we must think of God as doing all things simultaneously, remembering that 'all' includes[—]with the commands which He issues[—]the thought behind them. Six days are mentioned because for the things coming into existence there was need of order."[3] Philo amplified his reasoning in a later work:

> It is quite foolish to think that the world was created in six days or in a space of time at all. Why? Because every period of time is a series of days and nights, and these can only be made such by the movement of the sun as it goes over and under the earth; but the sun is a part of heaven, so that time is confessedly more recent than the world. It would therefore be correct to say that the world was not made in time, but that time was formed by means of the world, for it was heaven's movement that was the index of the nature of time. When, then, Moses says, "He finished His work on the sixth day," we must understand him to be adducing not a quantity of days, but a perfect number, namely six.[4]

In a survey of the Genesis creation days, Josephus noted the need to explain the meaning of the expression "one day"[5] and promised to do so, but never did. One might wonder whether he found this expression neither easy nor straightforward to interpret.

Second-Century Christian Scholars

The earliest-known Christian writings on the meaning of the creation days date back to the second century. Justin Martyr (c. AD 100–165) and Irenaeus (c. AD 120–140 to 200–203) drew support from Psalm 90:4 and 2 Peter 3:8 to suggest that at least one of the creation days could be an epoch of perhaps 1,000 years.[6] Describing the events of the sixth creation day, Irenaeus stated,

> In the day they [Adam and Eve] did eat, in the same did they die, and became death's debtors, since it was one day of the creation. For it is said, "There was made in the evening, and there was made in the morning one day." Now in this same day that they did eat, in that also did they die.…On one and the same day on which they ate they also died (for it is one day of creation).…He (Adam) did not overstep the thousand years, but died within their limit…for since "a day of the Lord is as a thousand years," he did not overstep the thousand years, but died within them.[7]

Whatever Irenaeus actually believed, here, he appeared at least open to the possibility that the creation days are something other than 24-hour periods.

Third-Century Christian Scholars

Hippolytus (c. AD 170–235) apparently wrote more extensively than others on the Genesis creation days, but most of his writings have been lost. What scholars have recovered gives no explicit indications of what he believed about the duration of the creation days or about dates for creation beyond his statements that humans have resided on Earth for only several thousand years.[8]

Clement of Alexandria (c. AD 150 to 211–215) echoed Philo's belief that the Hexameron were not 24-hour days.[9] He claimed that the creation days communicated the order and priority of created things but not time. As he understood it, creation could not take place in time since "time was born along with things which exist."[10]

Origen (c. AD 185–254) taught that in approaching certain difficulties in Scripture we should seek a spiritual meaning, not always a concrete one. In the six creation days he saw just such a difficulty.[11] He claimed that time as we mark it did not exist until the fourth day.

> The text said that "there was evening and there was morning," it did not say: "the first day," but said, "one day." It is because there was not yet time before the world existed. But time begins to exist with the following

days.[12]

Now what man of intelligence will believe that the first, and the second, and the third day, and the evening and the morning existed without the Sun, Moon, and stars?[13]

Neither could the seventh day be a period of 24 hours, according to Origen. He saw the Hexameron as representing the time that people work on the earth (the period of human history), while the seventh day represents the time between the creation of the world and its extinction at the ascension of all the righteous.

> He [Celsus] knows nothing of the day of the Sabbath and rest of God, which follows the completion of the world's creation, and which lasts during the duration of the world, and in which all those will keep festival with God who have done all their works in their six days, and who, because they have omitted none of their duties will ascend to the contemplation (of celestial things) and to the assembly of righteous and blessed beings.[14]

Writing later in the third century, Lactantius of North Africa, Victorinus of Pettau, and Methodius of Olympus all indicated in their writings that many of their contemporaries espoused the idea that just as there were seven days of creation, so there would follow thereafter seven days of human history in which each such day would last for 1,000 years. Psalm 90:4 and 2 Peter 3:8 were the scriptural basis for this idea (which was supported by Justin Martyr and Irenaeus).[15] However, it would be an incorrect extrapolation to conclude that Lactantius, Victorinus, and Methodius believed that the Genesis creation days lasted 1,000 years each. In their surviving writings we have from them they never clarified their belief about the duration of the Hexameron.[16]

Augustine's Analysis

Among early church leaders, no one penned a more extensive analysis of the creation days' duration than Augustine (AD 354–430). In *The City of God*, this esteemed scholar wrote, "As for these 'days,' it is difficult, perhaps impossible to think—let alone explain in words—what they mean."[17] In *The Literal Meaning of Genesis* he added, "But at least we know that it [the Genesis creation day] is different from the ordinary day with which we are familiar."[18] In the same book he added this comment: "Seven days by our reckoning after the model of the days of creation, make up a week. By the passage of such weeks time rolls on,

and in these weeks one day is constituted by the course of the sun from its rising to its setting; but we must bear in mind that these days indeed recall the days of creation, but without in any way being really similar to them."[19]

Augustine understood the evenings and mornings of the Genesis creation days in a figurative sense. He concluded that the evening of each creation day referred to the occasion when the angels gazed down on the created things after they contemplated the Creator, and that the morning referred to the occasion when they rose up from their knowledge of the created things to praise the Creator.[20]

In *Confessions*, Augustine noted that for the seventh day Genesis makes no mention of an evening and a morning. He deduced from this omission that God sanctified the seventh day, making it an epoch extending onward into eternity.[21]

Other Fourth-Century Scholars

Between AD 314 and 316, Eusebius (c. AD 260–339), a bishop of Caesarea, wrote *Preparation for the Gospel*, a lengthy apologetic work arranged into 15 books. In books I–VI he attacked the creation doctrines of the Greeks, Romans, Phoenicians, Egyptians, and pagans. In book VII he devoted six pages to explaining the Genesis creation account. However, nowhere did Eusebius address the universe's or Earth's creation dates or the length of the Genesis days. He was aware, nonetheless, that the Hebrew word for day, *yôm*, could refer to a timescale longer than 24 hours. He quoted Genesis 2:4 as follows: "This is the book of the generation of heaven and earth, in the *day* that God made the heaven and the earth, and all the things that are therein" (emphasis added).[22]

In book XI Eusebius again addressed the events of creation but neglected any mention of the timescale for the creation events, other than to state that there was a definite point of beginning and to quote Genesis 2:4 as he did in book VII.[23]

Basil (c. AD 329–379), also a bishop of Caesarea, wrote at least nine homilies on the first chapter of Genesis. He hinted at the difficulty of discovering the date for the universe's creation: "You may know the epoch when the formation of the world began, if, ascending into the past, you endeavour to discover the first day. You will thus find what was the first movement of time."[24]

In reference to the first Genesis creation day, Basil posed this question: "Why does Scripture say 'one day' not 'the first day'?" In response, he elaborated,

> If then the beginning of time is called "one day" rather than "the first day," it is because Scripture wishes to establish its relationship with

> eternity. It was, in reality, fit and natural to call "one" the day whose character is to be one wholly separated and isolated from all the others. If Scripture speaks to us of many ages, saying everywhere, "age of age, and ages of ages," we do not see it enumerate them as first, second, and third. It follows that we are hereby shown not so much limits, ends, and succession of ages, as distinctions between various states and modes of action.[25]

In the remainder of his homilies on Genesis 1, Basil shifted attention away from the timing of creation to the how and what of God's creative actions.

Ambrose (c. AD 339–397), a bishop of Milan, is the early church leader most frequently quoted as supporting the young-earth interpretation of the Hexameron as a 144-hour period. Among early church leaders, Ambrose holds the record, by far, for commentary on the creation days. However, in his 280-page homily on the subject, he devoted less than a page to the length of the creation days. In one place he said, "Scripture established a law that twenty-four hours, including both day and night, should be given the name of day only, as if one were to say the length of one day is twenty-four hours in extent.…The nights in this reckoning are considered to be component parts of the days that are counted. Therefore, just as there is a single revolution of time, so there is but one day."[26] However, in the following sentence, Ambrose (perhaps thinking about Genesis 2:4, where *yôm* refers to the entire creation week) acknowledged, "There are many who call even a week one day, because it returns to itself, just as one day does, and one might say seven times revolves back on itself."[27] One sentence later, he referred to the possibility of defining *yôm* as an era or epoch: "Hence, Scripture appeals at times of an age of the world."[28] He followed this acknowledgment with examples of the "day of the Lord" and the "eternal day of reward" in the new creation. Thus, it is not clear what age Ambrose deemed the universe and the earth to be.

A Fair Assessment

While the early church fathers never explicitly proclaimed that either Earth or the universe was older than several tens of thousands of years, neither did they explicitly deny it. In their writings, they express far more concern over how long humans have resided on Earth than they do over the history of Earth itself. Consequently, citing an early church father's belief in the recent origin of humanity does not necessarily prove that the same scholar was dogmatically wedded to the belief that days of creation lasted but 144 hours or that the

universe and Earth were created only thousands of years ago. As theoretical chemist and apologist John Millam noted in “Coming to Grips with the Early Church Fathers’ Perspective on Genesis,” neither the duration of the creation days nor the age of the earth “was ever listed as part of the ‘rule of faith’ (Latin *regula fidei*), which was a statement of key doctrine.”[29]

Concerning the universe and Earth, the fathers took a united and explicit stand on only two doctrines. The first is that the universe has a beginning, implying that it has existed for only a finite time. The second is what they termed “creation *ex nihilo*,” the belief that God created the universe out of nothing. By “nothing” they meant that the universe we detect did not come from any entity we can conceivably detect (Hebrews 11:3).

Christianity’s early leaders interpreted the length of the creation days in different ways. They gave the topic little attention compared with such matters as the triune nature of the Godhead, the deity of Christ, and the means, methods, and products of God’s creation.

Of more significance than their conclusions on the creation days is the observation that early Christian authors were free of today’s scientific bias. It cannot be argued that these ancient minds were influenced by such modern ideas as Darwinism. They wrote long before astronomical, geological, and paleontological evidence for the antiquity of the universe, Earth, and life had been discovered. Yet nearly all the key figures acknowledged that the length of the Genesis creation days presented a challenge to their understanding and interpretation. Those who did not say so may have implied this difficulty by avoiding any specific comment on the subject.

Except for Augustine, the early church leaders expressed their views tentatively. There is no indication that they sharply debated the issue or took a dogmatic stance. Instead, it appears that they charitably tolerated a diversity of views.

The original source literature notes a different tone for the early church leaders compared to that of today’s leaders. Missing from the ancient writings is the trumpeted certainty and dogmatic insistence on only one interpretation of the creation days. Missing are the emotional insults tossed at those who dared to disagree with them regarding this issue. Rather, the early church leaders gently expressed their views with tolerance toward those who differed. They seem to have appreciated the mystery and been content to wait for further revelation and understanding. In this context, modern young-earth creationism did not begin until the early part of the twentieth century.

Another type of literature also reveals important attitude differences before the creation-day controversy ever began—the Christian creeds.

Chapter 5

The Creedal Climate

If all pre-Darwin Christians unanimously and unambiguously held one view on the length of the creation days, evidence for such a position would likely be found in the creedal statements written during the first 1,700 years of church history. The creeds declare the core beliefs of the Christian faith. Before education became widespread (and still today), believers often committed early creedal statements to memory, reciting them during worship services to preserve the unity of the faith. The early creeds also distinguished Christian believers from nonbelievers, countered heretical teachings, and provided basic instruction about the faith to converts.

As literacy grew and Bibles became available to lay Christians during the Reformation period (sixteenth and seventeenth centuries), church councils developed much longer confessional statements. In addition to the major doctrinal themes, these later statements addressed prayer, the sacraments, and other faith issues. The Heidelberg Catechism (approved by a Heidelberg synod in 1563), for example, gives thoughtful answers to 129 questions about Christian beliefs. The most detailed document is the Westminster Confession (1647), which contains 33 chapters, ranging from one paragraph to several hundred words long.

Early Creation Affirmation

The early creeds of the Christian church state that God is an uncreated Being who was responsible for creating both the physical and spiritual realms. The Apostles' Creed simply states, "I believe in God, the Father almighty, creator of heaven and earth."[1] The Nicene Creed similarly limits its statement on creation to this: "We believe in one God, the Father almighty, maker of heaven and earth, of all things visible and invisible."[2] The longest of the early creeds, the Athanasian Creed, makes no statement on creation other than to declare that each member of the Trinity is "neither made nor created."[3]

In keeping with the tone and content of the early church fathers' writings on creation, the early creeds do not express any particular position on the duration of the creation days or the dates for creation.

Reformation Confessions

Among the best-known Reformation confessions are the Heidelberg Catechism, the Belgic Confession, and the Westminster Confession. These form the doctrinal standards for Presbyterian and other Protestant congregations around the world. Each of these confessional documents is a lengthy statement explaining the central doctrines of the Christian faith.

The Heidelberg Catechism states the following concerning creation:

> God created them [man and woman] good and in his own image, that is, in true righteousness and holiness, so that they might truly know God their creator, love him with all their heart, and live with him in eternal happiness for his praise and glory.[4]
>
> The eternal Father of our Lord Jesus Christ, who out of nothing created heaven and earth and everything in them, who still upholds and rules them by his eternal counsel and providence…[5]
>
> All creatures are so completely in his [God's] hand that without his will they can neither move nor be moved.[6]

The framers of this catechism made no mention of the Genesis creation days or their duration.

The Belgic Confession (approved by an Antwerp synod in 1566) devotes four of its 37 articles to creation. It declares that every member of the Trinity participated in creation and that God is "the cause, origin, and source of all things, visible as well as invisible."[7] Concerning the deity of Christ, Article 10 declares,

> Moses says that God "created the world," and John says that "all things were created by the Word," which he calls God. The apostle says that "God made the world by his Son," He also says that "God created all things by Jesus Christ." And so it must follow that he who is called God, the Word, the Son, and Jesus Christ already existed when all things were created by him.[8]

Article 12 adds,

> We believe that the Father created heaven and earth and all other

> creatures from nothing, when it seemed good to him, by his Word—that is to say, by his Son. He has given all creatures their being, form, and appearance, and their various functions for serving their Creator.…He also created the angels good, that they might be his messengers and serve his elect.[9]

Article 14 addresses the creation of man: "We believe that God created man from the dust of the earth and made and formed him in his image and likeness—good, just, and holy; able by his own will to conform in all things to the will of God."[10]

The Belgic Confession further affirms that the created realm supplies a true record of what God has done:

> We know him [God] by two means: First, by the creation, preservation, and government of the universe, since that universe is before our eyes like a beautiful book in which all creatures, great and small, are as letters to make us ponder the invisible things of God: his eternal power and his divinity, as the apostle Paul says in Romans 1:20. All these things are enough to convict men and to leave them without excuse. Second, he makes himself known to us more openly by his holy and divine Word.[11]

The confession's author encouraged believers to treat nature's record as "a beautiful book," an accurate and relevant account of God's creative activity. Only Article 12 makes any mention of *when* God created—"when it seemed good to him."[12] This statement implies that God existed and functioned before He chose to create.[13] As to how long ago this creation took place, the confession does not specify.

The Westminster Confession of Faith, chapter IV, speaks exclusively of creation. The first section addresses the creation of the world; the second, the creation of humanity.

Concerning the world, it says, "It pleased God the Father, Son, and Holy Ghost, for the manifestation of the glory of his eternal power, wisdom, and goodness, in the beginning to create, or make of nothing, the world, and all things therein whether visible or invisible, in the space of six days, and all very good."[14] As to humankind's creation, the confession continues:

> After God had made all other creatures, he created man, male and female, with reasonable and immortal souls, endued with knowledge,

> righteousness, and true holiness, after his own image, having the law of God written in their hearts, and power to fulfill it, and yet under a possibility of transgressing, being left to the liberty of their own free will, which was subject to change.[15]

Concerning creation dates, the Westminster Confession is abundantly clear that humanity is the last of God's creative works to occur "in the space of six days."

The Westminster Assembly of Divines (authors of the confession) consisted of 151 commissioned members convened by the English Parliament in 1643. Most were ordained clergy. Some held doctoral degrees in religion. Twenty-one were members of the House of Commons. For over three centuries, the creation statements they wrote received scant attention. However, in the last few years, a vigorous and sometimes heated debate has flared over exactly what the Westminster Assembly meant by the phrase "in the space of six days." Some young-earth creationists claim that the authors specifically meant "in the space of six consecutive 24-hour days."[16]

In 2001, young-earth creationists Ligon Duncan and David Hall asserted that "any Westminster divine who wrote on the subject of creation adopted the 24-hour view" and that "no Westminster divine held to a long age of creation."[17] This assertion was based on Hall's analysis of certain writings of the Westminster gathering, from which he concluded that 14 voting members and 1 nonvoting member of the assembly *explicitly* endorsed a 144-hour interpretation of the creation days, while an additional 9 voting members and 1 nonvoting member *implicitly* endorsed such a view.[18]

However, of the 25 scholars that Hall cited, only 19 actually penned anything on the Genesis creation days. The other six simply endorsed the work of one of the other 19. Their endorsements are generic to the work, not to the specific issue of the duration of the creation days.

William Barker, professor of church history at Westminster Theological Seminary (WTS), made an independent assessment of Hall's sources.[19] He granted that five of the Westminster divines held to 24-hour creation days. However, he argued that "it will not do to claim for the six 24-hour day view those who merely refer to six days of creation" and that "mere support for the chronology of James Ussher, of a date for the creation of man of around 4,000 BC, also does not serve to indicate a commitment to six 24-hour days of creation."[20]

None of the divines expressed the dogmatism that typifies young-earth

literature today. Their writings (even those by John Lightfoot and Ussher) avoid attacks on other people's character and motives, and they contain no alarmist warnings about those who disagreed with them.

As for the 126 Westminster divines who wrote nothing at all about the dates for creation, one cannot presume to know what they did or did not believe. We simply do not know.

In one sense, what the Westminster divines personally believed about the dates for creation remains immaterial. What they chose to include in the confession concerning the days of creation is neither more nor less than what the Bible teaches. Their selection of the phrase "in the space of six days" straightforwardly counters the belief Augustine expressed in *The City of God*, and that Sir Thomas Browne indicated in *Religio Medici* (1643), that all of creation took place in a single instant.[21] At the same time, their wording leaves the duration of the six days open to further exegetical study.

Newton and His Contemporaries

Hall concluded his analysis of the Westminster divines by issuing a challenge: "My friends who hold the expansive view [that the Genesis creation days are longer than 144 hours] deny that they are following early nineteenth-century science, but they fail to produce examples of pre-nineteenth century exegesis that advocates [*sic*] their view."[22]

Ironically, in 2001, Hall himself drew public attention to a good example—a letter Isaac Newton sent to Thomas Burnet, King William III's chaplain. Commenting on that document, Hall wrote, "Clearly, Newton did not agree with viewing the creation days as 'fictional' or 'metaphorical,' but viewed them as normal days."[23] However, Newton's own words in that letter are these: "Now for ye number & length of ye six days: by what is said above you may make ye first day as long as you please & ye second day too."[24] Throughout the letter Newton attributed the formation of Earth's atmosphere, of the continental landmasses, and of specific hills and mountains to gradual, natural processes over long time periods under God's control and design.[25]

Newton expressed his day-age view of the Genesis creation account in other letters as well.[26] Moreover, he testified that his view was popular among his contemporaries, based on Bible texts such as Job 15:7, Psalm 90:2, and Proverbs 8:25.[27] And Burnet wrote a book in 1681 that argued for an old-earth interpretation of Genesis 1.[28]

Modern Statements of Faith

Attempts in the 1990s to force a young-earth view of creation into doctrinal statements and, thereby, make adherence to a young-earth interpretation a condition for church membership led both the Presbyterian Church in America (PCA) and WTS to convene panels of scholars to study the Bible's teaching on creation. Both panels were charged with determining the limits of permissible interpretations of the Genesis 1 creation days under the assumptions of strict biblical inerrancy, biblical supernaturalism, a denial of naturalistic or Darwinian interpretation of life's history, a belief in creation *ex nihilo* (out of nothing), and a belief in Adam and Eve as actual historical persons from whom all of humanity is descended.

Both panels concluded that the Genesis creation days could be faithfully interpreted as long time periods.[29] Specific details about the makeup of the panels and their reports appear in chapter 22.

Creedal Tolerance

For those young-earth creationists who center their case for a young Earth on historical examination of the biblical creation texts (for example, Duncan, Hall, James Jordan, and Douglas Kelly), this review of church literature is significant. It shows that none of the church creeds contain any exclusive language with respect to the nature and duration of the Genesis creation days.

Kenneth Samples, professor of theology and philosophy, noted that Christianity's greatest thinkers allowed for a diversity of views on the nature and duration of the creation days. "From the time of the church fathers, through the Reformation, and up to the present, various views have prevailed, some more broadly represented than others, but none was ever considered the definitive, or the only, orthodox biblical position."[30]

Respected church scholars from the past, in essence, have granted scholars today the mandate to continue studying the biblical texts *and* nature's record so as to better understand both. Avoiding the interpretive barriers described in the next chapter will keep us moving forward toward peaceful resolution of the creation-day controversy.

Chapter 6

Toward Better Interpretations

At times the pitch and persistence of the creation-day conflict have nearly drowned out the most important and helpful paths toward peaceful resolution. Acknowledging the trustworthiness and consistency of the Bible's words, together with the facts of nature, can lead us away from the turmoil and into greater unity. In the interest of peace, we can review what Scripture says.

First, the Bible declares its message to be true:

- God is not a man, that he should lie. (Numbers 23:19)
- The words of the Lord are flawless. (Psalm 12:6)
- The law of the Lord is perfect.…The statutes of the Lord are trustworthy.… The precepts of the Lord are right. (Psalm 19:7–8)
- All [God's] words are true. (Psalm 119:160)
- Every word of God is flawless. (Proverbs 30:5)
- The Scripture cannot be broken. (John 10:35)
- It is impossible for God to lie. (Hebrews 6:18)
- God is light; in him there is no darkness at all. (1 John 1:5)

Second, the Bible also declares that the record of nature is a reliable and understandable means for God to speak to people:[1]

> The heavens declare the glory of God; the skies proclaim the work of his hands. Day after day they pour forth speech; night after night they display knowledge. There is no speech or language where their voice is not heard. Their voice goes out into all the earth, their words to the ends of the world. (Psalm 19:1–4)

Romans 1:18–20 shows how clearly God speaks through the record of nature:

> The wrath of God is being revealed from heaven against all the godlessness and wickedness of men who suppress the truth by their wickedness, since what may be known about God is plain to them, because God has made it plain to them. For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse.

Despite sin, and thanks to God's grace, all people are capable of discerning certain basic qualities about the Creator. Nevertheless, disagreement on certain issues, including creation's timing, persists. Language barriers, human limitations, and inadequate testing hinder perfect understanding of God's revelation through the study of Scripture (theology) and through the study of the created realm (science), even given the best of intentions.[2] While misunderstandings typically generate disagreement, willingness to recognize and work through the obstacles brings unity.

Language Barriers

Language differences increase the difficulty of comprehending the meaning of the creation "day." The entire Old Testament, except for Aramaic portions of Daniel (2:4b–7:28) and Ezra (4:8–6:18), comes to us from ancient Hebrew. The New Testament is written in *koinē* Greek, the common dialect (as opposed to Attic or classical Greek) of the first century AD. The Hebrew and Greek languages of today differ in several ways from biblical Hebrew and Greek.

Each human language has strengths and weaknesses. The size of its vocabulary gives English great strength. Nearly 4 million words (including species names and biochemical terms) compared to just several thousand each in biblical Hebrew and Greek. But this great strength is also a weakness with respect to Bible translation because English is so dynamic. This volatility requires frequent retranslations from the original biblical languages, while the huge difference in vocabulary size requires many different translations in order to faithfully and fully communicate the rich meaning, thought, and emotion in the Bible's original texts.

By no coincidence does the creation-day controversy rage most fiercely among English-speaking Christians. Such readers of the Bible may be unaware of the nuances of meaning in the various Hebrew verbs used to describe God's creative activities in Genesis 1 and 2. With so many words available in English to describe long time periods (having specific start and end points), many

readers don't realize that in biblical Hebrew only one such word exists. Likewise, English readers may not know that many Hebrew nouns possess multiple, literal definitions. For example, the following Hebrew words used in Genesis 1 each possess from three to five different literal definitions: *ʾereṣ*, *shāmayim*, and *yôm* (usually translated as "earth," "heaven," and "day," respectively).

Human Limitations

Another great obstacle to the resolution of the creation-day controversy is the attitude expressed by claims like "I don't interpret the Bible; I just read it."[3] More than one young-earth creationist leader I've talked with has denied the need for further study and ongoing dialogue. One told me there were no possible "cracks" in his understanding of the text. For him, the need for discussion didn't exist, and his understanding of the subject was beyond question.

Who does not need to acknowledge human limitation? Sincere Christians can study the Bible all their lives and still not plumb its depths. Further, their background, education, and preconceived ideas can influence the way they view various passages.[4] While the basic message of the gospel (the means by which humans can be redeemed from their sinful ways) seems clear to most evangelicals, discussion arises even on this matter. On issues not directly related to the gospel, the meaning of God's recorded Word is not always obvious with a surface reading. Thus, honest human interpretations can and do differ. "Plain" or "literal" interpretations are still interpretations. Literary genre must be taken into account. Figures of speech must be given attention. The immediate and broader context, as well as other grammatical and historical data, demand attention. Scripture also interprets Scripture—passages covering a particular topic in detail help clarify other passages. Such interpretive requirements acknowledge and help protect against the possibility of human misunderstanding, oversight, and error.

The Bible, as a finite communication from our infinite God, contains only 66 books, each one limited in scope. These books address a limited range of topics to a limited level of detail (see John 21:25). No mere human can claim complete knowledge of God's mind. The learned apostle Paul reminded us that we "know in part" (1 Corinthians 13:12), and we come to God with whatever small part we understand.

Scientists face challenges in interpreting nature, too. Knowledge about the universe is incomplete and will remain so. Astronomers have yet to measure all the planets, stars, and galaxies distributed on the space surface of the universe.

When astronomers peer through a telescope into the night sky, they understand many of the details they see through the lens of their education, their experience, as well as their equipment. The quality of each will influence the outcome of their work. No matter how skilled, they are subject to human limitations.

So, how can people overcome biased and incomplete interpretations? A good start would be to admit them freely to God and to one another. Humility demands that Christians hold interpretations of controversial passages somewhat tentatively, expressing a willingness to learn more. No matter how much study anyone devotes to an issue such as the creation date, room still exists to improve understanding. Constructive dialogue can contribute substantially to spiritual growth. People who study creation have everything to gain by working together, especially by exploring a variety of interpretations and putting each one through various tests. As the book of Job exhorts, "Let us discern for ourselves what is right; let us learn together what is good" (Job 34:4). And as Isaiah echoes, "Come now, let us reason together" (Isaiah 1:18).

Testing Interpretations

In his recent book on evolution and creationism, emeritus biology professor John Moore commented that "science and religion still use very different thought patterns—one based on evidence and the other on belief."[5] He further distinguished creationism from evolution by asserting the former is "based on faith" while the latter is "based on confirmable evidence."[6]

Current culture subscribes to this false dichotomy: facts and faith don't mix. Yet the Bible claims that faith is built on reasonable evidence. All the Hebrew and Greek words in the Bible translated into English as "faith" document the importance of belief—and action—being based on verifiable truth (see appendix A).

Both the Old and New Testaments emphasize the importance of testing, of making sure the evidence supports truth claims. Moses instructed the Israelites to test individuals who claimed to be speaking or writing under divine inspiration (Deuteronomy 18:21–22). The prophet Malachi quoted God as saying, "Test me in this" (Malachi 3:10). The apostle Paul urged Christ's followers, "Test everything. Hold on to the good" (1 Thessalonians 5:21). The apostle John similarly wrote, "Test the spirits to see whether they are from God" (1 John 4:1).

In addition, Luke affirmed the importance of testing by complimenting people in Berea who "examined the Scriptures every day to see if what Paul said was true" (Acts 17:11). The Bereans set an important example for us as they tested Paul's words and checked his teaching against the law, history, songs, and

prophecies preserved through the centuries with confirmed accuracy.

Tests of consistency, both internal and external, served as the crucible from which the New Testament canon emerged. Through the filters of integration and corroboration, the creeds were distilled. The quest for consistency defines the goal of all responsible Bible scholarship—in fact, for all responsible scholarship, including science.

One of the most direct and significant connections between the work of Bible scholars and the work of scientists lies in the methodology of the quest. Laypeople sometimes express surprise that the approach to literary, and particularly Bible, interpretation so closely resembles the approach best known as the scientific method. The surprise evaporates, however, when one recognizes that Genesis 1 reads like a primer on the scientific method: an opening statement identifying the frame(s) of reference (or points of view) and initial conditions, followed by an orderly description of a sequence of events, followed by a statement of the final conditions, and closing with some conclusions. Among the holy books that undergird the world's religions, the Bible stands alone in offering more than twenty lengthy texts addressing the topic of creation (see table 6). Job 37–39, Psalm 104, and Proverbs 8 in particular explain in considerable detail the creation events described in Genesis 1. Thus, in the Bible itself are multiple opportunities to test and refine one's interpretations of Genesis 1.

History reveals that the scientific method of investigation—a method developed by Renaissance men well-grounded in God's Word—has its roots in Scripture. Biblical convictions and values, as well as intellectual drive and prowess, gave rise to the scientific age. The modern scientific revolution emerged at both the times and locations of the Protestant Reformation. Scottish theologian Thomas Torrance and an interdisciplinary team of scholars have documented how Christian theology (and Reformed theology in particular) played a critical role in the birth and development of the scientific method that led to amazing advances.[7]

A willingness to pursue continual, progressive testing of interpretations of Bible texts and of nature's data have, for centuries, led human investigators closer and closer to better understanding ("rightly dividing," 2 Timothy 2:15, KJV) the truth contained in both biblical passages and natural phenomena. The testing method involves a series of steps designed to help investigators tentatively develop interpretations and subsequently improve those interpretations. The biblical *and* scientific interpretive process, especially as applied to a given physical event or sequence of events, includes eight essential steps:

1. Collect relevant texts and observations.
2. Identify the frame(s) of reference for each.
3. Determine the context and initial conditions for the event(s).
4. Determine what takes place, when, and where, and the sequence of events within each text or observation.
5. Note the final conditions.
6. Form a tentative interpretation to explain both the how and the why of the event or sequence.
7. Examine the tentative interpretation in light of additional relevant texts and observations, eliminate extraneous data, and add any previously overlooked important information.
8. Revise the initial interpretation as necessary to achieve consistency with all available information.

This approach restrains the temptation to form interpretations and adopt beliefs too quickly and too resolutely. It encourages the investigator to delay drawing even tentative conclusions until completing the first five steps. This testing method does not, however, end with step 8. The process goes on and on. After completing the method once, the interpreter returns to step 1 and repeats the procedure through a new cycle.

Extensive testing and retesting helps investigators hold interpretations or beliefs lightly so that during this process these interpretations can be revised or even ruled out. Good interpretations require smaller and smaller revisions with each cycle through the sequence. Poor interpretations manifest irreconcilable inconsistencies or demand larger and larger revisions with each cycle. Beliefs must always remain open to scrutiny, with the goal of approaching ever more closely to (though never fully attaining) the whole truth.

Evaluating Interpretations

As Galileo pointed out, the greatest potential for misinterpretation lies in the failure to properly apply any one of the first three steps. Skipping the first one is especially problematic. Much of the conflict concerning the creation account comes from the presumption that the biblical teaching on creation resides primarily in Genesis 1 and 2. Christians and non-Christians tend to develop their interpretations of Genesis 1 and 2 without testing them for consistency with the other 21 creation-relevant passages in the Bible (see table 6).

A tumultuous controversy exists, for example, over what Genesis teaches about the origin and structure of the universe. Few people realize that David, Isaiah, Jeremiah, Job, and Paul said more about cosmic creation than did Moses in Genesis. The ferocity of the clash dissipates when one integrates all these passages (see chapter 13 for details).

The Bible's teaching on creation is not limited to the Scripture portions listed in table 6. Shorter creation-relevant texts can be found in virtually every book of the Bible. Texts containing at least one sentence of creation information are listed in appendix B. Additional words and phrases are too numerous to list.

Table 6: Creation-Relevant Accounts in the Bible

Creation Text	Creation Theme
Genesis 1	The one true God made the universe, the world, and all life.
Genesis 2	God created humans and marriage, and assigned responsibility.
Genesis 3–6	Sin entered creation.
Genesis 6–9	Humans became reprobate and imperiled the creation.
Genesis 10–11	God dispersed humanity to protect creation.
Job 9	Creation reveals God's power and design.
Job 34–41	Creation is far more complex than humans comprehend.
Psalm 65	God's provision and care for creation are optimal.
Psalm 104	God gives details of the physical creation chronology.
Psalm 139	Each human life is a unique creation.
Psalms 147–148	All creation praises God.
Proverbs 8	Creation is temporal, but God is eternal.
Ecclesiastes 1,3,8–12	Fixed physical laws govern creation.
Isaiah 40–51	God gives details of cosmic creation and His intent as Creator.
Romans 1–8	God's purpose for creation is redemption in Christ.
1 Corinthians 15	Creation and death precede the glory to come.
2 Corinthians 4	God's light shines through cracked (by sin) "jars of clay"
Hebrews 1	God describes the purposes for which He created angels.
Hebrews 4	God's work and rest are complete and ongoing.
2 Peter 3	This creation will end.
Revelation 20–22	The new creation awaits.

Falsifiability and Predictability

One of the most important tests of any interpretive model (detailed interpretation of a particular phenomenon or a related set of phenomena) is how well the model survives vigorous attempts to falsify it and how accurately it "predicts," or anticipates, discoveries. Moses, for example, exhorted the Israelites to test those

claiming to be prophets by the accuracy of their predictions. Even one false prediction served as grounds for rejecting that prophet's message as sent from God (Deuteronomy 18:14–22).

Old and New Testament prophets made both short- and long-range predictions. Isaiah (chapters 36–37), for example, predicted in great detail how and when the seemingly invincible Assyrian army threatening to destroy Judah and Jerusalem would be crushed without a fight. Days later, when everything Isaiah wrote about the Assyrian invaders proved correct, his credibility as a prophet of God was firmly established. Isaiah also made specific predictions about the coming Messiah, fulfilled 700 years later. Many more of his predictions (about the second rebirth of Israel as a Jewish nation, Isaiah 49) were fulfilled nearly 2,700 years later. Confidence in the fulfillment of these long-range predictions rested in the verifiable accuracy of Isaiah's short-range predictions.

A biblical application for the currently raging creation controversy is to compare creation models that make specific short-range predictions concerning what scientists will discover as they explore the created realm more deeply. If all the short-range predictions flowing out of a model come true, then that model should be enthusiastically supported. If all but one or two minor predictions prove accurate, then that model should be received as a good model needing minor revisions to make it even better. If nearly all the predictions arising out of a model fail to come true, then that model should be considered unworkable, needing major overhaul, if it can be salvaged at all. If none of the predictions come true, or if it is not possible to make any based on the model, then the model should be ruled out. The more specific and detailed the model, the greater the opportunity to test its success. (A sample application of this testing method appears in chapter 23.)

Tempering Emotions

God calls people to "make every effort to live in peace with all men and to be holy.…See to it that no one misses the grace of God and that no bitter root grows up to cause trouble and defile many" (Hebrews 12:14–15; see also Romans 12:18). Tolerance *and* discrimination expressed in a biblically balanced way are crucial for progress toward conflict resolution.

In order to keep peace, some totalitarian governments and administrations tolerate only one view. An example of such an extreme response to conflict came to my attention some years ago when I gave a lecture to faculty at Texas A&M University. A Romanian physicist told of how he'd been forbidden to teach on the big bang during the Soviet era because it made the universe "too young" and

implied the existence of God.

Many churches (and schools) attempt to keep peace today by allowing only one position on the creation-day controversy and requiring all leaders and teachers to embrace that ideology. Any questioning of that viewpoint elicits disapproval or disciplinary action.[8]

At the opposite extreme, total "tolerance" makes even appropriate expressions of discrimination taboo. To avoid offending anyone's beliefs, politicians, educators, and even some church leaders openly discourage critique (or testing) of anyone's religious beliefs. However, if leaders offer "no comment" or, worse yet, declare the creation-day topic irresolvable and "off-limits," they frustrate the learners in their constituency. The frustration can build for only so long before it breaks out into disputes and conflicts.

Discrimination and tolerance need not be mutually exclusive. Tempered by gentleness and respect, they add an exciting element to the adventure of learning. They can even produce unity. By making each interpretation fair game for thorough testing, the degree to which a view proves valid becomes the degree to which it can be affirmed. This testing method promotes vigorous competition among ideas. When it comes to controversies over the creation date, both churches and schools can welcome the entry of all ideas and interpretations, along with the challenge to accept or reject them based on the rules of internal and external consistency and predictive power. This approach moves the discussion further from subjective interaction and closer to objective discourse. Different views are simply put to the test.

Given ongoing advances in theological scholarship and scientific discovery, differences can be resolved. Humility, learning, and testing make peace possible. Meanwhile, keeping in mind creation's "big picture," as set forth in specific Scripture passages, can also calm the controversy's storm.

Chapter 7

Anchored in Scripture

Genesis 1 records a dramatic story: “within six days” God miraculously transformed a “formless and void” Earth into a well-furnished home for humanity. He then created two human beings, male and female, to live there. How strange that in the awesome scope of this account the meaning of one word, “day,” should become the focus of ferocity. Is the length of a creation day 24 hours? Or can the word “day” refer to millions of years? In the midst of the tumult, the Bible anchors a person in the truths of the “big picture.”

A wide-angle lens provides the framework for putting details into perspective. The big picture of creation outlines not only *what* was created but also *why* it was created. It even shows what existed before creation and offers a glimpse into the creation’s future.

No single passage reveals the entire masterpiece. At best, each text uncovers an element or two. By fitting these pieces together and discovering their nuances, one can begin to see and make sense of the overall picture. Much division and hostility (as noted in chapter 6) arise from the tendency to view the Genesis 1 and 2 accounts as comprehensive. Assuming a big picture from just one or two parts can lead to a distorted whole.

The Big Picture

By integrating the 21 biblical passages that address creation (see table 6) and constructing a scenario consistent with all those texts, the scope and splendor of creation takes on breathtaking proportions. At the same time, a basic framework emerges, the basis for building a unified—and unifying—model. That structure includes the following sequence of creation events upon which many Christians would agree:

1. God created all matter, energy, space, and time (the universe).
2. God prepared the universe and Earth as a home for humanity.
3. God created many life-forms, including plants and animals, to enhance the quality of life for human beings.

4. God created Adam and Eve and placed them in a wondrous garden.
5. God allowed Satan to tempt Adam and Eve, to subtly solicit their rebellion against God's authority. (The doctrine of God's sovereignty says that nothing happens outside of God's control, purpose, and foreknowledge.)
6. God allowed Adam and Eve the freedom to disobey and thereby pass their rebellious nature to their descendants, subjecting all humanity to the presence of sin and its impact (death and intensified pain and work) on their future.
7. God gave humanity hope in the promise of the coming Redeemer.
8. God came to Earth in human form (Jesus of Nazareth) to atone for sin and unlock sin's death grip on humanity.
9. God is preparing a new creation for redeemed humans.
10. God will complete His conquest of evil, and remove redeemed humans from any contact with evil, when He replaces this present universe with a new heaven and Earth.
11. God will bring redeemed humans into the new creation, where they will receive an unimaginably great reward.

This big picture frames the discussion (in the next four chapters) of creation's scriptural and theological details. The current chapter concentrates on biblical (that is, exegetical) issues.

Legitimate study of Scripture takes into account the original language, context, grammar, author's intent, and related biblical texts.[1] Key scriptural points related to the creation dates, and discussed in the next few pages, focus on:

- word choices (along with their definitions and usages)
- day markers
- difficulties of having no Sun or Moon
- a chronology's function
- sixth-day events
- the seventh day
- the coming eighth day
- biblical clocks

Word Choices: *Yôm,* *ʿEreb,* and *Bōqer*

The Hebrew word *yôm*, translated "day," is used in biblical Hebrew (as in modern English) to indicate any of four time periods: (a) some portion of the daylight (hours); (b) sunrise to sunset; (c) sunset to sunset; or (d) a segment of time without any reference to solar days (from weeks to a year to several years to an age or epoch).[2] *Yôm* cannot, however, be interpreted as indefinite (such as anytime or someday) or as infinite time.

William Wilson, in his *Old Testament Word Studies*, explains that *yôm* is "frequently put for time in general, or for a long time; a whole period under consideration.…Day [*yôm*] is also put for a particular season or time when any extraordinary event happens."[3]

Even in English (which includes many more words than Hebrew for describing time periods), such expressions as "in my grandfather's day" and "during the day of the dinosaurs" are common. Biblical examples include the use of *yôm* to describe harvest "time," a future era, and a time that encompasses summer and winter.[4] In references to the "day of the Lord," the word *yôm* appears to indicate a span of many months or longer, depending on one's interpretation of yet-to-be-fulfilled prophecies. So the question becomes, what other clues do the biblical creation texts give for the definition of *yôm*?

Some people see the words translated as "evening" and "morning" as evidence that *yôm* refers to a 24-hour period. However, other valid options exist. The Hebrew word *ʿereb*, translated "evening," also means "sunset," "night," "in the evening," "at evening," "at the turn of evening," or "between two evenings."[5] And the word *bōqer*, translated "morning," also means "the dawn," "end of darkness," "the coming of dawn," "beginning of day," "all day," "in the morning," "bright joy after night of distress" (for example, "dawn of prosperity"), "morrow," or "next day," with possible metaphoric uses as well.[6]

In other words, "evening" and "morning" refer to the beginning and ending of a day, whatever definition of "day" applies. For example, "in my grandfather's day" refers to the time period surrounding his lifetime. The morning and evening of his lifetime would be my grandfather's youth and old age.

In examining other biblical texts' occurrences of *yôm*, some people who promote a young-earth perspective attempt to make a statistical argument. For example, authors Mark Van Bebber and Paul Taylor wrote, "This phrase [evening and morning] is used 38 times in the Old Testament, not counting Genesis 1. Each time, without exception, the phrase refers to a normal 24-hour-type day."[7]

Interestingly, the word "day" (or *yôm*) appears in none of these examples.

The word's plural form occurs only in 1 Samuel 17:16. In only a few of the 38 examples do the words "evening" and "morning" appear in the same sentence or verse. The phrase "evening and morning" itself appears only one time, in Psalm 55:17. King David said, "Evening, and morning, and at noon, will I pray" (KJV). However, even this occurrence is of little relevance. The expression being considered here—"and there was evening, and there was morning"—appears only in Genesis 1.

The claim that *yôm*, when attached to an ordinal (second, third, fourth, and so on), always refers to a 24-hour period must also be questioned.[8] Van Bebber and Taylor have said that 358 out of the 359 times *yôm* is used in the Bible, outside of Genesis 1 and with an ordinal modifier, it represents a 24-hour day.[9] However, in examining each passage, the reader discovers that only 249 of these usages are the singular form of *yôm*, and all 249 are in the context of human activity or human history. But Genesis 1 speaks of divine activity or natural history apart from, and unrelated to, human activity. Furthermore, no rule of Hebrew usage or grammar requires that when *yôm* appears with an ordinal it can only mean a 24-hour period.

Recently, theologian Andrew Steinmann revived Basil's observation (see "Other Fourth-Century Scholars" in chapter 4) about the distinction in Genesis 1 between the first creation day and the succeeding five creation days.[10] Basil noted that Genesis 1:5 refers to the first creation day as "day one" (a literal word-for-word translation from the Hebrew text), while Genesis 1:8–31 refers to creation days two through six as "second day," "third day," "fourth day," "fifth day," and "sixth day." The fourth-century scholar saw the distinction as a possible implication that the first creation day's duration could have been different, probably much longer, than the succeeding five creation days.

Steinmann, however, claimed the "day one" phrase in Genesis 1:5 (as distinct from the other creation days) is God's way of indicating the duration of *all* the creation days. According to Steinmann, God here defines a creation day as one evening and one morning, a 24-hour period. He attempted to seal his case with the observation that the "day one" phrase appears only once in the Bible.

Steinmann's assertions may be interesting, but do they constitute an airtight case? A word-by-word translation of Genesis 1:5b from the Hebrew reads as follows: "And was evening, and was morning day one."[11] Nothing in this sentence explicitly establishes *yôm*'s duration. This rendering of the sentence in which "day one" appears could just as reasonably suggest a meaning other than 24 hours.

Declaring that "day one" (*yôm ʾeḥad* in the Hebrew) is unique to Genesis 1:5

also represents a distortion. The expression shows up in Zechariah 14:7. A word-for-word Hebrew translation of this passage reads, “And it will be day one which shall be known to Jehovah.”[12] In this context, “day one” refers to the “day of the Lord,” which Bible scholars interpret as a time period longer than 24 hours.

For centuries, Bible commentators have noted that in Hosea 6:2 (where ordinals are used) “day” refers to a longer period—a year, several years, a thousand years, or perhaps more.[13] “After two days he [God] will revive us [Israel]; on the third day he will restore us.”

This passage is just one among many Old Testament passages in which *yôm* refers to a long time period. Others include the numerous references to the “day of the Lord,” or “that day.”

Many young-earth creationist leaders assert that if the author of Genesis 1 wanted to unambiguously convey a long time period, he would have used the Hebrew word *ʿôlām* instead of *yôm*. However, according to Hebrew language textbooks, *ʿôlām* “came to be used to refer to a long age or period” only in “postbiblical Jewish writings.”[14] In biblical times, *ʿôlām* meant “forever,” “perpetual,” “antiquity,” “continuous existence,” “lasting,” “always,” “of olden times,” or “the remote past, future, or both.”[15] More than 300 times in the Old Testament, *ʿôlām* is used “to indicate indefinite continuance into the very distant future,” while in only some 20 instances does it “clearly refer to the past.”[16] The range of *ʿôlām*’s usage did not include a set period of time.[17] *Yôm* remains the only biblical Hebrew word that can refer to a long time period with a definite start and end point.

Moreover, in Genesis 2:4 the word “day” (*yôm*) refers to all six creation days, a period longer than 24 hours. The literal Hebrew of this passage reads, “These are the generations of the heavens and the earth when they were created in the day of their making.” Commentators differ as to whether the phrase “these are the generations” is a summary of what precedes it or a preview of what follows.[18] If it is a summary of what precedes the phrase, then the populations of living things said to have been created in Genesis 1 are here called “generations” (*tôlēdôt*), a term commonly used to refer to the multiple generations represented in genealogies. In either case, the wording of this verse challenges the assertion that the word “day” (*yôm*) in the creation account can only refer to a 24-hour period.

Completed Acts

In analyzing the structure and grammar of Genesis 1:1–2 Hebrew linguists have determined these texts proclaim that the creation of the universe and the

formation of Earth must predate the events described in the six days of creation (beginning at Genesis 1:3) by an unspecified but finite time duration. Thus, whichever one of the four literal definitions one chooses for the Hebrew noun *yôm* to delineate the duration of the six creation days, Genesis 1 allows for both the universe and Earth to be as old as what astronomers and physicists have measured them to be.

In his book *Genesis 1–4: A Linguistic, Literary, and Theological Commentary*, C. John Collins wrote, "The verb created in Genesis 1:1 is in the perfect, and the normal use of the perfect at the very beginning of a pericope is to denote an event that took place before the storyline gets under way."[19] He adds, "A number [of narrative pericopes] do begin with a verb in the perfect, and they do so in order to describe an event that precedes the main storyline."[20]

Rodney Whitefield explained in his book *Reading Genesis One: Comparing Biblical Hebrew with English Translation*, and in his booklet summary, *Genesis One and the Age of the Earth*, that in biblical Hebrew verbs by themselves do not specify the duration of actions. However, word order is one way of establishing the ordering of past actions.[21]

Whitefield pointed out that in biblical Hebrew narrative the verb most frequently appears first followed by the subject of the verb. This is the case for the verbs that appear in all but three of the thirty-one verses that comprise Genesis 1. Exceptions, however, are found in Genesis 1:1–2. In describing the creation of the universe and the status of Earth, Genesis 1:1 and the first clause in Genesis 1:2, respectively, place the verb in the second rather than the first position. Placing the verb as the second word of a sentence or clause is one way, Whitefield explains, that biblical Hebrew establishes that a particular action has already been completed.[22] Thus, Genesis 1:1 declares that the universe had a beginning and that its creation is a completed event. Genesis 1:2 proclaims that Earth had existed in a formless and empty state. That is, the universe and Earth are already in place before the events of the six creation days.

The phrase "and God said" that—starting in Genesis 1:3—heralds the eight creative commands in the account of the six creation days confirms the conclusion drawn by Collins and Whitefield. In each case, the eight such occurrences of "and God said" starts a sequential narrative that follows up on what occurred before. Therefore, just as the text implies that the creation events of day three, for example, occurred after the creation events of day two, the creation events of the first day must have taken place after those described in Genesis 1:1–2.

The completed nature of the creation of the universe and the primordial Earth

implies that an unspecified passage of time transpired between God's creation of the two. Likewise, an unspecified time period transpired between Earth's initial formation and the events of creation day one.

Day Markers

Ancient Hebrews most often marked 24-hour days with "evening to evening" (see for example Leviticus 23:32). The "and there was evening, and there was morning" expression in Genesis 1 is unique. Therefore, the repeated word-for-word translation of the Hebrew text used in Genesis 1 for the six creation days —"and there was evening, and there was morning"—alerts the reader that these days may have been periods other than 24-hour days.

Absence of Sun or Moon

Young-earth creationist leaders interpret Genesis 1 as teaching that the earth is 72 hours older than the Sun.[23] They insist that no natural light existed anywhere in the universe until God said, "Let there be light," on day one. They also claim that God did not create the Sun, Moon, and stars until day four.

However, the Genesis 1 text speaks about plants proliferating on Earth's landmasses on day three. The young-earth interpretation implies that these plants survived for a day without benefit of the Sun's light and heat. This idea rests on the impossibility of plant survival if creation day three were a long time period. It also suggests that if the days were consecutive 24-hour periods, God could sustain plants by illuminating Earth with His Shekinah glory or some other miraculous intervention. Theologian James Jordan proposed that God initially stretched out a thin veil of uniformly bright light over the earth, then on day four spread that veil "upwards and outwards to form outer space," finally breaking it up and congealing it "to form stars, planets, asteroids, dust, etc."[24]

The problem with such a proposal is that even in a time period as brief as 24 hours, plants (and, indeed, all life) require more than just the equivalent of the Sun's heat and light. They need everything God established during the first three creation days—a stable planet no longer hostile to life (or "formless and void"). For a stable, hospitable Earth, many specific solar characteristics, especially the Sun's gravity, must be operational.[25] In the absence of the Sun, Earth's orbital path, rotation, atmosphere, oceans, continents, and water cycle would suffer catastrophic consequences.

If the Sun, Moon, stars, and presumably planets in the vicinity of Earth were dropped into place on the fourth day, the gravitational perturbations would have radically altered Earth and instantly destroyed all life. Proposing that primordial

gravitational fields existed in the locations of the present Sun, Moon, and stars previous to creation day four will not save the young-earth model. The removal of such fields and their orbital and rotational properties (really, the equivalent of surrogate stars, planets, moons, and sun), and their replacement with actual stars, planets, moons, and the Sun, would be even more catastrophic to Earth and life.

Likewise, the Moon is critical for life. The Moon prevents destructive orbital resonances, stabilizes the tilt of Earth's rotation axis, and helps establish tidal flow patterns in Earth's oceans and atmosphere. These are only a few of its life-support functions.[26]

As a way around these enormous complications, some young-earth creationist leaders suggest that God could have radically altered physics.[27] While no Christian would doubt that He *could* have, both biblical texts and astronomical observations support the conclusion that He did not. For example, Jeremiah 33:25 explicitly refers to "the fixed laws of heaven and earth," while Romans 8:20–22 states that "bondage to decay," an apt description of the second law of thermodynamics, applies to the "whole creation."

Astronomically, because of the time required for light to travel from stars and galaxies to astronomers' telescopes, observations of distant sources provide a direct and faithful record of the state of the physical laws and constants throughout cosmic history. Astronomers see no evidence from any past era for even a tiny change in physical laws or constants. Observations show that possible variations must be less than 2 parts per 10,000,000,000,000,000 per year over the past 12 billion years.[28] Laboratory measurements limit possible variations to as little as 4 parts per 100,000,000,000,000,000 per year.[29] Thus, research confirms that the laws and constants of physics have operated invariably and continuously throughout cosmic history, including the creation days.

Analyzing the grammar in the biblical text helps settle these issues. Genesis 1 employs one set of verbs for the creation of birds, mammals, humans, and the universe. These verbs—*bārāʾ*, *ʿāśâ*, and *yāṣar*—mean "create," "make," and "fashion" or "form," respectively.[30] Another verb, *hāyâ*, means "exist, be, happen, or come to pass"[31] and is used in conjunction with the appearance of "light" on day one and of the "lights in the expanse of the sky" on day four. This difference of usage is consistent with a scenario that says God created light in the beginning when He created the universe's matter, energy, space, and time. It is also consistent with the creation week's start point at the advent of light on Earth's surface—that divinely orchestrated moment when light first penetrated the opaque medium enshrouding the primordial planet. It is consistent, too, with

God's rhetorical question recorded in Job 38:8–9:

> Who shut up the sea behind doors
> when it burst forth from the womb,
> when I made the clouds its garment
> and wrapped it in thick darkness?

In a later miracle (fourth day), God transformed Earth's atmosphere from translucent to transparent. At that time, the Sun, Moon, and stars became visible from Earth's surface as distinct light sources. (For more details, see chapter 21.)

This exegetical approach not only arises from a modern understanding of the structure and formation of stars and planets, but also dates back to at least the 1680s.[32]

Chronology's Function

A study of other chronologies in the Bible reveals a common characteristic: they record sequences that are both significant and discernible to the author's contemporaries and to future readers. The timing and order are important to show the careful unfolding of God's plan and to affirm His control. The discernibility of chronologies provides a means for validating the message of God's spokesmen. Examples of such chronologies include Jeremiah 31:38–40 (a prediction, now fulfilled, of the location and construction sequence of Jerusalem's nine suburbs during the second rebirth of Israel as a nation); Daniel 9:24–27 (a timetable for the rebuilding of Jerusalem, the Messiah's coming and death, the destruction of Jerusalem, the years of desolation, and the final restoration); and Daniel 11:2–35 (a prediction, now fulfilled, sequencing the victories, defeats, and intrigues of various kings and kingdoms throughout the Greek and Roman eras). The supernatural accuracy of such chronologies attests to their inspiration, giving assurance for today and hope for tomorrow.

Recorded events not intended to be time-discernible to the reader are presented without the use of sequence markers. For example, in Acts 6, Luke did not indicate the order in which the first seven deacons of the church were chosen. He merely listed them without specifying who was chosen first, second, third, and so forth.

For the creation chronology, long creation days (orders of magnitude longer than 24-hour periods) during which increasingly complex life-forms were created can be verified and help validate the accuracy of the writer's statements (that is, the Bible writers must have been supernaturally inspired to accurately predict future scientific discoveries). But if all creation were completed in six

24-hour days, the most sophisticated measuring techniques available, or even foreseeably available, would be incapable of discerning the sequence of events.

Sixth-Day Events

Genesis 1 states that three different kinds of advanced land mammals and *both* Adam and Eve were created on the sixth day. Genesis 2:9 provides further amplification, listing events between Adam's creation and Eve's creation. First, God created Adam from the dust of the ground. Second, God planted a garden in Eden, making "all kinds of trees to grow out of the ground." Third, God placed Adam inside the Garden of Eden. Adam, after receiving instructions from God, worked and cared for the garden. After that, he carried out his assignment from God to name all the animals (specifically the *nepesh* creatures—birds, mammals, and higher reptiles). In the process, Adam discovered that none of these creatures was a suitable helper and companion for him.

The narrative suggests that Adam had sufficient interaction with the plants and animals of the garden to realize that something was missing from his life. Then God put Adam into a deep sleep, performed an operation and, when Adam awoke, introduced him to the newly created woman, Eve.

Upon seeing Eve, Adam exclaimed, "*Happaʿam*." This same expression appears in Genesis 30:20, translated as "now at last" and in Genesis 46:30 as "now finally."[33] The *Theological Wordbook of the Old Testament* translates Genesis 2:23 as "at last bone of my bones."[34] The *Brown-Driver-Briggs Hebrew and English Lexicon* translates it as "now at length."[35]

The Genesis 1 narrative continues with Adam and Eve receiving instructions from God (still on the sixth creation day) for managing plants, animals, and other of Earth's resources. One can easily imagine a lengthy communication. Considered together, many weeks', months', or even years' worth of activities took place in this latter portion of the sixth day:

- Adam engaged in four different careers, or apprenticeships, on the sixth creation day (gardening, studying animals, naming animals, and learning how to relate to Eve).
- Adam and Eve learned how to manage Earth's resources for the benefit of all life. To be meaningful and beneficial, such important education and training could not have been crammed into only a few hours.

Some young-earth creationist leaders argue that Adam's mental acuity was

so much greater before he sinned that he completed these tasks at superhuman speed.[36] This line of reasoning, however, fails to account for Adam's response to meeting Eve and for the following five observations:

1. No biblical basis exists for suggesting that Adam functioned at superhuman speeds before he sinned.
2. The Bible never claims that intellect (as opposed to wisdom) is correlated with the degree of sin in one's life. Intellect is not a reliable measure of freedom from sin.
3. Greater intellect would not significantly impact Adam's sixth-day tasks and experiences.
4. Adam, in his sinless state, would surely be all the more meticulous in performing his God-assigned tasks.
5. Jesus, though He was sinless in every way, did not (apparently) perform His carpentry work or other daily activities, physical or mental, at a faster than normal rate.

The Seventh Day

While each of the first six creation days is marked by a beginning ("morning") and an ending ("evening"), no such boundaries are assigned to the seventh day, neither in Genesis 1 and 2 nor anywhere else in the Bible. Given the parallel structure in the narration of the creation days, such a distinct omission from the description of the seventh day strongly suggests that this day has (or had) not yet ended.

Hebrews 4:1–11 draws from Psalm 95:11 to signify that God's day of rest (day seven) continues. King David wrote, "So I [God] declared on oath in my anger, 'They shall never enter my rest.'"

The writer of Hebrews was even more specific:

> For somewhere [God] has spoken about the seventh day in these words: "And on the seventh day God rested from all his work."…It still remains that some will enter that rest.…There remains, then, a Sabbath-rest for the people of God; for anyone who enters God's rest also rests from his own work, just as God did from his. Let us, therefore, make every effort to enter that rest. (Hebrews 4:4–11)

According to the Hebrews passage, the seventh day carries on through the

centuries: from Adam and Eve through Israel's development as a nation, through the time of Christ's earthly ministry, through the early days of the church, and on into the future.

Supporting evidence for the seventh day as an ongoing rest period (from creating) appears in John 5:16–18. Here, Jesus defended His healing on the Sabbath by saying that God, His Father, "is always at his work to this very day, and I, too, am working" (verse 17). Jesus' appeal is that He is honoring the Sabbath the same way His Father does. That is, His Father works "to this very day" even though "this very day" is part of His Sabbath rest. God—both the Son and Father—honors His Sabbath by ceasing from *creation* work. God's Sabbath (seventh day) does not preclude His healing people any more than it precludes a man from changing his baby's diaper on Sunday.

These passages suggest that the seventh-day rest in Genesis 1 and 2 represents a minimum of several thousand years and a maximum that is open-ended but finite. (Bible scholars who hold a framework view believe that God is finished with all His creating and that therefore the seventh day extends into eternity.)[37] Given the parallelism of the creation days in the Genesis account, it seems reasonable to conclude that the first six days also were long time periods.

Genesis 1 Answers a Fossil Record Enigma

The fossil record provides confirmation of an ongoing biblical seventh day, a day of cessation from cosmic creative activity. According to the fossils, more and more species of life came into existence during the millennia before humans. The number of new species more than balanced the number going extinct. Then came the human species.

During human history, the species extinction rate has remained high while the introduction rate measures a virtual zero. Estimates of the current extinction rate vary widely, from as low as one species per day to as high as five species per hour.[38]

Half of the approximately 8,000 mammal species that existed at the time of Adam and Eve's creation are now extinct. Meanwhile, not even one new mammalian species has appeared. Biologists Paul and Anne Ehrlich report, "The production of a new animal species in nature has yet to be documented.…In the vast majority of cases, the rate of change is so slow that it has not even been possible to detect an increase in the amount of differentiation."[39] Obviously a tremendous imbalance between extinctions and speciation now exists. Though humanity's influence on that rate is significant,[40] scientists conclude that even

without it at least one species per year would go extinct.[41]

If long, the creation days of Genesis provide an explanation. For six days (the fossil record eras) God created new life-forms. After the creation of Adam and Eve, however, God ceased from His work of creating new life-forms (the seventh day). Although He still works in providential ways, His creation rest, or "cessation," continues to this day.

The Coming Eighth Day

The creation week represents just part of God's creation activity. His cessation from creating had a definite start point (Genesis 2:2–3) and, if the rhetorical pattern applies, will have a definite end point. Thousands of years have already passed between the morning and (future) evening of God's rest day.

According to Revelation 21 and 22, once God fulfills His purposes for the cosmos, He will replace it with an entirely new creation—a new heaven and new Earth and the New Jerusalem. His Sabbath rest is scheduled to end.

Biblical Clocks

Bible writers often compared God's eternal existence to the longevity of the mountains or the "foundations of the earth."

- Before the mountains were born or you brought forth the earth and the world, from everlasting to everlasting, you are God. (Psalm 90:2)
- When there were no oceans, I [wisdom] was given birth, when there were no springs abounding with water; before the mountains were settled in place, before the hills, I was given birth, before he made the earth or its fields or any of the dust of the world. (Proverbs 8:24–26)
- Generations come and generations go, but the earth remains forever.…All streams flow into the sea, yet the sea is never full. To the place the streams come from, there they return again.…It was here already, long ago. (Ecclesiastes 1:4, 7, 10)
- Hear, O mountains, the Lord's accusation; listen, you everlasting foundations of the earth. (Micah 6:2)

All these passages depict the immeasurable antiquity of God's presence and plans. The brief span of a 3,000-year terrestrial history (in the historical context of the authors of Psalms, Proverbs, Ecclesiastes, Micah, Habakkuk, and 2 Peter) seems a possible but unlikely metaphor for God's eternality. That time span

would have been no greater than recorded human history and only three times longer than Methuselah's life span. The fact that the Bible does consider the antiquity of the mountains[42] and the founding of the earth suitable metaphors for God's eternality conveys the image of an ancient planet.

Habakkuk 3:6 directly, rather than metaphorically, declares that the mountains are "ancient" and the hills are "age-old." In 2 Peter 3:5, the heavens (the stars and the universe) are said to have existed "long ago."

Scripture Says More

Though not an exhaustive treatment of the subject, these exegetical considerations—including vocabulary, grammar, and context—directly address the length of the creation days. Many more Bible passages imply or indirectly refer to the timing of creation. Such passages must be studied and understood within the context of larger theological issues. The next chapter offers a look at these.

Chapter 8

Guided by Theology

The Bible is a harbor of truth. And yet, navigating a harbor safely often requires a guide who offers clear, specific direction around dangerous obstacles, especially during a storm. God calls Christians to love Him with all of their minds, and to do so, serious followers must explore the breadth and depth of His recorded Word. Jesus said, “Seek and you will find” (Matthew 7:7). Good theology helps direct an honest search.

Wise church scholars throughout history have acknowledged that determining the precise meaning of a biblical word or passage sometimes requires more effort than a mere surface reading. Many passages that address or allude to the age of the universe and Earth are difficult to interpret. Such sections require careful consideration of both context and relevant theological points. Failure to be cautious and thorough in analyzing them can lead to inaccurate conclusions. The following theological issues offer significant guidance to better interpretations of scriptural references regarding the length of creation days.

God Does Not Trick or Deceive

According to the Bible, God is truthful and He expresses Himself truthfully in all His works and words, both in the creation of the physical world and in the inspiration of His written Word. When Jesus, the visible expression of the invisible God, said to His disciples, “I am…the truth,” He identified one of His divine attributes (John 14:6). Many familiar Bible verses declare that God is truthful and He does not lie in word or in deed.[1] Nor does He hide revealed truth from those who want to understand it. Even the desire to search for truth comes from Him (see Jeremiah 31:33 and Romans 9:15–16).

God’s character must be kept in mind when developing a view on creation’s timing. Objects of creation, scientifically analyzed, will reveal their true age—provided the analysis is theoretically valid, correctly applied, and properly evaluated. For created things to show a deceptive appearance of age would violate God’s own stated character and purpose.

The Bible says that God created Adam and Eve with adult-sized bodies and adult capabilities. But nowhere does it hint that God implanted several years of

deterioration in their newly formed bodies. Adam and Eve were made, not born. Knowing (from God's own report) that they were created as exceptions to the subsequent natural rule, age cannot be inferred from the size and capability of their bodies.

Reliable age indicators for humans do exist, however. Liver spots on the skin, scar tissue, muscle and skin tone, visual acuity, blood and bone chemistry, and memories of past events provide fairly accurate measures of human age. Using these age indicators would have revealed Adam and Eve's initial lack of physical aging.

Another biblical example sometimes quoted as evidence for deceptive appearance of age is Jesus' first public miracle: turning water into wine. The text (John 2:7–10) states that the wine Jesus miraculously made had superb flavor. But that flavor did not necessarily come from an instantaneous aging process.[2] In fact, no amount of aging can transform water into wine.

Neither Adam and Eve nor the water Jesus turned into wine are available for accurate age testing. Adam and Eve died. The wine was consumed. Thus, neither of these examples can be authenticated as evidence supporting apparent (but unreal) age.

The universe and Earth *are* available, however. So the abundant and consistent evidence from astronomy, physics, geology, and paleontology can and must be considered.

The appearance-of-age hypothesis also manifests a considerable philosophical problem. If the universe exhibits the mere appearance of age rather than authentic age, then its age becomes a nonverifiable/nonfalsifiable proposition. If a proposition cannot be falsified, neither can it be verified. In this case, no evidence could count either for or against the universe's age.

More serious yet for the appearance-of-age argument is a theological problem. In many respects, it forces a denial of physical reality's unambiguous theological implications. It requires denial of what can be logically inferred or deduced from the simple acknowledgment of what is real in the physical realm. This problem, similar to one encountered in the early church, can have grave ramifications (see chapter 18).

Creation Reveals God's Character

The Bible clearly affirms that God's handiwork displays His character: "For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse" (Romans 1:20). Other passages also make clear that the universe we see and experience proves not only God's existence

and identity as Creator of all things[3] but also His character attributes such as love, power, righteousness, justice, and wisdom—and His role as provider, teacher, and protector.[4]

According to Christian theology, then, an honest investigation of nature leads to discovery of truths, including truths about God and His otherwise invisible character qualities. People are "without excuse" because the physical universe speaks in a trustworthy manner. God could not remain consistent with His character and hold people accountable for their response to revelation in the creation if, indeed, the record of nature is a distorted message.

In no way does God's revelation via the universe detract from the importance of His written revelation. Nor does this belief in the trustworthiness of nature's message imply that God never intervenes in the natural realm by performing miracles. It does mean that when He performs such miracles God does not remove, hide, or distort physical evidence for them. While one might argue that God could have altered the laws of physics at the instant Adam sinned against Him, theology again demonstrates that He would have left evidence to that effect. Since Jeremiah and Paul stated that the physical laws are fixed (Jeremiah 33:25; Romans 8:19–22), and since the astronomical record shows no evidence of an alteration, we can conclude God did not change them. What He "could have done" becomes irrelevant. (See chapters 13–16 for a discussion of astronomy's inviolable testimony of natural history.)

A Dual Revelation

For simplicity's sake, one may be tempted to limit God's revelation to the words of the Bible. Since the Bible declares God and His Word to be truth,[5] information from any source outside the Bible might be considered inferior and suspect. If that were the case, however, no extra biblical data would hold value for clarifying what the Bible teaches on an issue or for prompting correction of faulty interpretations.

The Bible itself removes any confusion on this point. According to Psalm 19:1–4, God speaks reliably through creation, revealing His character and other truths:

> The heavens declare the glory of God;
> the skies proclaim the work of his hands.
> Day after day they pour forth speech;
> night after night they display knowledge.
> There is no speech or language

where their voice is not heard.
Their voice goes out into all the earth,
their words to the ends of the world.

Addressing his three friends, Job challenged them,

Ask the animals, and they will teach you,
or the birds of the air, and they will tell you;
or speak to the earth, and it will teach you,
or let the fish of the sea inform you. (Job 12:7–8)

Psalm 50:1–6 states:

The Mighty One, God, the Lord,
speaks and summons the earth
from the rising of the sun to the place where it sets.
From Zion, perfect in beauty,
God shines forth.
Our God comes and will not be silent.…
And the heavens proclaim his righteousness.

Psalm 97:6 asserts:

The heavens proclaim his righteousness,
and all the peoples see his glory.

The Bible teaches a dual, consistent revelation. Just as readers rightfully expect valid interpretation of Isaiah to be consistent with that of Mark, so too they can expect accurate interpretation of the facts of nature to be consistent with the message of Genesis and the rest of Scripture. The inspired words of Scripture confirm that this "voice" of nature faithfully communicates information about God. (A list of additional verses appears in appendix C.)

This consistency does not mean, however, that the record of nature is as *complete* and *specific* about God as the Bible or that it speaks on all important matters. Although the facts of nature can be trusted as truth, the central truths of the Christian faith—the Trinity (that God exists as one essence eternally in the three coequal persons of the Father, Son, and Holy Spirit); the Incarnation (that the Son became a human being, Jesus Christ, for our salvation); the redeeming work of Jesus of Nazareth in fulfilling the law, dying on the cross, and rising

from the dead; the work of the Holy Spirit to instill faith and love; the role of the church as the body of believers in Jesus Christ; and the future return of Christ to judge all human beings for eternity—cannot be gleaned from a study of nature. On these and other doctrinal subjects, the Bible is our sole reliable source of information. The Bible, therefore, holds a definite priority over the facts of nature and a unique authority as the sufficient standard for Christian doctrine.

On other subjects, nature's record provides our sole reliable source of information. The physical properties of quarks, the rotation rates of galaxies, and the nuclear ground state energy levels of the elements serve as examples.

Truth, by definition, is information free of contradiction and error. One revelation of God's truth cannot be held as inferior or superior to another. It can be different, just as the content of Ezra is distinct from that of Romans, but truth cannot be better or worse. Thus, when science appears to conflict with theology, we have no reason to reject either the facts of nature or the Bible's words. Rather, we have reason to reexamine our interpretations, because the facts of nature and Scripture will always agree.

One Time to Reveal

There is one time in cosmic history when the universe most fully declares the glory and righteousness of God. The laws and constants of physics impose theoretical limits on how much of cosmic history human beings are able to observe at any given time.

It takes time for light to travel along the space surface of the universe and enter an astronomer's telescope. The universe is now sufficiently ancient that light from the cosmic creation event has had the necessary time to reach telescopes on Earth. Consequently, astronomers can "witness" God's act of bringing the universe into existence.

If God had placed humans on Earth any earlier than about 13.8 billion years after the cosmic creation event, then humanity would have been unable to observe one of the most potent scientific evidences for God as the Creator of all physical reality. The *earlier* we humans enter the cosmic scene (relative to the 13.8 billion years), the smaller the fraction of cosmic history available for observation.

The converse is also true. The accelerating expansion of the universe due to the effect of dark energy[6] will eventually cause the radiation from the cosmic creation event to move away from us at greater than the velocity of light. From that point onward astronomers will lose their capacity to witness the earliest moments of the universe's creation. The *later* humans enter the cosmic scene (relative to the 13.8 billion years), the smaller the fraction of cosmic history we

can study.

The bottom line is that God created humans at the best possible time in the history of the universe for us to see His glory and righteousness revealed in the heavens. To word it another way, only at about 14 billion years after the cosmic creation event can humans observe all of cosmic history and witness the creation of the universe. A universe as young as most young-earth creationists claim is a universe in which Psalm 19:1–4, Psalm 50:6, and Psalm 97:6 lose much of their impact.

A Vast Universe

Writers of Scripture compared the number of God's children with the number of stars in the sky and the number of grains of sand on the seashore—a "countless" number.[7] Hebrew and Greek numbering systems included numbers up to billions. "Countless" suggests at least an order of magnitude greater than billions: tens of billions.

These biblical metaphors for vastness translate into statements about age. Given tens of billions of stars as a minimum size, and noting that the stars in our galaxy are separated from each other by average distances of about 10 light-years, the equation for the volume of a sphere can be used to calculate that the diameter of the universe must be no less than 56,000 light-years. Since material objects in the observable universe cannot move more rapidly than the velocity of light,[8] and since the velocity of light must remain constant for physical life to exist (see "Did God Build Faster Than Light's Velocity?"), one can conclude that the biblically established *minimum* age for the universe is 56,000 years.

Other "vastness" data show that the universe is minimally much larger and older yet, and we see no biblical or scientific evidence contradicting that minimum. The Milky Way Galaxy, of which our Sun is a member star, contains about 200 billion stars. The galaxy's shape, however, resembles a flattened disk rather than a sphere. That disk has a measured diameter of 120,000 light-years. Those light-years translate into a minimum age for the galaxy (hence, for the cosmos) of 120,000 years.

According to recent findings, the number of stars in the universe totals approximately 10^{23} (a number that also approximates the sum of the grains of sand on Earth's seashores, as the Bible metaphorically suggests). Again, using size to indicate age, 10^{23} stars separated from one another by about 10 light-years (a conservative underestimate for the whole universe) would indicate a minimum diameter of 580 million light-years, thus a minimum age of 580 million years.

Did God Build Faster Than Light's Velocity?

God certainly has the power to build the universe at a more rapid rate than light's velocity, but the physical evidence (from astronomers' observations of the past, see "Expansion of the Universe" through "Cosmic Background Radiation Temperatures" in chapter 14) indicates that He did not do so. For example, if God made the velocity of light significantly faster 6,000 years ago than it is today, He would not have hidden that fact from astronomers who measure light's velocity in stars and nebulae located 6,000 (or more) light-years away. A consistent pattern in God's revelations is that when He performs miracles He does not purposefully remove or intentionally hide the evidence of those miracles.

Sabbath Analogies

God's fourth commandment says the seventh day of each week is to be honored as holy: "Six days you shall labor…but the seventh day is a Sabbath.… For in six days the Lord made the heavens and the earth…but he rested on the seventh day" (Exodus 20:9, 11). Young-earth creationist leaders often cite this passage as proof positive for the 24-hour creation-day interpretation. However, this passage is just one of five in the Pentateuch (the books of Moses) that address the fourth commandment.[9] For three of these passages (Exodus 35:2; Leviticus 23:3; Deuteronomy 5:12–15), no connection at all is drawn between God's work week and humanity's. For the remaining two passages, the "proof" would hold only if neither the word for "day" nor the word for "Sabbath" were ever used with reference to any time period other than 24 hours. The flexibility of *yôm* for "day" has already been addressed. But "Sabbath," too, has variable usage.

In all five passages, the Sabbath rest for humanity is referred to as "*a* Sabbath," indicating that there may be more than one kind of Sabbath. Hebrew scholar Gleason Archer noted, "By no means does this [Exodus 20:9–11] demonstrate that 24-hour intervals were involved in the first six 'days,' any more than the eight-day celebration of the Feast of Tabernacles proves that the wilderness wanderings under Moses occupied only eight days."[10]

Sometimes the Sabbath is a full year, as in Leviticus 25:4, where God commands a 12-month rest period for agricultural land. Sabbaths for God's physical creation appear to be related to the biological limits of His creatures. Thus, a 24-hour rest period every seven calendar days is appropriate for humans, while a 12-month rest period every seven years is best for agricultural fields. Since God is not subject to biological limits, His "rest" period can be of any

duration He chooses. The reference to a Sabbath seems to be a reference to the pattern of one out of seven, not its precise duration as part of the creation days. Therefore, the creation days need not be interpreted, based on the Exodus 20 passage, as 24-hour periods.

The apostle Paul made a similar point. When some Christians tried to enforce a particular day as the Sabbath, he wrote that believers should honor a Sabbath, but with the freedom to consider any day of the week as a rest period (Romans 14:5–6).

Just as the high priests of Israel served "at a sanctuary that is a copy and shadow of what is in heaven" (Hebrews 8:5), so the days demarked by the rotation of the earth may be copies and shadows of the days distinguished by God in the Genesis creation record. The human and the temporal are always copies and shadows of the divine and the eternal, not vice versa. The seven days of our calendar week follow God's established pattern. His "work week" gives us a humanlike picture we can grasp.

This communication tool is common in the Bible. Scripture frequently speaks of God's hand, eyes, arm, even wings. The context in each case makes clear that these descriptions are not to be taken concretely. Rather, each word presents a picture to help us understand spiritual reality about God and His relationship to us. Such usage in no way negates these words' "truthfulness."

The difference is *not* simply one of a "literal" versus "figurative" interpretation. Literal interpretation, properly understood, is a method of interpretation that gives full weight to all aspects of a passage's context, including the immediate textual context, the literary genre of the passage, the way words were used in the culture, the historical setting and purpose of the text, and the broader theological context. The suggestion of a pattern here is not a gratuitously figurative or symbolic interpretation of God's creative week but rather a recognition of anthropomorphism commonly used elsewhere in Scripture to describe God and His relationship to creation, including His creatures. The analogy of our Sabbath to God's rest does not demand a creation week of seven 24-hour days. Age-long creation days fit the analogy equally well.

More Than One Beginning

Jesus said, "At the beginning of creation God 'made them male and female'" (Mark 10:6). Ken Ham, Henry Morris, and John Morris have claimed this statement implies that virtually no time transpired between the creation of the universe and the creation of Adam and Eve.[11] Henry Morris asserted that "Jesus Christ…who was *there* at the beginning of the creation, said that man and

woman were there, too!”[12] Morris used this passage to assert that Jesus “was a young-earth creationist.”[13]

However, even from a young-earth perspective on the creation week, this interpretation of Mark 10:6 cannot be correct. Adam and Eve were not created until the sixth creation day, *after* the creation of the universe and the earth. Therefore, Adam and Eve could not have been present at the beginning of the universe.

The Greek phrase translated “the beginning of creation” in Mark 10:6 is *archēs ktiseos* (a Greek equivalent for “the” is missing). *Archēs* means “beginning” or “origin,” while *ktiseos* means “act of founding, establishing, building, or creating.”[14] Nothing in Mark 10:6 or its immediate context explicitly identifies the “beginning of creation” as the beginning of the universe, Earth, life on Earth, humanity, or some other aspect of creation. The question asked of Jesus was about marriage. Thus, the context suggests that He was referring to the beginning of humanity’s story, the story of the first husband and wife. On that basis, the Mark 10:6 “beginning of creation” most likely refers to the beginning of marriage.

That Jesus referred to the beginning of marriage finds corroboration in the parallel passage, Matthew 19:4–8, in which He said, “At the beginning the Creator ‘made them male and female’” and “Moses permitted you to divorce your wives because your hearts were hard. But it was not this way from the beginning.” John Whitcomb and Henry Morris conceded the point in 1961, saying, “In Matthew 19:4 He [Jesus] referred to the creation of Adam and Eve in the Garden of Eden.”[15]

God’s Rest Ends Long after It Begins

Though God has not made new life-forms since creating Eve, His Sabbath day of rest (from creation) is scheduled to end. According to Revelation 20 and 21, once God does away with evil, He will replace this present universe with new heavens, a new Earth, and the New Jerusalem, all having new physical laws and dimensions designed to make possible our eternal life and rewards in His presence.[16]

The clearest evidence of different physics in the new creation comes from the promise of “no more death or mourning or crying or pain, for the old order of things has passed away” (Revelation 21:4). As Romans 8:21–23 further amplifies, the universe “will be liberated from its bondage to decay” when the children of God receive their adoption and the redemption of their bodies. That is, there will be no second law of thermodynamics (decay) and thus no gravity or

electromagnetism in the new creation.[17]

The significant point is that the creation week in Genesis 1 describes God's first creation week only. God will create again (see chapter 10). His rest period, or cessation from creating, has a definite start point (right after the creation of Eve) and an end point (when God creates the new heavens and Earth). Thousands of years pass between this beginning and ending. The parallel structure in the description of the seven Genesis creation days suggests the other creation days are also long periods, longer than 24 hours.

Speed Doesn't Signify Power

Some young-earth creationist leaders link the length of the creation week to the doctrine of God's omnipotence. They say that a cosmic creation date billions of years ago somehow depreciates God's unlimited power. They reason that a God who takes only six short days to create must be stronger than a deity who takes billions of years.

Two fallacies underlie this line of reasoning. One is that God's speed in creating correlates with His power. It does not. Six days would be too long. For that matter, six nanoseconds would be too long. If time were the measure of His power, God would have created everything in an immeasurable instant.

The second fallacy lies in the assumption that an all-powerful God is under compulsion to exercise all His power all the time. He is not. A man capable of running a four-minute mile may choose—for any number of reasons—to walk a mile in 15 minutes. God also can choose whatever time frame He pleases.

Current society's hyperactivity in no way reflects the Creator. God is never anxious. He is always patient and often takes His time. Consider how long He took to lead the children of Israel out of Egypt; how long He waited to fulfill His plan of salvation through Christ's life, death, and resurrection;[18] and how long He still waits for His children to complete their assignment, the Great Commission. The apostle Peter emphasized this difference of perspective: "The Lord is not slow in keeping his promise, as some understand slowness" (2 Peter 3:9).

No mere human can fully understand the reasons God does things the way He does. But even if we cannot comprehend all His reasons, no one has a basis for second-guessing the Almighty. He is God, and His ways and thoughts are above ours (Isaiah 55:8). Certainly God has His reasons for the timescale He chose for creation. One thing we can discern, however, is that the timescale He chose perfectly fits His strategy for revealing His glory and conquering evil. This theme is the subject of the next chapter.

Chapter 9

Good God, Cruel World

One emotional lightning rod stands taller than all others in the creation-day controversy: “Allowing for the millions of years for the fossil layers means accepting death, bloodshed, disease, and suffering before Adam’s sin.”[1] The idea of death before the fall (of Adam and Eve) sparks heated debates. Young-earth spokespersons say an ancient fossil record “documents death, disease, suffering, cruelty, and brutality. It is a very ugly record.”[2] How can such “ugliness” be compatible with a powerful, loving Creator? Young-earth scholars say it cannot.[3]

Most people believe death is bad. Attributing the death of creatures to the God of the Bible shakes their concept of His love and compassion. But do multiplied generations of death and extinction contradict God’s character or His descriptions of creation as “good” and “very good”?

Henry Morris, founder of the Institute for Creation Research (ICR), declared day-age creationism to be the worst interpretive option because it means God must “redirect and recharge everything at intervals.”[4] He argued that “the very concept of geological ages implies divine confusion and cruelty.”[5]

At the heart of such comments lie profound questions about the advent of evil and God’s response to it. Does the blame for all ills fall rightfully on Adam’s shoulders? Is death before Adam inconsistent with the whole of Scripture? Do millions of years of life history imply a cruel and brutal God? An impotent and confused God?

Adam’s Fault

If death of any kind in any context is evil, then a loving God would never design His creatures to die. By this reasoning, young-earth creationists deduce that God introduced death at the fall to teach humanity the horrible consequences of disobedience to Him. In this case, Adam and Eve’s rebellion against God in the Garden of Eden must be responsible for all the death and extinction experienced in nature.

Such a view of Adam’s sin, however, seems to imply that God meted out sudden punishment on plants and animals who did nothing to deserve His wrath, or that He couldn’t or wouldn’t protect the rest of creation from man’s offense.

Either possibility calls God's character and power into question.

Death before Adam

The New Testament gives valuable insight into the introduction of death brought about by Adam's sin. Romans 5:12 says: "Sin entered the world through one man, and death through sin, and in this way death came to all men, because all sinned." Young-earth creationist leaders interpret this verse to mean no death came to any creature before Adam's disobedience, and therefore the time between the creation of the first life-forms and Adam's rebellion must have been brief enough to avoid overpopulation, starvation, and any other cause of death.

The absence of all plant and animal death before Adam's sin, however, poses just as great a problem for three 24-hour creation days as it does for three long eras. Many species of life can't survive even three hours without food, and the mere ingestion of food by animals requires the death of plants or at least plant parts. Genesis 2 implies that before Adam and Eve sinned, animals moved about, and Adam and Eve also walked about and ate. Movement translates to metabolism, and metabolic processes require eating. Thus, the death of plants or at least plant parts must have occurred before Adam sinned.

Insects also would have died. They would have been on leaves and fruit eaten by larger animals. Sea creatures would have consumed plankton. Elephants and other large animals lumbering about would likely have stepped on and crushed a few bugs, mites, and protozoa. Snow, hail, rain, heat, wind, and waves would likely have injured and killed at least a few of Earth's more fragile creatures. Young-earth creationist authors respond by arguing that the Bible never attributes life and death to plants and lower animals.[6] The original Hebrew text of the Old Testament, however, does explicitly state that at least the lower animals do experience life and death (see table 9.1).

The notion expressed by some young-earth leaders that Romans 5:12 refers to "soulish" death rather than physical death also leads to some inconsistencies. In the Genesis creation account, soulish creatures include birds and mammals—endowed by God with mind, will, and emotions—capable of relating to humans in a special way. Besides being endowed with the soulish characteristics of these creatures, humans also possess spiritual attributes, including the capacity to relate to God Himself. These soulish and spiritual capacities distinguish their bearers from all other animals. However, interpreting Romans 5:12 to include the death of *all* soulish creatures leads to the conclusion that birds and mammals incur "death through sin."

Table 9.1: Scriptural Evidence That Primitive Animals Experience Life and Death

Note: The Hebrew words translated as "die," "died," and "death" in the following NIV passages are *mût* and *māwet*. These are the same words that the Bible uses for human death.	
1.	The fish in the Nile will die…The fish in the Nile died. (Exodus 7:18, 21)
2.	The frogs died in the houses, in the courtyards, and in the fields. (Exodus 8:13)
3.	He turned their waters into blood, causing their fish to die. (Psalm 105:29)
4.	Dead flies give perfume a bad smell. (Ecclesiastes 10:1)
5.	Their fish…die of thirst. (Isaiah 50:2)

A search of Scripture shows that of all life on Earth, only humans deserve the "sinner" label. Only humans make moral choices that bring "death through sin." The death Adam experienced is carefully qualified in the text as being visited on "all men"—with no reference to plants and animals (Romans 5:12, 18–19).

According to 1 Corinthians 15:21, when "death came through a man," it came to humans alone, not to humans *and* animals. First Corinthians 15:22–23 explains, "As in Adam all die, so in Christ all will be made alive. But each in his own turn: Christ, the firstfruits; then, when he comes, those who belong to him." In His atoning sacrifice on the cross, Jesus broke sin's death grip on humanity and smashed through the barrier that Adam's rebellion erected between people and God. Through His crucifixion and resurrection, Christ secured eternal life and indestructible bodies (at His return) for all who turn from their sin and receive God's pardon. Any person who chooses spiritual life in Christ receives it. Eventually, when Christ's purposes for the cosmos are fulfilled, the eternal life already possessed spiritually by believers in Christ results in eternal physical life.

Since only humans possess spirits, only humans can be "made alive in Christ." Neither Romans 5 nor 1 Corinthians 15 (the only Bible passages explicitly addressing death brought by Adam's sin) gives any compelling reason to deny that physical death could have come to plants and animals prior to

Adam's sin. In fact, no passage in either the Old or New Testament rules out the physical death of plants or animals before the fall of Adam.

Carnivorous Behavior

Many Christians and non-Christians have difficulty accepting that a God of love and power could be responsible not just for herbivorous activity but also for carnivorous behavior. Often I've heard people assert that carnivorous activity must result from humanity's sin, not from God's design. I believe Genesis 1 offers a different perspective.

On creation day six, *before* God created Adam and Eve and *before* sin infected the earthly realm, the Lord created two different kinds of large-bodied land mammals: "livestock" and "wild animals" (New International Version); "cattle" and "beasts of the earth" (King James Version). The respective Hebrew nouns are *b^{e}hēmâ* and *ḥayyâ*. *B^{e}hēmâ* is used frequently in the Old Testament for animals people domesticate for agricultural purposes.[7] *Ḥayyâ* refers to animals that are difficult to tame and, if untamed, dangerous to encounter. In its commentary on Genesis 1:24, the Reformation Study Bible states, "livestock… beasts of the earth. The contrast between wild and domesticated animals differentiates carnivores from cattle."[8]

Wild plant-eating mammals are easy to tame and relatively inexpensive to maintain. They make excellent farm animals. Wild meat-eating mammals, by contrast, are difficult to tame and uneconomic for agriculture but can make wonderful pets, if tamed. It seems that God made both kinds of creatures: one for our economic well-being and the other for our enjoyment.

Could God have made good pets for us that are not carnivores? Certainly. However, given the physical laws governing the universe, laws God chose, the best pets will be carnivores. An organism's place in the food chain determines its capacity for efficient work. The difference in activity between creatures consuming low-calorie, low-nutrient leaves and those consuming meat is dramatic. Considering how creatures convert chemical energy into kinetic energy, carnivorous activity results from the laws of thermodynamics, not from sin. Large, active, agile land mammals either must spend virtually all their waking hours grazing, drinking, digesting, and defecating (making them unsuitable for house pets) or they must consume meat. None of this metabolic reality implies that the thermodynamic laws are evil. Without them, physical life in this universe would be impossible (see "Decay before Adam").

Does Genesis 1 Command a Vegetarian Diet?

In Genesis 1:29–30 and 9:2–3 God gave humanity some specific dietary guidelines appropriate to their circumstances at the time. Early humans lived for hundreds of years, and a vegetarian diet was essential for their long-term health. Later, God shortened human life spans to a maximum of about 120 years (Genesis 6:3) and lifted the prohibition on meat consumption (Genesis 9:2–3). In that time context, meat consumption posed no significant health risk. With reference to animals, who rely on instinct rather than choice in their eating habits, His instructions in Genesis 1:28–30 were aimed at the human managers of green plants and reflect no change from one passage and time frame to the next. God simply stated and reiterated the importance of green plants. Both animals and humans ingest some nongreen plants, such as mushrooms. However, green plants are the foundation of the food chain. It seems likely that God emphasized to Adam and Eve (and us) that since all life depends on green plants for survival, proper management of these plants would be essential.

Some young-earth creation scholars dismiss the teeth, jaws, and claws of carnivores as inadequate evidence that they always killed prey. Such attributes, they assert, would not have prevented them from subsisting on a vegetarian diet. Here, they ignore the challenge of internal organ structure. The digestive tract, particularly the colon and the liver, for many of these creatures makes it impossible for them to survive on an unprocessed vegetarian diet.

In the wild, carnivores actually help herbivores maintain their health and minimize their suffering. Unlike human hunters, wild carnivores typically kill the sick and the weak. A pack of wolves, for example, cannot and will not even attempt to kill a healthy, uninjured adult moose. Lions can kill healthy mice but do not, since the nutrients gained would not be worth the effort. By removing the sick and the weak from herbivore flocks, carnivores help guard herbivore populations from disease and genetic defects. By limiting the herbivore populations, carnivores also prevent such populations from overgrazing the land and thus eventually suffering and dying from lack of food. Thanks to carnivores, herbivore health is maximized and death rates minimized.

The Bible says carnivores receive their prey from God’s hand (Job 38:39–41; Psalm 104:21, 24–28). Psalm 104:27–28 describes how God’s creatures “all look to [Him] to give them their food at the proper time. When [God] give[s] it to them…they are satisfied with good things.” Since God calls such acts “good,” Christians may want to exercise caution before calling carnivorous activity “evil.”

Suffering

Because some animals are capable of having a relationship with humans, people have an emotional reaction to the idea of killing them, for food or otherwise. We especially tend to anthropomorphize the animals we raise as pets. But animal suffering of any kind cannot be equated with human suffering. The awareness and anticipation of future agony, physical or spiritual or both, greatly intensifies human pain. Animals, by contrast, neither anticipate nor worry about the future.

Just as animal pain and suffering are distinct from human pain and suffering, so too the suffering of lower animals is distinct from that of birds and mammals. Though less in each case, it is not zero. A recent scientific study establishes that fish, for example, feel pain at a relatively high level.[9] The heart rates of trout who had their lips injected with bee venom or acetic acid increased by 30 percent compared to trout whose lips were injected with saline solution or were simply handled and put back into the water. Trout injected with acetic acid and bee venom rubbed their lips against objects and took twice as long to resume feeding.

Insects, too, experience sensations that bother them. As any child playing outside with a magnifying glass has discovered, insects quickly flee whenever intense light and heat are focused on them.

Even plants experience "bleeding," bruising, scarring, and death. To some, the suffering of plants seems perfectly acceptable within the scope of God's love, while the suffering of animals does not. Some express little concern over the pain, suffering, and death of insects. But all physical life suffers and dies. From a Christian worldview perspective, however, a profound difference exists between the physical death of a spiritual creature (a human) and the death of any other physical life-form.

As hard as it may be for us to see good in death, death serves a purpose. The 3.8 billion years of plant and animal death and extinction that preceded humanity provided for the needs of civilization. Through that death and decay, God gave humanity enormous biodeposits of sand, limestone, marble, topsoil, coal, oil, and natural gas. Cryptogamic colonies (symbiotic colonies of cyanobacteria, fungi, and primitive mosses) converted the surfaces of silicate landmasses (the continents) into soil suitable for the support of advanced plants. Sulfate-reducing bacteria converted soluble metal compounds that would have poisoned advanced animal life into insoluble metal compounds. These compounds became so concentrated (thanks to the bacteria) that humans could mine rich deposits of iron, copper, lead, zinc, molybdenum, chromium, silver, and other natural resources. Civilization, which enables Christians to carry out Christ's command to take the gospel to all the world's people groups (Matthew 28:18–20), is based

on the abundance of these assets.

Extent of Biodeposit Assets

Humans are beneficiaries of the remains of millions of generations of plants and animals that preceded us. The sheer quantity of biodeposit resources embedded in Earth's crust defies any conceivable young-earth explanation.

Total traditional fossil fuel resources (coal, oil, and natural gas) before industrial consumption began stood at 9–13 trillion tons (58.8–81.8 trillion barrels of oil equivalent).[10] Nontraditional fossil fuel resources (clathrates and kerogen) known to arise from once-living organisms stood at 920 to 91,170 trillion tons.[11] The residue of organic matter embedded in limestone adds up to 75,000 to 120,000 trillion tons.[12] As table 9.2 shows, the total inventory of just these biodeposits totals 76 to 217 quadrillion tons.

How do these figures compare with solar energy captured by plants and photosynthetic organisms and with Earth's biomass? Traditional and nontraditional fossil fuel deposits before the industrial revolution exceeded per annum solar energy captured (500 billion barrels of oil equivalent[13]) by a minimum of 12,000 times (maximum of 1,255,000 times). Biological material embedded in Earth's crust exceeds the planet's current living biomass (625 billion tons[14]) by a minimum of 122,000 times (maximum of 348,000 times).

Even if all Earth's living biomass were continuously converted into biodeposits with 100 percent efficiency, young-earth models cannot explain the extent of the biodeposits. More problematic yet, their models claim that virtually all of Earth's biodeposits were laid down during the five months between the beginning of the Noahic flood and the ark's coming to rest on the mountains of Ararat.

Some young-earth creation scientists recognize the challenges biodeposits present to their models.[15] Their response is threefold. First, they claim that only a tiny fraction of the limestone, clathrates, and kerogen are biological in origin. Second, they say that before the flood there was just one continent situated near the equator with a climate akin to today's Amazon jungle possibly augmented by some kind of planet-encompassing canopy, all of which produced a biomass as much as a hundred times greater than today's. Third, they assert that dead biological material was accumulating on Earth's surface from the time between Adam and Noah (1,656 years in their models) and that the flood transformed all this material into biodeposits.

The first claim is refuted by abundant evidence that the majority of Earth's limestone, clathrates, and kerogen really is of biological origin. Biologically

derived material exhibits a lower carbon-13 to carbon-12 ratio. Geophysicists find ubiquitous evidence for this lower ratio in limestone, clathrates, and kerogen deposits.[16] They also note that methane hydrates (clathrates) occur predominantly near continental margins at water depths of 350 to 3,000 meters and none at all below 5,000 meters. Those are the depths at which sufficient organic material is deposited into the sediments and where the temperature and pressure conditions permit methane to be converted into methane hydrates. If the methane in the hydrates were not mainly biogenic, clathrates would be much more broadly distributed.

One problem with the second claim is that biodeposits are unevenly distributed. Coal and oil, for example, exist within just a few locales on each of the continental landmasses. More than 90 percent of Earth's continental landmass area is devoid of any deposits of oil, coal, or natural gas.

Table 9.2: Inventory of Some of Earth's Biodeposits

biodeposit source	quantity (in quadrillions of tons)
coal, oil, and natural gas	0.0009–0.013
clathrates	0.020–7.17
kerogen	0.9–90
organics in limestone	75–120
total	**76–217**

Another problem with the second claim is that all the proposed canopy theories are infeasible (see "Did a Life-Enhancing Canopy Surround Earth?"). Still another problem with the second claim is the quantity of ice overlaying Antarctica and Greenland. If Antarctica and Greenland had tropical climates before and during the flood, then the models to which global flood proponents adhere[17] would allow only 4,300 to 5,000 years for all of Antarctica's and Greenland's ice to accumulate. The greatest measured thickness of Antarctic ice is more than 4,770 meters (15,650 feet)[18] and the average annual precipitation for the Antarctic continent is just 6.5 inches and less than half that value for the regions of thickest ice.[19] Even if none of the snow and ice in Antarctica were to sublimate (change from solid to vapor state), and none of it were to suffer compression from the weight of ice lying above, the ice there is still 12 times thicker than a young-earth scenario would allow.

Some young-earth creationists claim that all of Antarctica and Greenland's

ice was laid down during Noah's flood. Those floodwaters, however, rose for only five months. Without a workable canopy theory, where could all the water for the required ice come from? Why is that much ice only on Antarctica and Greenland? Especially catastrophic to this young-earth claim are the 800,000 provable annual layers found at the Dome C core drill site in Antarctica that reveal eight contiguous cycles of the variations in the eccentricity of Earth's orbit about the Sun (see "Nature's Calendars" in chapter 16 for more details and documentation).

The third claim presumes that under benign, catastrophe-free conditions, dead biological material will accumulate without any processes subtracting some of that material. However, God has designed organisms so that after death, when exposed to the elements, their bodies almost completely degrade. Furthermore, the biodegradation is rapid, on the order of months and years, not millennia. This rapid biodegradability is crucial for sustaining the nutrient recycling that a biologically diverse, biomass-rich planet requires.

In addition, much of Earth's biomass is comprised of detritivores and decomposers. Detritivores are species of life that feed on dead biological matter. They play a primary role in ridding the environment of the remains of organic material. Decomposers are species that convert what is left over by the detritivores, such as bone and fur, into raw soil nutrients such as carbon, nitrogen, calcium, and magnesium compounds. Thus, under benign conditions only a tiny percentage of dead biological material accumulates.

Did a Life-Enhancing Canopy Surround Earth?

Most young-earth creationists attempt to explain long life spans prior to Noah's flood and huge hydrocarbon and limestone deposits by proposing that a thick water canopy once surrounded Earth. They claim such a canopy would have shielded life from radiation, greatly extended human longevity, created a warm, humid environment to augment Earth's biomass and, once collapsed, suddenly inundated Earth's entire surface, destroying all life (except that on the ark) and even much of Earth's topography.

This hypothesis fails every plausibility test. First, a canopy with enough water to cover Earth would either dissipate to interplanetary space (if it were vaporous) or come crashing down under gravity's influence. A vapor canopy, even if it existed for a short time, would have set up such a powerful greenhouse (heating) effect that no ice or liquid water would remain on Earth to sustain life, making the flood unnecessary. If the canopy were liquid or ice, converting the ice to liquid or liquid to vapor would consume so much heat as to freeze all life

on Earth. Again, the flood would be unnecessary.

Increasing Earth's surface heat and humidity by just a little would increase the total living biomass by only a small amount. Earth's surface area and the solar energy flow limit the living biomass to a quantity far below what is needed to explain all Earth's biodeposits within a time span briefer than a million years. Although a vapor canopy would provide some protection against ultraviolet radiation, it would not impede the hard cosmic rays that fundamentally limit human life spans to about 120 years.

The First Sinner

Young-earth creationists claim that sin brought about the physical death of animals and humans. James Stambaugh, for example, wrote, "The point seems clear—with sin and the curse of God these negative things [including physical death] came into being."[20] Blaming all death on Adam and Eve alone, however, overlooks the fact that they were not the first creatures to sin against God. According to Scripture, Satan was the first. His self-exaltation incurred spiritual death—eternal separation from God (Ezekiel 28:14–18).

The Bible does not specify the timing of Satan's initial rebellion. Clearly, it occurred before God allowed him to enter into the Garden of Eden. Job 38:7 tells us that angels existed when God laid the foundations of the earth. It is possible that Satan sinned before this event. He may have sinned even before God created the universe. Therefore, to hold Adam responsible for all decay and death in the universe distorts the history of sin and God's response to it.

Holding Adam responsible for all death and decay also runs counter to the tree of life. Why would God put the tree of life in the Garden of Eden if there was no possibility of death before the fall?

An Ideal Creation

In Genesis 1, the creation is called "good" and "very good" but not "ultimate perfection." Revelation 21 and 22 promise a vastly superior creation yet to come. This perfect creation follows God's "wrapping up" of the present one.

Romans 8 and Revelation 20–21 reveal that one of God's purposes for our present cosmos is to provide a just-right setting for the permanent and rapid (relative to creation's duration) conquest of human evil, a conquest that retains human free will and thus the reality of human love. While the characteristics of the universe and Earth are ideal—that is, "perfect"—for the conquest of evil, they are far from perfect for glorified creatures. For humans forever free from the presence, power, and penalty of sin, this universe contains too many

limitations of space, time, and physics for them to experience the depth of relationships and the extent of rewards God intends for them to enjoy. (In two other books, I contrast the physics of the universe with the physics of the new creation and discuss several reasons for the distinctions.[21])

Bloodshed

In Old Testament times, the Israelites shed animal blood as part of their worship. These sacrifices illustrated the horror of sin and the price that must be paid to undo its consequences. They foreshadowed the shedding of the Savior-God's blood as atonement for human sin. Hebrews 9:22 says, "The law requires that nearly everything be cleansed with blood, and without the shedding of blood there is no forgiveness." However, I don't believe that Answers in Genesis president Ken Ham's emphatic conclusion logically follows: "If death and bloodshed of animals (or man) existed before Adam sinned, then the whole basis of atonement—the basis of redemption—is destroyed."[22]

There is no remission of sin without the shedding of *Christ's* blood, not animal blood. This is the heart of the Good News: Christ lived and died to pay for human sin. Hebrews 10:1–4 explains that the blood of animal sacrifices will *not* take away sin. The killing of animals (in sacrifice) was a physical foreshadowing of real atonement. It foreshadowed the ultimate effective sacrifice that only God Himself could provide. The timing of the introduction of death into the world does not affect the efficacy of Christ's atonement.

The consequences for sin are both physical and spiritual death. Thus, no animal sacrifice could take care of the problem. The crime of rebellion against God is fundamentally spiritual. The culprit (humanity) is spiritual as well as physical, so the atonement had to be made by a spiritual Being—who was also physical. Unlike every other human, Jesus was both innocent and capable, as God incarnate, of paying the full atonement price.

Bloodshed of animals before Adam's sin does not distort or discount the atonement doctrine. In no way does the atonement doctrine demand a creation scenario in which God's creatures never received a scratch or other bloodletting wound before Adam and Eve sinned. Incidentally, ruling out the possibility of any death or bloodshed for 48 hours of animal life is as big a problem as ruling it out for millions of years. Even in an ideal earthly environment, horses would have crushed bacteria and ants beneath their hooves. Animals of all types would have been scratched and bruised as they brushed against twigs and vegetation and walked or crawled over sand and rocks.

Decay before Adam

Animal death and bloodshed are inevitable by-products of the law of decay. God built this law into the cosmos in anticipation (with foreknowledge) that some of His spiritual creatures (angels and humans) would rebel against His authority. Romans 8:20–22 describes the enslavement of the entire creation to the law of decay:

> For the creation was subjected to frustration, not by its own choice, but by the will of the one who subjected it, in hope that the creation itself will be liberated from its bondage to decay and brought into the glorious freedom of the children of God. We know that the whole creation has been groaning as in the pains of childbirth right up to the present time.

Most young-earth creationist leaders interpret these words to imply that Adam and Eve's sin initiated *all* decay processes, including pain, suffering, and death. They conclude that entropy (decreasing order, or increasing decay, in the universe) did not take effect until Adam and Eve sinned. They deduce, therefore, that the time between the cosmic creation event and the fall of humanity must have been brief enough to explain why physical evidence shows decay operating without a break. In other words, the creation days would need to be very, very short.

Answers in Genesis spokespersons attempt to separate death and suffering from the universe's increasing (and essential) entropy. They claim, "God withdrew some of His sustaining power (Colossians 1:15–17) at the fall so that the decay effect of the Second Law [of thermodynamics] was no longer countered."[23] In other words, they claim that decay and entropy are separable entities.

This claim rests on a misunderstanding of two relationships—the one between decay and entropy and the one between decay and work. First, decay is the effect, or inescapable outcome, of entropy. Second, decay is essential to work. Without decay, work (at least in the universe God designed) does not occur. (See "Decay and Work.") Without work, physical life is impossible. Breathing, circulating blood, contracting muscles, digesting food—*all* life-sustaining processes involve work. And life has existed, according to Genesis 1, at least from the third creation day onward. Genesis 2:15 says that on the sixth day Adam "worked," tending the Garden of Eden, before he sinned. Therefore, to interpret Romans 8:20–22 as implying that Adam's sin inaugurated the decay process seems untenable.

Romans 8 explicitly states when the law of decay will end. It also implies

when this slavery began. References to “the creation” and “the whole creation” (verse 22) encompass the entire creation from beginning to end. According to the equations of general relativity, the entire creation includes not only all the matter and energy in the cosmos but also the entirety of space and time.[24] From this perspective, the verse would suggest that the decay process has been in effect since the universe was created; that is, since the beginning of time, a conclusion supported by Jeremiah’s declaration that the laws for the heavens and Earth are fixed (Jeremiah 33:25).

Many young-earth creationist leaders feel forced to deny, to a large degree, the operation of the law of decay (second law of thermodynamics) prior to Adam’s sin. They see that law’s inevitable consequences—death, extinction, and disorder—as something bad.[25] However, both Scripture and science show otherwise.

Romans 8:19–21 explains that God, not Satan, subjected the creation to this law, not in punishment but in hope and promise of the freedom that lies ahead. As exquisite expressions of the law of decay,[26] stars glitter in the night sky. Physical creatures digest food, perform work, and move about.[27] Astronomers looking back in time through amazing observational technology see no interruption in the operation of the second thermodynamic law throughout cosmic and terrestrial history.[28] Genesis and other passages of Scripture clearly state that the physical realities of starlight, metabolism, and movement preceded Adam and Eve’s sin.[29]

Romans 8 may also refer to another type of decay: the disorder in people’s lives and environments that results from their rebellion against God. In Genesis 1:28, God commands us to tend the environment. But because of sin, the environment has been ravaged. The human effect on the environment is analogous to sending a two-year-old child to clean up a closet. Just as one must wait for the two-year-old to grow up before expecting him to fully comprehend and bring order to the problem, so too God waits for the human race to mature enough to understand and obey God’s “care instructions” for the new creation.

Decay and Work

The second law of thermodynamics observes that heat flows from hot bodies to cold bodies. As a consequence of this heat flow, the universe becomes progressively more mixed or disordered over time. This increasing disorder or decay defines the principle termed *entropy*.

In the process of increasing entropy, or decay, lies the potential to perform

physical work. Because of the principle of pervasive decay, heat energy can be transformed into mechanical energy, or work, if, and only if, the heat flow is channeled through a machine, a motor, or an engine.[30] The greater the temperature difference between the hot body and the cold body, the more heat energy is available to perform work. Given the laws of physics that God ordained for the universe, the process of decay makes work possible and therefore makes physical life possible. To put it another way, work is possible only if energy is dissipated (decayed) from a lower to higher entropy state. Decay is essential to physical life!

Good Pain

Turning once again to the passage that recounts God's response to Adam and Eve's sin, we see evidence that physical pain—closely connected with decay—likely existed before the fall. In Genesis 3:16, God says to Eve, "I will greatly increase [or multiply] your pains in childbearing." He does not say "introduce"; He says "increase" or "multiply," implying that pain already existed. Likewise, to Adam, God explains that henceforth he will work *harder* (Genesis 2:15; 3:17–19).

Though we all dislike pain, we have good reasons to be grateful for it. Pain is essential for our safety and survival. Our nervous systems, equipped with quick pain response, protect us from many dangers in our environment.

Adam and Eve needed intact nervous systems before they sinned, not only as a protection but also as a benefit. Their sense of touch would have been a source of pleasure, discovery, and protection in the garden. Can we really imagine life in this universe without the sense of touch? Yet fire has always been hot. It always would have burned.

One feature of the law of decay seems especially beneficial in the context of sin: the more humans sin, the more pain and work we encounter. For example, the more we abuse our tools, machines, farmlands, and co-laborers, the less productive and cooperative they become, which in turn burdens us with more work and more pain. God seems to have optimally designed the laws of physics (in advance) to give us the maximum motivation to turn from sin and come to Him for help.[31] When Adam and Eve were banished from the Garden of Eden, the need to landscape and plant their own gardens required the discipline of extra work and extra pain.

What fundamentally changed at the fall was not physics but the human race. As God declared to Adam in Genesis 3:17, "Cursed is the ground because of you." Because of human sin, Earth's environment becomes progressively more

disarrayed and damaged.

God's curses in Genesis 3 are limited. Satan is cursed. The woman is cursed. The man is cursed. The ground is cursed as a consequence of the changes in human behavior. However, there is no extension beyond these four. There is no mention, for example, of any curse coming upon the animals.

Pathway to Life

The heart of the Christian gospel message is that true life can be achieved only through death. The Creator of the universe Himself had to die so that humans could receive eternal life. New life in Jesus Christ is possible only if we are willing to die to self, to put aside our right to lead our lives as we see fit, and give control of our life and destiny to the One who created us.

Jesus in His earthly ministry offered the following analogy. A kernel of wheat cannot fulfill its destiny to become a plant bearing many seeds of wheat unless it falls to the ground and dies.[32] Similarly, humans gain eternal life in the new creation through dying. The message of the New Testament epistles is that the pathway to life everlasting is through physical death.

Why, then, should any believer in God look upon death as something that is fundamentally bad in all contexts and counter to the will of God? Only through death can evil be conquered. Death for the Christian is in one sense a gift.

Perfect Plans

While sin causes humans to react negatively to decay, work, pain, and physical death, all these things ultimately tie into God's plan to conquer sin permanently. Scripture presents a compelling case that all these things existed even before Adam's rebellion against God.[33] Moreover, the revelation provided by God through nature supports this conclusion (see chapters 13–18).

Why would God choose physical laws that allowed for decay and disorder, pain and death from the beginning? Full understanding lies beyond our human capacity. The Lord declares,

> As the heavens are higher than the earth,
> so are my ways higher than your ways
> and my thoughts than your thoughts. (Isaiah 55:9)

And yet, though we cannot fully comprehend, we can see some of the ways physical laws contribute to accomplishing God's good purposes.[34] While these laws necessarily involve decay processes, one day the need for these laws will

disappear. This glorious liberation—and a pathway to peace in the creation-day controversy—take center stage in the next chapter.

Chapter 10

Peace through Paradise

Will we go back to Eden? Or will we go on to the unknown—a brand-new creation? Differing visions of the future home of God's people spark dispute among interpreters of the biblical creation story. Some Christians believe in a restoration of paradise and the eternal existence of the stars, Sun, Moon, and Earth. Others are convinced that this universe and Earth will come to an end, giving way to a promised land unlike any we've ever known. Successful resolution of the debate over the future can quell some animosity over what happened in the past.

Scripture supplies more information about the future of the universe and Earth than it does about creation's past. Though disagreements over the new creation exist, Christian dialogue about the future of creation typically seems much less volatile than discussion of its past. For these reasons, conversation about what lies ahead for creation may be more productive for resolving differences than arguing about the age of Earth and the universe. In other words, a look toward the future, instead of the past, holds promise as a pathway to resolution and peace.

Contrasting Positions

The book of Revelation, the intriguing and challenging conclusion to the Bible, presents a stunning glimpse of the new heavens and earth, including the "New Jerusalem." The text establishes the time frame: *after* the great white throne judgment, which permanently and irrevocably does away with all sin and evil (Revelation 20:11–15). From careful reflection on the descriptive details offered by the apostle John, the reader can gather that the laws of thermodynamics, gravity, and electromagnetism will no longer remain in effect. Key indicators include the absence of shadows, night and day, pain, sorrow, death, hunger, and thirst, and so forth. The image of New Jerusalem as an enormous cube or pyramid—metaphorical or otherwise—gives a further hint about gravity's absence. (Gravity forces all physical objects larger than a few hundred miles across into spherical shapes.) The picture that emerges from Revelation 21 and 22 fits consistently with other New Testament passages indicating that the first creation, introduced in Genesis 1 and 2, will cease to exist when God's purposes

for it—including the redemption of humanity and conquest of evil—are fully accomplished.

In this context the permanent restoration of an earthly paradise, even one as wonderful as the Garden of Eden, is not God's ultimate goal.[1] The heart of the gospel message is that Christ's death on the cross and resurrection from the dead secure (for those who receive it) deliverance from the consequences of sin and, finally, even from the presence and possibility of sin—deliverance to eternal life with God in His indescribably glorious realm. A creation limited by the cosmic space-time dimensions and the familiar physical laws is not sufficient to hold that reward. A significant doctrinal point here is that this entire universe and the "very good" conditions of the Garden of Eden before Adam's fall into sin are inadequate to contain the wonders God has planned for His people.

By contrast, most leaders of young-earth creationist ministries teach that the universe was perfect—without decay, suffering, disorder, and death—before the fall.[2] They describe the new creation as a restoration and revamping of the original.[3] Consequently, they teach that the universe including Earth, the Sun, Moon, and stars, will exist into eternity.[4]

Henry Morris, founder of the Institute for Creation Research (ICR), defended the idea of an eternally existing universe with three Bible passages:[5]

1. He set them [the sun, moon, stars, highest heavens, and waters above the skies] in place for ever and ever; he gave a decree that will never pass away. (Psalm 148:5–6)
2. I know that everything God does will endure forever; nothing can be added to it and nothing taken from it. (Ecclesiastes 3:14)
3. They that be wise shall shine as the brightness of the firmament; and they that turn many to righteousness as the stars for ever and ever. (Daniel 12:3, KJV)

The leaders at ICR assert that the universe is essentially static.[6] They deny astronomers' (even Christian astronomers') assertion that "we can still see stellar evolution taking place in the heavens. We can see stars, galaxies, and planets in various stages of this cosmic evolutionary process."[7]

Their response: "*No we can't!* The heavens and the earth were '*finished*'" (italics in original).[8] As proof, they cite Hebrews 4:3: "[God's] works were finished from the foundation of the world."

Testing Interpretations

A small sampling of verses cannot adequately support a doctrine of such significance as the future dwelling place for God's chosen and redeemed people. Again, all relevant texts must be collected and their frames of reference identified. Using these criteria to compare interpretations reveals valuable insight.

Are Stars Eternal?

Before embarking on a broader excursion through the biblical data, one must ask whether the verses cited above actually support a never-ending Earth and universe. A closer look at the original language helps illuminate the writer's intent. The Hebrew word translated "forever" in Ecclesiastes 3:14, and "for ever and ever" in Psalm 148:6 and Daniel 12:3, is *ʿôlām*. These latter two verses also include the Hebrew word *ʿad*. When *ʿôlām* is used with or without *ʿad*, it usually denotes "long continuance into the future."[9] Morris actually agreed with the lexicons (in his other writings) that "the word *ʿôlām* certainly does not have to mean 'forever' unless the context so indicates."[10] These passages by David, Solomon, and Daniel contain no indication of eternality. They lose none of their poetical or theological impact if interpreted to say that the heavens and Earth will last a long time.[11]

Are Heavenly Bodies Static?

Hebrews 4:1–11 teaches that God's Sabbath rest (the cessation of His creative work) began after He created Eve, continues through the present, and lasts until the time God completes the final conquest of evil. At issue is whether God's "rest" from creating implies that star, planet, and galaxy formation and development have ceased since the creation of Eve.

Six Old Testament creation accounts (Genesis 1; Genesis 2; Job 38–41; Psalm 104; Proverbs 8; and Ecclesiastes 1–3, 8–12) consistently say that God's creation of this universe is finished. However, these same accounts, along with others, make clear that natural processes established during the creation days continue. Raindrops and snowflakes form and fall;[12] the Sun traverses a circuit within the starry heavens;[13] the winds blow; the rivers flow;[14] the grasses and trees sprout, grow, and die;[15] the earth quakes; the mountains erupt;[16] the Sun and stars shine;[17] and young are born to all kinds of creatures. The Christian worldview sees no violation of God's rest in these ongoing processes.

Perhaps if astronomy were more widely taught in schools, more people would know that star and planet formation is a simpler process than raindrop and snowflake formation. A person who believes in ongoing raindrop formation need

not hesitate to acknowledge ongoing star formation. The difficulty for some Christian laypeople may arise from astronomers' word choice. Galactic gas clouds where stars form are sometimes called "pillars of creation," and astronomers often refer to stellar burning as stellar "evolution." In the language of astronomers, the Bible's claim that the Sun and stars continue to shine is equivalent to stating that stellar evolution is occurring.

Greater awareness of such astronomical phenomena as the ongoing changes in young T Tauri stars and old Cepheid variable stars, the emergence of new stars from evaporating gaseous globules, and the "birth" of neutron stars and black holes from the burnt-out remains of supernova eruptions can help dispel the myth of static stars and a static universe.

A Temporal Universe and Earth

I've searched the Bible for other verses that may imply an eternal universe and Earth, but I've found none.[18] On the other hand, I've found many verses explicitly stating that at some future time the heavens and Earth will cease to exist. The author of Hebrews quotes the psalmist (Psalm 102:25–27) in saying,

> In the beginning you laid the foundations of the earth,
> and the heavens are the work of your hands.
> They will perish, but you remain;
> they will all wear out like a garment.
> Like clothing you will change them
> and they will be discarded.
> But you remain the same,
> and your years will never end.[19]

Isaiah said that "all the stars of the heavens will be dissolved and the sky rolled up like a scroll," "the heavens will vanish like smoke," and God "will create new heavens and a new earth. The former things will not be remembered, nor will they come to mind" (Isaiah 34:4; 51:6; 65:17). Peter added,

> Long ago by God's word the heavens existed and the earth was formed. …By the same word the present heavens and earth are reserved for fire, being kept for the day of judgment and destruction of ungodly men.… The heavens will disappear with a roar; the elements will be destroyed by fire.…Everything will be destroyed in this way.…That day will bring about the destruction of the heavens by fire, and the elements will melt in

> the heat. But in keeping with his promise we are looking forward to a new heaven and a new earth, the home of righteousness. (2 Peter 3:5–13)

Jesus Himself proclaimed that “heaven and earth will pass away” (Matthew 24:35).

Finally, in the context of the great white throne judgment, John announced that “Earth and sky fled from his [Christ’s] presence, and there was no place for them” (Revelation 20:11). The words “perished,” “dissolved,” “vanish,” “pass away,” “disappear,” “destruction,” and “fled” all imply that a time will come when the present heavens and Earth will cease to exist. From a cosmological perspective, phrases such as “rolled up like a scroll,” “reserved for fire,” “elements will be destroyed by fire,” “elements will melt in the heat,” “everything will be destroyed in this way,” “destruction of the heavens by fire,” and “no place for them” all suggest that the universe will be swallowed up in some kind of singularity and thus, cease to exist. These verses do not hint at a reappearance of the known cosmos. Revelation 21:1–5 records that when “the first heaven and the first earth had passed away,” God declared, “I am making everything new!”

A Brand-New Creation

Just how new is the new creation? By John’s description, we can gather that it will be completely and radically new. As mentioned previously, the familiar laws of gravity, electromagnetism, and thermodynamics will apparently be missing in the new creation. The text directly claims that everything we associate with the second law of thermodynamics—decay, death, pain, and so forth—will be nonexistent there. In the words of Revelation 21:4, “There will be no more death or mourning or crying or pain, for the old order of things has passed away.”

The geometry of the New Jerusalem, whether literal or metaphorical, suggests the absence of the law of gravity. (Because the New Jerusalem is at least a three-dimensional structure, with sides that measure about 1,500 miles each, gravity must not be operating or the city would be forced into a sphere. See “Contrasting Positions.”[20]) Electromagnetism dictates that light coexists with darkness, but the new creation will be filled with “light,” free of darkness. Nor will there be objects like the Sun, the stars, or lamps as sources of illumination.[21] In fact, such bodies are impossible in the new creation (see box, “Impossibility of Stars in the New Creation”). In 1 Corinthians 2:9, Paul quotes the Old Testament, saying,

No eye has seen,
no ear has heard,
no mind has conceived
what God has prepared for those who love him.[22]

Imagining or visualizing phenomena within the laws of physics and the space-time dimensions of our universe *is* possible. However, for humans to visualize phenomena in a realm beyond the dimensions and physical laws of the universe is *not*. Therefore, the message of the new creation is one demonstration that the Bible's content must come from the transcendent One who created humans and the creation in which we now dwell.

Eden's Open Door

Even before God created the universe, He foreknew the impact of sin. When placing Adam and Eve in Eden, God could have—but did not—build some kind of wall around Eden so that rebellious Satan and his minions could not enter. Instead, the sovereign, all-powerful, all-loving Creator chose to leave Eden's gate open, permitting the tempter to approach Adam and Eve.

God was not taken by surprise. His grand plan, conceived even before humanity's creation and fall, even before the creation of the universe, was to bring about a greater and better end than Eden's splendor could ever afford. A universe governed by the second law of thermodynamics and the other laws of physics provides the perfect place for humans to experience the profound love of God through the sacrificial act of Jesus Christ on the cross. It also provides the best possible realm for the permanent conquest of evil, and it helps this creation prepare redeemed humans for the greatest possible reward in the new creation.[23]

Impossibility of Stars in the New Creation

Apart from the biblical statements in Revelation, there is a scientific reason for the absence of the Sun, Moon, and stars in the new creation. Without the laws of gravity, thermodynamics, and electromagnetism, these objects are impossible.[24] Even very slight changes or interruptions in those laws would mean that stars could not burn.[25]

Another reason the Sun and stars will cease to exist is that for either stable stars or stable orbits of planets around stars to be possible, the universe's dynamics must operate under three very large, rapidly expanding dimensions of space.[26] Such a space structure means that the universe will soon (within 50

billion years) become too stretched out for new stars to form. Since no star can shine or burn for more than 120 billion years,[27] all stars inevitably must cease their shining.

Better than Eden

To me, the most disturbing ramification of the notion that the universe and Earth remain into eternity is the way it diminishes God's glory and believers' rewards. This universe cannot provide all the relationships and rewards God promises to redeemed human beings. The "renewed Earth and universe" hypothesis falls immeasurably short of the future reality God promises.

That future represents one of the chief doctrinal distinctions separating Christianity from all other religions. Whereas other religions (and cults) hold out the promise of an imaginable paradise similar to Eden, Christianity promises deliverance from the confines of the original creation, even in its purest manifestation.

Relative to the new creation humanity lives in bondage to a land of familiarity. Much like the Israelites of Moses' time, people today long for the security of known conditions. The conditions of life in an Eden-like earthly paradise more readily connect with human imagination and longings than does freedom from the laws of physics and from the limits of cosmic time and space. Only a spiritual "birth" (to use the biblical metaphor) can awaken the yearning for the "heaven" our transcendent Creator invites us to enter.[28]

Adam and Eve were confined (just as we are) to a single time dimension that neither stops nor reverses and to three large space dimensions. These dimensional restrictions permit only a few intimate relationships. In fact, the ultimate intimacy possible in this creation can be attained only in a marriage relationship by saying yes to intimacy with one person and no to intimacy with all others. This foundation for a successful marriage was set in place *before* sin entered the picture (Genesis 2:24–25).

Even if we stretch to imagine life beyond our present dimensional limits, God assures us that His reality is better—beyond our thinking (see 1 Corinthians 2:9). Jesus referred collectively to believers in the new creation as His bride (Revelation 21:2, 9; 22:17). Evidently, our relationship with God and with one another will become much enhanced and enriched.

In deducing that our rewards and relationships in the new creation will no longer be constrained by our present physics and dimensions, I am not claiming that redeemed humans will *transcend* physics and dimensions. God alone transcends physics and dimensions. What Revelation 21–22 describes is a realm

with radically different physics and dimensions, but physics and dimensions nonetheless.

Could the new creation with its dramatically different physics and dimensions be some kind of "resurrected" universe? Possibly yes, if by resurrected we mean a universe and Earth as fundamentally different from the present universe and Earth and the former Garden of Eden as the promised resurrected bodies Paul describes in 1 Corinthians 15 are different from our present bodies. As Paul explains, the natural, decaying, and corruptible will be replaced with the spiritual, nondecaying, and incorruptible.

Deliverance from Major Conflict

In the context of eternity, the present creation is an efficient stage for God's revelation of love and grace and the overthrow of evil, sin, and shame. The Bible's two-creation message sets Christians free from defending or justifying the seeming "imperfections" of the current creation. This creation is not—and never has been—heaven. There's no reason to charge the scientific community with a conspiracy of deceit regarding nature's past record. Interpreters of the Bible and of natural history can dispassionately examine physical reality without fear or threat. Nothing about the so-called dark side of nature casts any shadow on the character or power of the Almighty.

An Unfathomable God

Concerns about long creation days as hallmarks of an imperfect God or, worse, a "cruel,"[29] "sadistic,"[30] "incompetent,"[31] or "monstrous"[32] God flow logically from the theological perspective of a universe and Earth that never end. If God merely restores humanity to Eden, then the decay and death that took place in the natural realm prior to human sin would serve no apparently good purpose. In that context, life on early Earth would make little sense.

God's omniscience and omnipotence—aspects of His transcendence—allow for His setting preconditions to address the events that will occur when Satan tempts the first humans. His omniscience and omnipotence also allow God to use our experience of sin, evil, suffering, discipline, persecution, love, grace, mercy, and joy to prepare us for an unimaginably glorious eternal destiny in the new creation. This perspective can help dissipate both attacks and defenses that lead to polarization and animosity. It can help develop a respectful approach that focuses on the core of the gospel message rather than on minor doctrinal differences. Recognition that the Bible promises deliverance from the original creation rather than a mere restoration of Eden can produce thoughtful dialogue and a path to peaceful reconciliation.

The theological underpinnings of a young-earth creation scenario are untenable under close scrutiny. History reveals, however, the driving force behind this theological artifice: fear, not fact. Fear claims long creation days somehow accommodate Darwinian evolution, specifically the assertion that by strictly natural processes operating over 3.8 billion years, life arose from a primordial soup and evolved on its own into human beings. If there were any foundation to this fear, then the reaction of young-earth creationists would be understandable, perhaps even laudable. But the question must be asked: Is this fear well-founded? Do long creation days and an old Earth and universe really accommodate naturalistic (or even theistic) evolution? The next chapter offers a clear and somewhat surprising answer.

Chapter 11

Young-Earth Darwinism?

A Canadian university professor I know refers to *evolution* as “the E word,” a word so emotionally charged that its mere mention sparks lightning among Christians. Countless people have been influenced by the beliefs of young-earth creationists and their evolutionist opponents, persuaded that to accept a long creation timescale is tantamount to accepting that amoebas turned into monkeys that turned into humans.

Late nineteenth- and early twentieth-century gradualists, influenced by science (especially the Newtonian universe model) and philosophy (especially that of Immanuel Kant), assumed that the seemingly endless expanse of the universe allowed infinite or nearly infinite time for life to “happen.”[1] They began to consider that random natural processes *without* supernatural involvement could explain all life on Earth—and perhaps elsewhere in the cosmos. Some scoffed at the biblical assertion that life was crafted by God.

The topic of evolution rouses unmitigated, unrelenting animosity between naturalists and supernaturalists. Unfortunately, both sides have assumed that the origin- and history-of-life timescale constitutes the crucial divide. As astronomical advances proved the universe to be some 10 to 15 billion years old, a majority of both scientists and Christians mistakenly assumed that billions of years allowed ample time for a naturalistic account of life. This error has been costly. Recent scholarship increasingly reveals that time boundaries as brief as only several billion years constrict evolutionary theory so tightly, particularly concerning life’s origin, as to strangle it.[2] In other words, a 14-billion-year-old universe is too young for any conceivable natural-process scenario to yield, on its own, even the simplest living organism. Yet biologists and chemists have spent years building naturalistic models based on these inadequate boundary conditions. Meanwhile, young-earth creationists feel forced to equate day-age creation with belief in a God who stood back and watched natural evolutionary processes unfold or perhaps worked through them. To defend biblical creation, they believe they have to defend a recent, consecutive calendar-day creation week.

Scientific advances on many fronts increasingly support an “interventionist”

(that is, miraculous) view of life's origin and development.[3] Yet young-earth creationist leaders oppose such advances, as if these advances are driven by evolutionary ideology. Perhaps the most stunning irony of the creation-day controversy lies buried—but alive—in young-earth creationists' literature. As the following paragraphs show, those leaders who have leveled some of the most stinging criticisms at old-earth creationists, accusing them of being evolutionists (theistic or otherwise),[4] are actually forced by their own interpretation of Scripture to be hyperevolutionists. Their confidence in the efficiency of natural-process evolution, or as they put it, "descent with variation,"[5] exceeds even that of the most ardent evolutionists.

Antievolutionists' Secret Embrace

Young-earth creationist leaders' views on the fall (Adam and Eve's original sin) and on the Genesis flood drive them—knowingly or not—into the surprising corner of belief in ultraefficient biological evolution. The first chapter of Genesis (supported by other Bible passages) says God ceased to introduce new life-forms after the sixth creation day.[6] Thus, young-earth creationists need an explanation for the huge number of new species of animals (namely, carnivores) they say appeared suddenly, after the fall, and proliferated again in the short span since the flood of Noah's day. How did these creatures get here, since God didn't create them?

According to young-earth teaching, animals ate only plants until the moment Adam and Eve rebelled against God's authority (see "Adam's Fault" through "Carnivorous Behavior" in chapter 9.)[7] Young-earth proponents assume carnivorous activity, which they consider evil because it involves animal death, would have been one of the consequences of human sin. Based on this perspective, all meat-eating creatures alive now and evident in the fossil record must have evolved rapidly (in several hundred years or less) and dramatically (the internal organs of carnivores are radically different from those of herbivores) from the plant-eating creatures God made during the creation week.

The young-earth creationists' interpretation of the Genesis flood exacerbates this apparent speciation problem. According to their interpretation, a globally extensive deluge wiped out all land-dwelling, air-breathing life on Earth, except those pairs of animals on board Noah's ark, and virtually all Earth's fossils and geological features resulted from this relatively recent cataclysmic event.

The size of Noah's ark and the limited number of humans on board (eight) present a serious problem for this view. Even if all the animals aboard hibernated throughout the flood's duration, the ark's maximum carrying capacity by young-

earth estimates would have been about 30,000 pairs of land animals.[8] But the fossil record indicates the existence of at least 100,000,000 such species,[9] of which more than 5,000,000—according to a recently completed quantification by biologists[10]—live on Earth today. By the reckoning of young-earth creationists these figures imply that in the era immediately following the flood the number of species increased from 30,000 to at least 2,000,000 more.

The problem grows worse. Shortly after the flood, young-earthers say, a large portion of the 30,000 pairs on board—most notably dinosaurs—went extinct. So, the remaining few thousand species that survived the flood and its aftermath must have evolved ("diversified"[11]) by rapid and efficient natural processes into 7,000,000 or more species.

Young-earth creationists recognize the magnitude of this problem. They conclude Noah took only pairs of each family or order, rather than a pair of every species or genus. In *The Genesis Flood*, Henry Morris and John Whitcomb suggest, for example, that zebras, horses, and several other horselike species evolved ("diversified"[12]) from a single horselike pair on the ark.[13] In the creationist journal, *Creation Ex Nihilo* (now *Creation*), Don Batten of Creation Ministries International and theologian A. W. (Bill) Mehlert each published articles where they propose that the entire cat family—tigers, lions, leopards, cheetahs, panthers, bobcats, and even ancestors of housecats—evolved from either one, possibly two, or conceivably three cat pairs on Noah's ark.[14] Mehlert argues that the 35 extant cat species in four genera plus extinct cat genera plus the sub-family of sabre-toothed extinct forms arose from (at most) two cat pairs through "created genetic variability potential" within the DNA of the original two to four individual cats.[15] Georgia Purdom and Bodie Hodge of Answers in Genesis (AiG) write, "After the Flood, the animals were told to 'be fruitful and multiply on the earth' (Genesis 8:17). As they did this, natural selection, mutation, and other mechanisms allowed speciation within the kinds to occur."[16]

Ironically, creation scientists propose an efficiency of natural biological evolution far greater than even the most optimistic Darwinist would dare suggest. As Philip Kitcher, philosopher of science at Columbia University observes, "Rates of speciation 'creation-science' would require…are truly breathtaking, orders of magnitude greater than any that have been dreamed of in evolutionary theory."[17]

Some young-earth creation scientists actually claim to observe such breathtakingly high rates of speciation. They point to hybridization experiments

where lions have been crossed with tigers to produce ligers, zebras with donkeys to make zonkeys, whales with dolphins to make wholphins, and goats with sheep to make geep. They cite such results as evidence that "12 living genera might have all descended from an original created kind."[18]

However, these hybridization experiments are irrelevant to the argument. It takes human intervention to force the hybrid results. In the wild, animals prefer to mate with members of their own species. Furthermore, even in the most extreme hybridization experiments, researchers experience great difficulty in getting the hybrids to reproduce after their own kind.

Animals, especially those as large and as advanced as horses, zebras, and cats, simply do not and cannot evolve or diversify under natural conditions at such extremely rapid rates (see box, "Size Matters"). If naturalistic evolutionary processes actually did proceed at such rapid rates, they would, of course, be observable in real time, in *our* time. Long-term evolution experiments refute the possibility of such rapid and dramatic changes.[19]

Another method exists for testing whether God created just one pair (or a few pairs) of animals for each order or family of creatures and then permitted Darwinian mechanisms, operating over a few hundred years, to separate the gene assortment of an original pair into dozens of different genera and different species. That method is to examine the DNA of the diverse species alive today. If the young-earth creation model is correct, DNA differentiation among the varied species within an order (or a family) should be only slightly greater than the differentiation among individuals within each species. So far, this test has been applied for large primates and bats. In both cases the differentiation among species is very much greater than that exhibited by individuals within a given species. In fact, the distinction among various species compared to individuals within a species is so great as to challenge traditional (gradualist) Darwinism—and certainly to rule out the rapid evolution that young-earth creationism necessitates.

What Is a Kind?

Exegetically, the speciation debate hinges on the meaning of the Hebrew word *mîn* used in Genesis 1 for the different creatures that reproduce after their own "kind." The usage of the word in Genesis 1, Leviticus, and Deuteronomy implies that creatures belonging to a *mîn* faithfully reproduce the characteristics of that *mîn* from one generation to all the generations that follow.[20] Young-earth creationists argue that the definition of *mîn* is sufficiently broad that herbivores could evolve to become carnivores and a pair of animals on board Noah's ark

could, in their post-flood reproduction, differentiate sufficiently to account for all species not only within a genus but even within an entire family or order.[21]

Such a broad definition for *mîn* seems to contradict usage of the word in other Old Testament passages. Leviticus 11:22 lists the locust, katydid, cricket, and grasshopper as distinct *mîn.* Deuteronomy 14:12–18 catalogs the eagle, falcon, hawk, red kite, black kite, vulture, and black vulture as separate *mîn*. In both Leviticus 11:15–17 and Deuteronomy 14:15–17 the horned owl, screech owl, little owl, great owl, and white owl are all referred to as individual *mîn*. Thus, the Bible seems to rule out a broad definition for *mîn*. It appears to accommodate a range of bird and mammal differentiation no greater than the usage of the English word "species." For insects, the differentiation appears no greater than the usage of the term "genus."

Size Matters

A growing body of evidence demonstrates that extinction risks in various species of mammals rises dramatically with increasing average adult body mass. Likewise, paleontologists and molecular biologists observe that apparent speciation rates decline with increasing body mass.[22]

One team of biologists showed that "whereas extinction risk in smaller [bodied] species is driven by environmental factors, in larger [bodied] species it is driven by a combination of environmental factors and intrinsic traits."[23] Furthermore, the team demonstrated that extinction-driving "impacts of both intrinsic and environmental factors increase sharply above a threshold body mass around 3 kilograms."[24]

Another research team established that large-bodied mammals (average adult mass = 369.5 kilograms) contrasted with small-bodied mammals (average adult mass = 275 grams) accumulate "slightly deleterious mutations in mitochondrial protein-coding genes"[25] at a much higher rate. A third study showed that for primates, extinction risk increases with female body mass.[26] In a quantitative model for terrestrial mammal evolution wherein the extinction probability increased logarithmically with adult body mass, two physicists confirmed that the model agreed well with data on extinct mammal species between 95–50 million years ago.[27]

Other research efforts confirm the conclusion that large-bodied terrestrial mammals experience rates of extinction far greater than the most optimistic naturalistic speciation rates.[28] This result, in part, explains why field biologists have failed to observe during the human era (God's Sabbath rest from physical

creation activity) even one example of a speciation event for mammals, while during the same epoch half of all mammal species—4,000 total—that were present at the time of Adam and Eve have disappeared. Thus, neither natural process evolution, theistic evolution, nor young-earth creationist descent-with-variation can realistically explain the history of large-bodied mammals.

Afraid of the Ages

Confidence in the superefficiency of biological evolution makes some young-earth creationists' refusal to consider other options on the timescale issue more comprehensible. If Darwinian processes could work as smoothly and rapidly as they believe, a millions- or billions-of-years-old Earth would seem to remove any need for God's involvement in the creation and diversification of life—the opposite conclusion to the one these Christians wholeheartedly intend to defend.

From a young-earth perspective, any concession that Earth or the universe may be more than about 10,000 years old undermines the foundation of their faith—the veracity of a core doctrine and of the Scriptures themselves. No wonder they so strongly oppose anyone, even fellow Christians, who propose an ancient universe and Earth.[29] The risks involved preclude an open-minded investigation of the scientific and biblical evidence for Earth's antiquity (see chapters 7–10 and 13–18).

Young-earth creationists call themselves antievolutionists. In truth, their antievolutionism rests not on the inadequacy of naturalistic processes but rather on the need to show that these Darwinian processes did not have sufficient time to produce nearly all the life-forms on the face of the earth.

Erasing Evolution Fears

Scientific information acts as an efficient surge protector against the swelling fear that evolution might be possible. One finding after another challenges the Darwinian mechanisms of natural selection and mutations.

Evolutionary theory operates on the belief that, given enough time, these mechanisms yield significant sustainable changes in the various species of life on Earth, enough changes to account for the diversity of life observed in the fossil record. The basis for the belief is twofold:

1. Natural selection has been observed under field conditions and in controlled breeding experiments to produce diversity. In just a few centuries, a single species can yield two sets of individuals so distinct

from one another that in a natural environment they will not mate to produce survivable, fertile progeny. Thus, one species (loosely defined) can apparently split into two.[30]

2. Successive mutations have been observed under field conditions and in laboratory experiments to produce offspring that, in just a few decades, can supplant the nonmutated members of the species. Thus, one species apparently changes into another.[31]

From observation of these two mechanisms, a person may presume that several billion years' worth of extrapolation could explain much, if not all, of the fossil record details. However, ongoing research indicates that the limitations on these mechanisms are much too severe.

Natural Selection Limits

The canine species provides a helpful example of how far natural selection can and cannot go. Through centuries of selective breeding, wild dogs have become hundreds of distinct pet breeds. Today we see teacup poodles no bigger than a person's hand and Great Danes nearly the size of a pony. Obviously, a male teacup poodle is unable to mate successfully with a female Great Dane.

Based on a common definition of a species (a class of creatures that can mate and produce fertile offspring), the dog species appears to have developed into more than one species. But the impact of that "speciation" must be considered. Both teacup poodles and Great Danes are fragile in terms of life expectancy and survivability. If forced to fend for themselves in the wild, they would rapidly go extinct. The further we breed the progeny away from the norm (or "mean") of the species, the less capable of survival the progeny become. Though to breed a dog even smaller than a teacup poodle may be possible, breeders will eventually bump against the limits of natural selection. The smaller the dog, the more difficult it is to keep the dog alive, even in the protection of a loving home.

Ironically, natural selection argues for stasis rather than for change.[32] In the case of dogs, if all barriers separating different breeds were removed and the breeds allowed to mingle freely in the wild, within relatively few generations the progeny would revert to the original "means."

Where natural selection does work to change a species, the change is minor. Humans today are about half a foot taller and can see better than people of two millennia ago. Most of this change can be attributed to improved diet, although some change does result from natural selection. For example, soldiers with

superior eyesight were better able to dodge spears and arrows in battle and thus lived to produce offspring with better vision. The contributions of natural selection to the human species remain so tiny, however, as to prove inconsequential for explaining the morphological and genetic differences between humans and all other species, including chimpanzees and Neanderthals.[33]

For some species, even the possibility of slight change does not exist. Natural selection is founded on the principle that a species will overpopulate to such a degree that only the fittest survive. But not all species overpopulate. Many species of birds, for example, reduce their egg production in direct proportion to the supply of food. Their populations are not limited by starvation and predation but rather by instinctively controlled breeding.

Mutational Change Limits

In the process of natural selection, one gene may be chosen over another. But in mutations (chemical changes in replicator molecules induced by radiation and other environmental stresses) the chemical structure of the gene itself is changed. Therefore, mutations carry the potential for producing relatively dramatic changes in the characteristics of a species. These changes, however, are limited by the generation time span and the population size of the species (among other factors).[34]

Mutations rarely occur. Typically only one individual in a million will experience a mutation. Most nonlethal mutations are neutral. That is, they have no discernible effect on the characteristics of the progeny carrying the change. Of the remaining mutations, the majority are harmful to the species. Depending on the species, the ratio of harmful to favorable mutations measures somewhere between 10,000 to 1 and 10,000,000 to 1.[35]

With favorable mutation rates as low as the observational evidence shows, most species cannot mutate rapidly enough to adapt to environmental stresses. The likelihood of eventual extinction far exceeds the likelihood of mutational advance into a new, survivable species. The exceptions to this rule are species with huge populations and a short generation time. Species with a quadrillion or more individuals and a life cycle (time between birth and reproduction) of three months or less may stand a reasonable chance of propagating enough favorable mutations in a short enough time to survive at least minor environmental challenges. Ants, termites, bacteria, and viruses fall into this category. For large-bodied species, however, mutations prove destructive. Virtually all large-bodied species go extinct before they can successfully change via mutation (see “Size

Matters”). For all species, nothing as significant as the development of new organs falls within the range of reasonable probability.

Evolutionary biologists respond to this dilemma by hypothesizing periods in Earth’s history during which the mutation rate greatly exceeded one per million individuals. However, circumstances (for example, X- and gamma-ray radiation) generating such a high mutation rate would also threaten the survival of all progeny, mutated and unmutated. Therefore, an increased mutation rate would be vastly counterbalanced by a decreased population and the resulting decreased probability that survivors would successfully reproduce and provide for the needs of their offspring.

Puzzling Fossil Record

Biological evolution faces yet another, perhaps more daunting challenge: the fossil record enigma. While speciation occurred in the past, it came to a virtual standstill once human history began. Specifically, the fossil record indicates that from the Avalon and Cambrian explosions (dated at 575 and 543 million years ago, respectively) until the appearance of the first humans (40,000 to 50,000 years ago according to cultural artifacts, or 50,000 to 100,000 years ago, according to DNA analysis), at least 100,000,000 species arrived on Earth[36] These figures imply that, on average, one new species appeared every five years. Meanwhile, since the appearance of humans, not a single new mammal species has been observed to come into existence. While biologists have observed a few new bird species, in each case the new “species” results from a single species becoming geographically divided, where birds on one side of the divide no longer mate with birds on the other side of the divide. For all animals, change in the morphological structure of a particular species typically occurs so slowly that an increase in the amount of differentiation cannot be detected.[37]

This lack of any significant evidence for human-era animal speciation poses a significant challenge for evolutionists, since during this same epoch animal extinction rates are very high. Currently, multiple species go extinct every year.[38] While ecologists agree that human environmental abuse accounts for most of this observed extinction, they also note that even without human interference at least one species per year would suffer extinction.[39]

All evolutionary models demand that speciation rates balance extinction rates. (Otherwise, the number of species would have dropped to zero long ago.) For the human era, the speciation rate clearly falls short of the extinction rate by many orders of magnitude.

The obvious imbalance between extinction and speciation troubled me

throughout my teenage years. The first time I read through the Bible, however, I observed in the creation accounts an answer to the enigma of the fossil record. In Ecclesiastes, Isaiah, Jeremiah, and Romans, I read that all creation (since the cosmic creation event) has been subjected to the physical laws God established for the universe. According to Psalm 104 (and according to these physical laws), it is the property of all life to die off eventually. But the psalmist says that when life died off, God replaced it (see 104:29–30). Genesis 1 records that for six days God created life, and more life, apparently replacing those species that went extinct, but that on the seventh day God ceased from this creating.

If the Genesis 1 creation days are long time periods, the Bible offers an explanation for the fossil record enigma. It tells why so much animal speciation occurred before the creation of humans and why virtually no animal speciation has occurred since: after God created Adam and Eve, He stopped creating new life-forms. The abundant evidence for animal speciation previous to humanity makes sense if God actively created new species to replace those going extinct.

Throughout six creation epochs, God created millions of new species. During the seventh epoch, He rests. That is, He ceases from creating new life-forms.

Why So Many Scientists Disbelieve

Belief in a personal God and an afterlife has remained relatively high among the American public. Over the past century polls indicate that belief in God (by whatever definition) ranges between 80 and 95 percent.[40] For professional scientists, however, the level of belief is lower. Surveys conducted in 1916 and 1996 found that 40 percent of scientists believed in a personal God and an afterlife.[41] Those same surveys showed a marked difference, however, in the level of belief among mathematicians, astronomers, physicists, chemists, and geologists compared to individuals working within the life sciences. For example, the level of belief among mathematicians stands at about 80 percent while for anthropologists and psychologists it is well below 10 percent.

The scientific disciplines are far from being equally populated. The International Astronomical Union, which includes nearly all the world's practicing professional astronomers, has just over 10,000 members. The number of professional biologists worldwide stands well above 3,000,000. Life scientists far outnumber physical scientists.

I see another important distinction among scientists. The vast majority of life scientists limit their research to the human era while the majority of physical scientists focus on the eons previous to the human era. Because of light-travel times, all astronomical data comes from the past. For field biologists, all data

comes from the present.

This second distinction may help explain why the level of belief in God is so much lower for life scientists than for physical scientists. The former group predominantly studies the seventh creation day when God has ceased from His creation activity. Consequently, most of these scientists see no evidence for God's direct involvement. The latter group spends much of their research effort studying the era when God actively intervened in the natural realm. Thus, most of these scientists see abundant evidence of God's handiwork.

The first and second distinctions suggest why the majority of scientists disbelieve. Far more scientists populate the life sciences where attention is focused on creation day seven compared to the physical sciences where much attention is focused on creation days one through six.

No Time to Fear

Interpreting the Genesis creation days as tens of millions or even hundreds of millions of years in no way lends support to evolutionism. Even these long time frames would have been far too brief to account for a naturalistic origin of life or for life to become more and more complex by natural processes. (The significant problem of insufficient time for evolution is thoroughly examined in another Reasons to Believe book, *Origins of Life*.)[42] The fear expressed by many sincere Christians that long creation days support the tenets of naturalistic evolution (belief that all life arises from natural processes alone) or theistic evolution (belief that God created only through setting up or guiding the natural processes) has neither scientific nor biblical foundation. However, yet another fear keeps the creation-day controversy swirling. This fear is the topic of the next chapter.

Chapter 12

Faith, Morality, and Long Creation Days

"A light rain over Seattle has caused a devastating hurricane to hit Miami." Most people would immediately react with suspicion if a weather broadcaster tried to convince them of this statement. Using sophisticated weather maps that indicate the flow of jet streams, storm fronts, and high and low pressure zones, meteorologists on the nightly news have educated millions of viewers on the complex relationship between atmospheric conditions and surface weather.

An even greater complexity exists in the relationship between biblical interpretations and behavior patterns, which makes spotting incompatible links between them far more difficult. Some young-earth creationist leaders have persuaded large segments of the Christian community to believe that a link exists between belief in an old Earth and a slide into immorality. But rather than causing people to react with suspicion, this disconnected logic plays on a genuine concern: if Christians manipulate biblical texts from the earliest chapter in the Bible to promote the agenda of biological evolution, more serious forms of compromise may well follow. One outspoken promoter of this erroneous connection, Ken Ham, president of Answers in Genesis, said, "If Christian leaders have told the next generation that one can accept the world's teachings in geology, biology, astronomy, etc., and use these to (re)interpret God's Word, then the door has been opened for this to happen in *every* area, including morality" (italics in original).[1]

Another spiritual forecaster, Henry Morris of the Institute for Creation Research (ICR), described the perceived problem this way: "The continued insistence on an ancient earth is purely because of the philosophic necessity to justify evolution and the pantheistic religion of eternal matter."[2] In *The Long War Against God*, Morris comments on how these views have led to social disintegration:

> The failure of Bible-believing Christian churches and schools to aggressively defend and promote true biblical creationism [young-earth creationism] is a major cause of the takeover by evolutionary humanism

> of our entire society.…The modern widespread rebellion against God's commandments related to the family is conditional upon the prior rejection of his creation activity and record thereof.[3]

These strong words reflect strong feelings.

John Morris, current president of ICR, elaborates on his father's comments, going so far as to call evolutionism "an unmitigated evil," the philosophical root of "fascism, racism, Marxism, social Darwinism, imperialism, etc." In his view, "the modern ills of promiscuity, homosexuality, abortion, humanism, new-age pantheism, etc., etc., flower from the same evil root,"[4] presumably because evolutionism devalues life and undermines moral law. The logic for this denunciation forms this syllogism: old-earth beliefs lead to evolutionism; evolutionism leads to unmitigated evil; therefore old-earth beliefs lead to unmitigated evil.

Long Days Linked to Evil

Failing to recognize the fundamental flaw in equating belief in an old earth with evolutionism (addressed in chapter 11), some Christians take the illogic a step further. Since old-earth beliefs lead to unmitigated evil, then old-earth proponents must be evil people. How, then, can anyone believing in an old earth possibly be a Christian? A spokesperson for the Bible Science Association (BSA) expressed outrage that the story of my commitment to Christ was published in a Christian magazine. He described me as "dangerous," adding that I'm "not an orthodox Christian" and claiming that my views on an old earth undermine belief in Christ's atonement.[5]

Ham made similar charges against old-earth creationists. "Such people, I believe, are described in Matthew 7:15: 'Beware of false prophets, which come to you in sheep's clothing, but inwardly they are ravening wolves.'"[6]

Doug Phillips, professor of apologetics for ICR, warns that to give ground on this creation belief would "undermine the foundation for every significant doctrine in Scripture…leaving the believer with no hope."[7] John Morris sees billions of years of new species appearing and old species becoming extinct as "inconsistent with God's omnipotence, omniscience, purposiveness, loving nature and even His grace."[8] He said, "In this [old-earth] view, death is *not* the penalty for sin, for it preceded man and his sin. But if death is not the penalty for sin, then the death of Jesus Christ did not pay that penalty, nor did His resurrection from the dead provide eternal life."[9]

Ham teaches that the old-earth view of creation "destroys the basis of the

Gospel message" and "the message of redemption,"[10] and BSA leaders agree:

> [Old-earth] theology denies the central teaching of Christianity…and rejects the connection that Scripture establishes between sin, death, and Christ's atonement.…In [this] theology death is natural. Death was a reality for millions of years before man ever arrived to sin. This leaves Christ's death on the cross as, at best, well-meaning, but beside the point.[11]

Referring to Christians who accept "billions of years" of creation history, Ham said, "They have put man in judgment of God. *Man* becomes the authority." He continued with his emotional appeal: "For me to accept an old age (billions of years) for the earth is to accept that fallible man's fallible methods are in authority over God's infallible Word. I can't do that!"[12]

Russell Humphreys, another ICR staff scientist, equated old-earth creationism with a sadistic God and a denial of Christ's second coming.[13] Both Henry and John Morris have claimed that the ministries of old-earth creationists lead to apostasy, not to soulwinning and spiritual growth.[14]

These outspoken leaders have widely and deeply influenced the beliefs of countless Christians (not to mention observers of Christianity) around the world. They passionately argue that foundational Christian doctrines are destroyed in the acknowledgment that the universe and Earth may be older than a few thousands of years. No wonder they—and some of those they have influenced—show so little restraint in branding old-earth creationists as apostates, deceivers, heretics, false prophets, and purveyors of sin and evil.

Severing Illogical Links

Attempts to link belief in an old earth with immorality rest on the false equating of long creation days with naturalism, an unjustified assumption addressed in chapter 11. Blaming evolution for unmitigated evil, scriptural compromise, denial of fundamental Christian doctrines, and disinterest in soulwinning and spiritual growth represents yet another fallacy, a sweeping generalization leading to an unwarranted conclusion. If evolution were really the underlying cause of virtually all such moral and social ills, why were such ills prevalent in the millennia prior to the introduction of evolutionary theory? The Scriptures speak clearly about the root of all evil, and that root is not evolution. Neither Satan nor the first humans stumbled over evolution. Satan stumbled over self-exaltation, and Adam and Eve followed suit, choosing autonomy above submission to their

Maker. Neither evolutionism nor any other -ism *causes* the autonomy so visible in today's world. Whatever people hide behind as an excuse for their autonomy represents an *effect* of that autonomy, referred to in Scripture as "the flesh" or "the sin nature."

The logic of Henry Morris' assertions that "an omniscient God could devise a better process of creation than the random, wasteful, inefficient trial-and-error charade of the so-called geological ages," and that "a loving merciful God would never be guilty of a creative process that would involve the suffering and death of multitudes of innocent" animals,[15] must be challenged.

If these assertions are true, what can we say of the present era? God has the capacity right now to reduce human suffering. But a loving, merciful God allows people (including those submitted to His authority) to suffer discomfort, illness, injury, and death. God refers to the death of His saints as "precious" (Psalm 116:15). Can it be that God has *good* purposes for what seem like bad things? Could Earth's long history of plant and animal death have been part of God's good preparation for humanity and human civilization, technology, and the efficient spreading of the gospel?[16]

While an omniscient, omnipotent God could have devised a *different* creation, to judge that He could "devise a better process of creation" goes beyond human authority—and human wisdom. As shown in chapter 10, given God's grand plans and goals for the *new* creation (the new heavens and new earth of Revelation 21), the groanings experienced by the present creation seem just a brief but essential experience along the way (Romans 8:18–25).

Severing Inappropriate Links

Attempts to link long creation days with evil and apostasy must be challenged on the grounds of impropriety as well as illogic. Such attempts foster a contemptuous attitude toward people whose work and character deserve better. That cloud of condemnation casts a long shadow, even over the reputation of some of Christianity's and the Bible's most distinguished defenders—Charles Hodge, Benjamin Warfield, Gleason Archer, Norman Geisler, and Walter Kaiser, for example. All have stood firm on biblical authority, biblical inerrancy, and conservative evangelical theology.

Hodge, a highly regarded theologian of the nineteenth century, played a role in developing a response to Darwin. Warfield is considered one of Christianity's most capable theologians of that same era and pioneered the defense of biblical inerrancy. Archer, an eminent Old Testament scholar educated at Harvard and fluent in 27 languages, earned respect as one of the most brilliant biblical

language scholars of the twentieth century. Geisler is a well-known and effective evangelical apologist. Another distinguished authority on Scripture, Kaiser was president of Gordon-Conwell Theological Seminary and served on the boards of numerous Christian organizations. These esteemed scholars do not take an old-earth position unwittingly or because they compromise Scripture. Rather, they view biblical inerrancy and an old-earth interpretation as dynamically working together in theology as well as in evangelism.

Noted author and philosopher Dallas Willard expressed concern over the level of animosity aimed at these individuals and many others. “The cutting edge of Christian evangelism today is blunted, the bond of love between many Christian leaders severely weakened, and the peace of mind of thoughtful individuals is destroyed by what seems to be a contradiction of faith and science over the physical universe. Simply put, it is suggested that you cannot be a Christian unless you reject the teachings of current science and the origin of the earth.”[17] In short, the hostility displayed in this dispute over the length of creation days damages Christians’ testimony of love.

A personal encounter I had near the Oak Ridge National Laboratory in Tennessee illustrates the problem. As I spoke to a group of research physicists there, giving evidences from physics and astronomy for a transcendent, personal, and caring Creator, I could see skepticism evaporating. Meanwhile, an ambush was forming. A group of young-earth creationists had come (on a four-hour car trip) to “take a stand.” They took over during the question-and-answer period, attempting to refute my physics and astronomy data, though they had little training in these subjects. The non-Christian scientists in the room were shocked that Christians would show such little respect for me or for them. By God’s grace, many of those scientists stayed late to ask questions. How ironic that some believers, in an effort to defend the faith, disrupted a meeting designed to introduce people to faith in Jesus Christ.

Kaiser has expressed his belief that “the Christian graces…ought to be exhibited in controversies of this sort.”[18] Working toward resolution of a conflict gives the participants an opportunity to grow in patience, kindness, compassion, gentleness, and humility. Zeal for *truth* can be honorably and respectfully demonstrated. Young-earth creationists deserve credit for their zeal, commitment, and courage in defending God’s Word as truth. If belief in an old earth did, in fact, disparage or deny that truth, they would be justified in opposing it. But even then, reverence for Scripture would require obedience to its instructions for dealing with error or even with supposed apostates and enemies of the faith (Matthew 18:15–17).

Belief in evolution does not necessarily identify a person as an enemy of the faith. Such belief may come from or lead to rejection of God's truth, but many adherents to evolution simply have not yet thought through the implications of what they have been taught. Most Darwinists and evolutionists I have met are inconsistent in the application of what they profess to believe about life's origin and development. However, they do not manifest all the evils John Morris suggests.

God calls Christians to treat each other with love, even when controversy arises or correction is needed. The biblical accounts of the early church's response to doctrinal conflict provide believers with useful examples (see Acts 15:1–35 and 18:24–28). Furthermore, God calls Christians to treat nonbelieving people as potential converts, not as enemies to be attacked and destroyed. As the apostle Paul pointed out in 1 Corinthians 6:9–11, there is hope even for those caught up in evil. Grace, mercy, and truth may bring them to repentance. Hatred and contempt may be rightfully expressed toward sin but not toward the sinner.

Many old-earth advocates—pastors and ministry leaders, seminary professors, homemakers, businesspeople, truck drivers, teachers, nurses, accountants, attorneys, and others—from diverse spiritual backgrounds and church affiliations remain unswervingly devoted to Christ, respecting His Word and walking in His ways. Living examples may, through time, have greater impact on breaking the illogical and inappropriate link between long days and immorality than does any amount of scientific evidence.

A man who visited the Sunday school class I teach initially expressed disbelief when he heard of my heart for evangelism. Class members began telling him stories, identifying people who came to faith in Christ as a result of my ministry. That day, he said, he relinquished his belief in the "evils" of old-earth creationism.

Seeing the flexibility and alertness of many evangelical congregations around the country gives me hope for change—for dispelling the myths and misconceptions surrounding acceptance of a theologically and scientifically credible creation timescale. I see a willingness (especially recently) to consider the needs, interests, and spiritual barriers of the community. Rigidity, dogmatism, suspicion, and contempt are being recognized as counterproductive. In an atmosphere of relaxed confidence, where dialogue is welcome and nonthreatening, we can move ahead more effectively than ever toward fulfilling God's purposes for His people.

Meanwhile, another issue, the much maligned and widely misunderstood "big bang," also raises such an emotional reaction as to hinder that progress. This theory is the topic of the next chapter.

Chapter 13

Big Bang:
The Bible Said It First

This chapter was composed at the suggestion and with the assistance of Dr. John Rea, professor emeritus in Old Testament at Regent University, Virginia Beach, Virginia.

Much as “the E word” (evolution) sparks lightning among Christians, so *big bang* also draws the rumble of thunder. Two fundamental issues darken the skies over this controversy. One is a failure to understand the big bang models. The other is a failure to understand the biblical roots of big bang cosmology.

Cosmic Creation

The big bang is big, but it is not a “bang” in the usual sense of the word. *Bang* conjures images of bomb blasts or exploding dynamite—phenomena associated with chaos, disorder, and destruction. In truth, the cosmic “bang” is an immensely powerful yet carefully planned and controlled burst of creation—a sudden release of power from which the universe unfurled in an exquisitely controlled expansion. In an instant, time, space, matter, and energy, along with the physical laws governing them all, came into existence from a source beyond the cosmos.

No other characteristic of the universe is so well designed as this cosmic expansion. The two parameters governing the expansion—the mass density and the space-energy density—must be fine-tuned. The fine-tuning for the space-energy density (dark matter) is more precise than 1 part in 10^{120} (that’s 120 zeros after the 1) in order to yield a universe of galaxies, stars, and planets—that is, a universe suitable for any kind of physical life.[1]

Why, then, do astronomers retain the term *big bang*? The simplest answer is that nicknames, for better or for worse, tend to stick. A hostile opponent of the theory, British astronomer Sir Fred Hoyle, coined the expression in the 1950s, attempting to ridicule this up-and-coming challenger to his “steady state” hypothesis. He objected to any theory that placed the origin, or Cause, of the universe outside itself; hence, to his thinking, outside the realm of scientific

inquiry.[2]

Perhaps because of its simplicity and catchy alliteration, the term *big bang* stuck. No one found a more memorable shorthand label for this (admittedly lengthy) description: a precisely controlled cosmic expansion from an infinitely, or near infinitely, compressed space-time volume that is infinitely, or near infinitely, hot brought instantly and transcendently into existence by a Creator operating beyond matter, energy, space, and time.

Not Just Hot Gas

Duane Gish and Henry Morris of the Institute for Creation Research (ICR) vigorously promoted the notion that the big bang contradicts thermodynamics. They interpreted the big bang as the ridiculous notion that a highly ordered system of galaxies, stars, planets, moons, and life naturally evolved from the chaos of hydrogen gas.[3] This enormous misconception reflects a widespread misunderstanding of thermodynamics and nucleosynthesis, in particular, and of the big bang theory in general.

When light elements such as hydrogen fuse to make heavier elements (up to the mass of iron), this nuclear fusion releases energy. Therefore, nuclear fusion or nuclear burning over time converts hydrogen into light elements and these light elements into heavier elements. Thus the second law of thermodynamics (which says entropy, or the degree of disorder, steadily increases) yields a gradual buildup of the ashes (heavy elements) from hydrogen burning.

The thermodynamics of cosmic expansion, if fine-tuned adequately, predict that these ashes, together with the remaining hydrogen, will eventually coalesce (in a way comparable to raindrop formation) to develop galaxies, stars, planets, and moons from gas and dust clouds. The remarkable, “unnatural” aspect of this process is the extreme fine-tuning not only in the laws and constants of physics but also in the gross features of the universe, such as its expansion rate, uniformity, total mass, and relative numbers and masses of different fundamental particles.[4] The possibility of life’s existence and survival depends on the fine-tuning of all these features.

Scientists Encounter a Beginning

Most textbooks addressing cosmology (study of the origin and structure of the universe) credit Arno Penzias and Robert Wilson with the discovery that the universe arose from a hot flash point. While these two were the first to detect the radiation left over from the creation event (in 1965),[5] they were not the first scientists to recognize that the universe had expanded and cooled from an

extremely hot and compact state. In 1925, astrophysicist and Jesuit priest Abbé Georges Lemaître became the first scientist to promote the idea of a big bang origin event.[6] Observations made by Edwin Hubble in 1929 established that a certain phenomenon (called spectral line redshifts) of galaxies results from a general expansion of the universe from some beginning point.[7] Then, in 1946, George Gamow calculated that the existing abundance of elements in the cosmos requires a nearly infinitely hot starting condition followed by relatively rapid cosmic expansion.[8]

The first theoretical evidence for a cosmic creation event dates back to 1916 when Albert Einstein noted that his field equations of general relativity predicted an expanding universe.[9] Recognizing that such expansion implies a beginning, Einstein altered his theory to conform to the common wisdom of his day; namely, belief in an eternal universe.[10]

As Einstein's alteration of his theory suggests, the big bang (creation event) threatened to overthrow evolutionary thinking. That thinking leaned heavily on the availability of nearly infinite time for natural processes to bring about the assembly of a living thing and for that first living organism to naturally evolve into modern-day life-forms. Other astronomers and physicists openly expressed their bias against the notion of a beginning. Sir Arthur Eddington, one of the most famous early twentieth-century cosmologists, rejected the big bang since "it seems to require a sudden and peculiar beginning of things."[11] He added, "Philosophically, the notion of a beginning is repugnant to me."[12] In 1930, he countered with a cosmic model of his own that allowed evolution "an infinite time to get started."[13] Whatever illusions biologists may have possessed, astronomers were quick to acknowledge that the several billion years of cosmic history afforded by the big bang were woefully inadequate to explain either the origin of life or the gradual development of various life-forms by natural means.

All of these scientists, however, were upstaged more than 2,500 years ago by Job, Moses, David, Isaiah, Jeremiah, and other Bible authors.

Ancient Claims

Scripture's prophets and apostles described four fundamental features of the big bang: a transcendent cosmic beginning in the finite past, cosmic expansion from that beginning, unchanging laws of physics, and an all-pervasive law of decay. Isaiah 42:5 makes reference to the first two features:

> This is what God the Lord says—
> he who created the heavens and stretched them out,

The Hebrew verb *bārāʾ*, (translated as "created" in this verse) has as its primary definition "bringing into existence something new, something that did not exist before."[14] The Old Testament proclaims seven times that God created (*bārāʾ*) the entirety of the heavens.[15] Passages like Hebrews 11:3 make this principle of transcendent creation more explicit by stating that the universe humans can measure and detect was made from that which cannot be measured or detected (that is, not from anything pertaining to matter, energy, space, and time). Isaiah 45:5–22, John 1:3, and Colossians 1:15–17 stipulate that God alone is the agent responsible for the universe's existence. References to God's existence and cause-and-effect actions prior to the existence of the universe, that is, prior to the existence of matter, energy, space, and time, appear in Proverbs 8:22–31, John 17:24, Ephesians 1:4, 2 Timothy 1:9, Titus 1:2, and 1 Peter 1:20 as well as in the Colossians 1 passage.

Claims for Cosmic Expansion

The cosmic characteristic of "stretching out" is stated in the Bible more frequently than any other. Eleven passages by five different authors depict this phenomenon: Job 9:8; Psalm 104:2; Isaiah 40:22; 42:5; 44:24; 45:12; 48:13; 51:13; Jeremiah 10:12; 51:15; and Zechariah 12:1. Three of these verses (Job 9:8; Isaiah 44:24; 45:12) say that God alone causes the stretching or expansion of the universe, suggesting that humans should discover something supernatural in the cosmic expansion phenomenon.

Ten of the eleven passages use the Hebrew verb *nāṭâ* in describing cosmic expansion. Biblical studies scholar Marvin Wilson, in the *Theological Wordbook of the Old Testament*, defines *nāṭâ* as "extend, stretch out, spread out."[16] Two of these ten passages employ a tent metaphor. Psalm 104:2 declares, "He [God] stretches out the heavens like a tent." Isaiah 40:22 proclaims, "He [God] stretches out the heavens like a canopy, and spreads them out like a tent to live in." Wilson points out that in biblical Hebrew '"to stretch out' the curtains of a tent is symbolic of growth."[17] And, like a tent, the physical reality of the universe is its surface. (All of space, time, matter, and energy, is constrained to the surface of the universe.)

Two different Hebrew verb forms of *nāṭâ* are used in these ten verses to describe the cosmic expansion. Seven of them use the qal participle form, namely Job 9:8; Psalm 104:2; Isaiah 40:22; 42:5; 44:24; 51:13; and Zechariah 12:1. These passages make reference to "the stretcher out of them [the heavens]." Three verses (Isaiah 45:12 and Jeremiah 10:12; 51:15) employ the qal

perfect form. These passages suggest that when God created the universe, He built the feature of cosmic expansion into its physics.

Isaiah 48:13 does not use the verb *nāṭâ* but instead a synonym, *tāpah*, in the piel perfect form, meaning that God spread out the heavens. Old Testament language scholar Ralph Alexander, in defining *tāpah* in his contribution to the *Theological Wordbook of the Old Testament* wrote, "The basic meaning is 'to stretch, expand, or draw out a surface.'"[18]

Another verb form, the imperfect, is used in combination with the active participle form in Isaiah 40:22. The first part of the verse makes reference to the expansion of the universe, while the second part of the verse is most literally translated as "and He has spread them [the heavens] out." The picture presented in Isaiah 40:22 is one of God sitting enthroned above, exercising His creative power, in part, by stretching out the heavens, with the added reference to God's past completed act that ensured the spreading out of the heavens.

This stretching out of the heavens matches the big bang theory. According to that model, all the physics (dimensions, laws, constants, and equations of physics) were instantly created, designed, and finished so as to guarantee cosmic expansion at exactly the right rates (with respect to time) to provide, eventually, for all the physical needs of life, human life in particular.

Unchanging Physical Laws

The Bible also speaks about other big bang features. Jeremiah 33:25 and Romans 8:20–22 indicate that "the fixed laws of heaven and earth," which includes thermodynamics, gravity, and electromagnetism, have universally operated throughout cosmic history.[19] Big bang theory agrees.

Romans 8:22 states that the entire creation has been subjected to "frustration" or "futility." The next verse declares that all of creation was, and is, in "slavery to decay" or "bondage to corruption." Ecclesiastes 1 and Revelation 21 also support this imagery of the whole universe suffering from progressive decay. Genesis 2 and 3 indicate that work and pain are part of the creation, both before and since Adam's rebellion in Eden. This ongoing slavery to decay aptly portrays the second law of thermodynamics, which states that as time goes on the universe becomes progressively more disordered or run down and that this progression to disorder (entropy) is essential for work to be possible.

Cosmic Cooling

The biblical descriptions of cosmic expansion from a beginning of space, time, matter, and energy, constant physics, and a pervasive law of decay imply that the

universe must become progressively colder as it gets older. Here's how: *any* physical system that expands under the operation of the law of decay (second law of thermodynamics) must be cooling down. A piston engine illustrates this principle of physics. When the piston chamber expands, the chamber temperature drops. The greater the expansion of the piston chamber, the greater the drop in temperature inside the chamber.

Since the entire universe has been expanding from the cosmic creation event under the influence of the law of decay, it, too, according to the biblically stated operation of the physical laws, must get progressively colder as it ages. That is, one can deduce from what the Bible says about the cosmic beginning and cosmic physics that the universe starts off nearly infinitely hot and cools in proportion to its ongoing expansion.

Big Bang Fundamentals

Many hot big bang theories exist, and emerging observations of the universe will determine which of the several dozen variants is correct. But all hot big bang models share these fundamental characteristics:

1. a transcendent cosmic beginning a finite time ago
2. cosmic expansion from that beginning
3. ongoing cosmic cooling from an extremely hot initial temperature

All three of the fundamental features of big bang cosmology are described directly or implied from the Bible's descriptions of the physical laws. The Bible made these statements 2,000 to 3,000 years before scientists (via astronomical observations and measurements) discovered these cosmic characteristics. In fact, no scientist proposed any idea like big bang cosmology until the twentieth century. What's more, the Bible alone among all the sacred writings of the world's religions expounds these three big bang fundamentals. Christian outrage over the big bang certainly seems misplaced.

Putting the Big Bang to the Test

In 1989, John Maddox, physics editor for the prestigious journal *Nature*, wrote an editorial titled "Down with the Big Bang." In it, this self-proclaimed atheist wishfully predicted that the big bang theory would not survive the initial observations coming from the Hubble Space Telescope.[20] In 1990, ICR joined in predicting that the big bang explanation for cosmic origins would die before the close of the twentieth century.[21] Meanwhile, based on our interpretation of

biblical cosmology, many science-trained Christians, including me, publicly predicted that evidence supporting the big bang would grow steadily stronger throughout the 1990s and beyond. The following list, focusing on big bang fundamentals, shows how these predictions fared.

1. Exhaustive testing has affirmed general relativity as the best proven principle in physics,[22] and the space-time theorems derived from general relativity establish a "singular" beginning for all the matter, energy, space, and time in the universe.[23] These theorems attest that the universe came into existence from a source or causal agent existing beyond matter, energy, space, and time.
2. Today, a whole family of more general space-time theorems exists.[24] These theorems apply to any universe that expands (on average) throughout its history.[25] They are applicable to all life-permitting inflationary hot big bang cosmic models (models wherein the effect of general relativity is augmented by a "scalar field" that expanded the universe at many times the velocity of light during a brief period when the universe was younger than a quadrillionth of a quadrillionth of a second old) as well as all life-suitable quantum gravity models. All reasonable cosmic models, wherein physical life is at least possible, are subject to the relentless grip of the space-time theorems.
3. Stable orbits of stars, planets, and moons have proved essential to the survival of physical life. Given the law of gravity, this stability is possible only if the geography of the universe is defined by three large space dimensions that expand rapidly for at least several billion years.[26]
4. Distant galaxies (seen at an earlier epoch in cosmic history) appear closer together in direct proportion to their distance from us.[27]
5. Distant stars and galaxies appear younger (seen at earlier developmental stages) in direct proportion to their distance from us.[28]
6. Quasars really are super-energetic compact sources (bodies) in the nuclei of giant, youthful, very distant galaxies.[29] Therefore, they reflect the early history of the universe. The numbers, distances, spectra, and luminosities of quasars are consistent with a universe that has been continuously expanding for 14 billion years.
7. Hypernovae, gamma-ray bursts, first-, second-, and third-generation stars are detected in the abundances and locations that the big bang theory predicts.[30]

8. The surface brightness variations that astronomers observe in the images of globular clusters and galaxies provide accurate measures of these objects' distances and ages. These measurements match the predictions of the big bang creation model.[31]
9. Astronomers observe stars with masses ranging from a tenth of the solar mass to a few dozen times the solar mass in stable burning states. This observed stability indicates that the universe is expanding at a highly fine-tuned rate. If the universe were expanding too quickly, no stars would have formed at all. If it were expanding too slowly, only black holes and neutron stars would have formed.[32]
10. The cosmic background radiation measured at great distances from Earth (thus, further back in time) proves hotter than such radiation in Earth's vicinity. In fact, the temperature is higher in direct proportion to the distance at which that radiation is measured and is consistent with continuous cosmic expansion for the past 14 billion years (see figure 13).[33]
11. The abundance of elements heavier than helium decreases in proportion to the distance from Earth. This pattern can be explained only by a universe that continuously expands and cools over the course of several billion years from an initially hot creation event.[34]
12. The abundances of helium, deuterium, and lithium observed in the universe can be explained only by a universe that continues expanding from an initial state of near-infinite density and temperature.[35]
13. The angular sizes and amplitudes of temperature variations seen in maps of the cosmic background radiation precisely fit what a big bang creation scenario would predict.[36]
14. The measured density of protons and neutrons in the universe matches the prediction arising from the hot big bang creation scenario.[37]
15. The "Hubble time," that is, the cosmic expansion time, or age of the universe, determined from maps of the temperature fluctuations in the cosmic background radiation and from direct distance and redshift measurements of distant galaxies (see "Redshift Velocities" in chapter 14), proves consistent with the measured age of the oldest stars, the measured abundance of long-lived radiometric elements, and the measured temperatures of the cosmic background radiation in distant gas clouds.[38]
16. By means of the Tolman test, astronomers have established that the redshift measurements of distant galaxies arise from a general cosmic expansion rather than from some unknown property of matter or from hypothesized interactions between light and matter as light travels through space (the

"tired light" hypothesis).[39]

17. The 10- to 25-percent-longer decay times of distant supernova light intensity (the time taken by an exploding supergiant star to transition from maximum to minimum brightness) affirm that supernova redshifts are attributable to Doppler-effect velocities. These velocities demonstrate that the universe has been continuously expanding for at least the past 10 billion years.[40]
18. Big bang theory explains the observation that the cosmic background radiation is slightly hotter in one direction of the heavens than in the opposite direction. This effect, according to the theory, would result from Earth's motion relative to the background radiation. Recently, independent teams showed that Earth indeed moves, relative to very distant galaxies, in the approximate direction and at the velocity observed and measured.[41]
19. For galaxies and stars to form out of the tiny temperature differences in the radiation released by the creation event, that cosmic background radiation must exhibit a certain level and distribution of polarization. Astronomers can now detect both the level and distribution of polarization predicted by the big bang.[42]

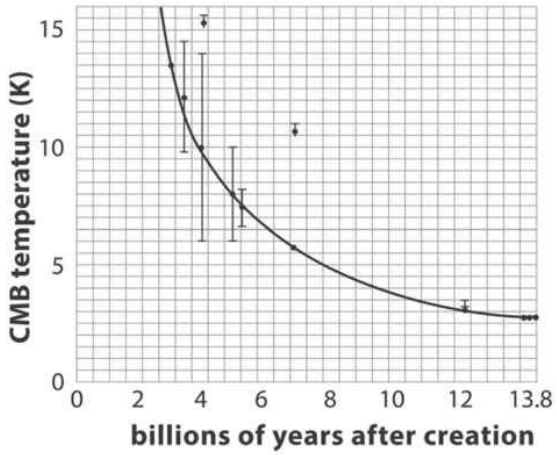


Figure 13: Evidence for Big Bang Model's Predicted Cooling
Today, the temperature of the radiation left over from the cosmic creation event measures 2.72548 ± 0.00057 K above absolute zero. This graph shows temperature measurements of that radiation from nine different past epochs of the universe's history. The measurements at 7.4 billion years after creation and 13 billion years after creation have error bars too small to depict. The downward errors show upper limit measurements. Superimposed on this graph is the temperature cooling curve predicted by hot big bang models. Credit: Reasons to Believe

Scientific evidence for the big bang has grown exponentially during the 1990s and the early part of the twenty-first century.[43] As *Astronomy* reported, "All roads of evidence lead to the Big Bang" and "no other theory even comes close" to the evidential base supporting it.[44]

During the next decade, a new generation of advanced telescopes and other instruments will be dedicated to research on cosmic origin and development. The already overwhelming evidence for this creation event will likely increase. Big bang verification should be eagerly embraced by Christians as a ray of sunshine, not a cloud, over our faith. We can enthusiastically welcome the breadth and depth of scientific research as powerful aids in convincing nonbelievers that God exists and that the Bible is His accurate, authoritative Word.

As further explored in the next chapter, this same type of scientific verification can help determine which creation-date interpretations are viable and which are not.

Chapter 14

Scientific Signs of Old Age

Gray hair, liver spots, and frailty are common signs of old age in humans. The scientific indicators for the "old age" of creation are even more abundant and definitive than those for humans. Hundreds of reliable markers demonstrate that creation (except for the human species) is *old*. In one of the most amazing breakthroughs of the past hundred years, technology has granted researchers the capacity to measure the size and age of the cosmos. Our generation can see what no other generation has been privileged to see: a remarkable detailed portrait depicting the creation miracle recorded in Genesis 1:1. This portrait supports and amplifies biblical creation chronology, but for now let's focus on the timing of that initial wonder.

Four Simple Methods

Given today's technology, the universe of stars and galaxies is as simple a system to measure and interpret as almost any other physical system. Stars are comprised of gases (primarily hydrogen and helium) right through to their cores. They are so far apart that they can be treated mathematically as points. Stars and galaxies move in the near-perfect vacuum of outer space, and their dynamics can be understood and accurately predicted simply by applying the laws of gravity.

From straightforward physics—gas laws, gravitational laws, thermodynamics, and nuclear physics—come secure estimates of the age of stars, galaxies, and the cosmos itself. Though familiarity with physics helps, the nonscientist can understand at least some aspects of how scientists arrived at these age determinations.

The four most easily understood methods for age-dating the universe involve the expansion of the universe, cosmic background radiation temperatures, stellar burning processes, and the cosmic abundances of radioactive elements.

Expansion of the Universe

As the preceding chapter documents, the Bible speaks of how God's own hand "stretches" out (that is, expands) the universe.[1] By carefully measuring how much the galaxies' spectral lines shift toward the longer wavelength, or the red

end of the spectrum (see “Redshift Velocities”), astronomers can determine how rapidly the space-time fabric of the universe stretches, or expands, from the creation event. They see that the farther away a given galaxy is, the faster it moves away from us. These observations tell us the universe is expanding outward from a beginning in space and time.

Spectral-line redshifts arise from the velocities of the galaxies relative to us, rather than from some unknown property of matter or from “tired light” (the hypothesis that the space-time fabric of the universe is static and the spectral-line redshifts of galaxies result from photons losing energy as they travel through space). This fact can be proved in three independent ways. The first is to use a surface brightness test called the Tolman test.[2] The second is to measure the decay time of distant supernova light curves and the duration of gamma-ray bursts to see if there is any “relativistic time dilation” (the special theory of relativity states that clocks moving at high velocities relative to Earth will tick less rapidly in proportion to the velocities they are traveling). The third is to see if galaxies far away (hence, seen further back in time) are more crowded together than nearer galaxies.

Redshift Velocities

The lines that astronomers see in a galaxy’s radiation spectrum indicate the wavelengths at which certain elements and compounds in the galaxy either emit or absorb light. If a galaxy is moving toward us, the wave crests become bunched together and thus appear at shorter, or bluer, wavelengths. If a galaxy is moving away from us, the wave crests become stretched out and thus appear at longer, or redder, wavelengths. Measuring the amount by which a galaxy’s spectral lines shift toward redder wavelengths determines the velocity at which that galaxy is moving away from us. In the same manner as dots on an expanding balloon move apart faster the farther apart they are, so too, in an expanding universe, the faster galaxies move away from us (hence, the greater their redshift) the farther away they are.

Richard Tolman proposed a straightforward way to test astronomers’ theory of redshifts back in 1930. But the technology to carry out that test did not exist until many decades later. In fact, the desire to carry out a definitive Tolman test was one reason for building the Hubble Space Telescope (HST).[3] In 2001, Lori Lubin of Caltech and Allan Sandage of Carnegie Observatories finally fulfilled

Tolman's dream. They obtained and published results convincingly demonstrating that the universe has continuously expanded for billions of years and that the measured redshifts of galaxies reliably determine the rate of cosmic expansion.[4] (See "Why the Tolman Test Proves Cosmic Expansion.") In 2010, Sandage published a much improved Tolman test confirmation of the cosmic expansion rate.[5]

The second cosmic expansion test springs from the fact that radiation from an exploding supergiant star (a supernova) takes a certain period of time to transition from maximum to minimum brightness. According to Einstein's special relativity, this time period stretches in proportion to the supernova's velocity relative to the observer. Several different teams have observed this relativistic time dilation effect in distant supernovae. These observations show that the universe has been continuously expanding for at least the past 10 billion years.[6]

The third test arises from images of galaxies at different distances. HST images reveal a tight correlation between the average proximity of galaxies to one another and the distance of those galaxies from us. At a distance of 10 billion light-years, which corresponds to a lookback time (that is, the time it takes light to travel from a distant galaxy to Earth) of 10 billion years, spiral galaxies are jammed so tightly together that they are ripping spiral arms off one another by gravity.

Why the Tolman Test Proves Cosmic Expansion

The Tolman test is robust because of its independence from other cosmological "interference" factors. Surface brightness is simply an astronomical object's luminosity divided by its radius squared. Any "distorting" geometric effects, such as space curvature, would impact the luminosity and radius measures identically. Thus, all such effects cancel each other out. Another reason the Tolman test is robust is because it predicts an enormous difference in results between an expanding universe and a nonexpanding universe. The surface brightness of identical objects in an expanding universe would be far less than that of identical objects in a nonexpanding universe. (It would be less by [1 + z] cubed. The "z" in each case is the redshift of an astronomical object.)

At a distance of 5 billion light-years, corresponding to 5 billion years ago, astronomers observe that galaxies are farther apart, distant enough from one

another that collisions between galaxies are much less frequent. For nearby galaxies, corresponding to a more recent era, galaxies are even farther apart, making collision events rare. Only in a universe that continuously expands from a creation event (from an infinitesimal volume) would astronomers see the average distance between adjacent galaxies continuously increase through time (see figure 14.1).

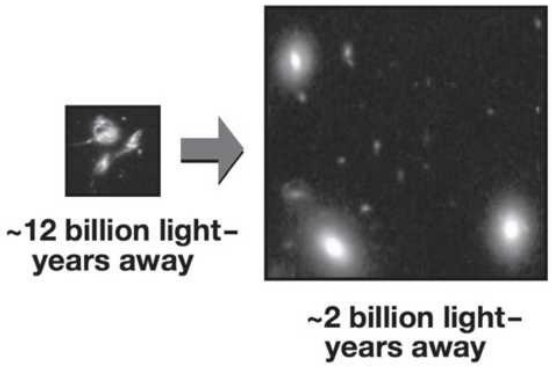


Figure 14.1: Galaxies Spreading Apart
The two HST images above are displayed at the same angular scale. The galaxies in the left image are jammed together so tightly that they are tearing spiral arms away from one another. The galaxies in the right image have spread so far apart that this phenomenon now rarely occurs. With a constant velocity of light, the lookback time in the left image is about 12 billion years compared to about 2 billion years for the right image. In addition to the stretching apart of galaxies in the intervening 10 billion years, the galaxies on the right compared to those on the left show obvious signs of aging. They are bigger due to mergers and yellower due to longer epochs of stellar burning. Credits: NASA/ESA/Hubble Heritage Team (STScI/AURA)

Validating Distance Measurements

Young-earth creationists have challenged astronomers' abilities to make accurate, reliable distance measurements to galaxies.[7] One such author wrote, "Faulty distances mean that any theory based on them—such as the big bang—is faulty too!"[8]

The faulty distance charge arises from the fact that astronomers have relied on indirect rather than direct distance measurements to galaxies. Direct measurements involve no assumptions about the nature of the astronomical object or the value of the constants of physics. They rely simply on plane geometry theorems. For example, if one knows the length of the base of an isosceles triangle, then measurements of the angles at either end of the base will deliver the distance to the vertex of the triangle.

But the length of the base and sizes of the angles are typically so tiny that accurate direct distance measurements can be made only for stars a few hundred light-years away. These few direct measurements must then be used to calibrate the indirect measurements. Because this "ladder" of indirect distance measuring

methods has been used to reach far out into space, young-earth creationists have questioned astronomers' capacities to reliably measure distances to galaxies and, hence, to unambiguously determine the age of the universe.

Recently, astronomers have overcome this limitation. Instead of Earth's orbit about the Sun as the triangle base, they can now use the diameters of orbits of maser sources about the central black holes of galaxies. Here, the base of the isosceles triangle is nearly a million times longer. Also, instead of optical telescopes a few tens of feet in diameter, they now can use an array of radio telescopes linked together as an interferometer to gain the angular resolving power of a telescope thousands of miles in diameter.

Very Long Baseline Array measurements of masers orbiting galaxies' central black holes have yielded direct distance measurements to the center of our Milky Way Galaxy[9] and to the centers of the galaxies NGC 4258,[10] UGC 3789,[11] and NGC 6264.[12] The measured distances are 26,000, 23,000,000, 162,000,000, and 470,000,000 light-years, respectively, with direct distance measurements to five additional galaxies soon forthcoming.[13] By establishing direct distance measurements out to 470,000,000 million light-years, there is no basis for doubting astronomers' indirect distance measuring methods, or that redshifts reveal actual distances to galaxies, or that the universe has continuously expanded (since the cosmic creation event) at a rate that varies by no more than about one percent.

These three different cosmic expansion tests show that galaxy redshifts really do indicate how rapidly galaxies are moving away from us. So, careful measurements of the distances to galaxies, combined with their redshift values, tell astronomers the rate of cosmic expansion. From this rate, they can then calculate how long the universe has been expanding (see "Cosmic Expansion Time").

With the trustworthiness of astronomers' galaxy redshift and distance measurements for determining cosmic expansion rates now established beyond reasonable doubt, the more such accurate measurements astronomers can accumulate, especially at large galaxy distances, the more precise their cosmic expansion rate determination can be. The latest and best efforts by astronomers are displayed in table 14. The consistency of the three independent methods is remarkable.

The reciprocal of the cosmic expansion rate (with slight adjustments arising from the values of the cosmic mass density, dark energy density, and geometry of the universe) straightforwardly yields the age of the universe (see "Cosmic

Expansion Time"). The mean (average) age of the universe so deduced is 13.79 ± 0.06 billion years.[14]

This cosmic expansion time turns out to be critical for the existence of physical life. The possibility of stable orbits for stars and planets, a necessity for life's survival, depends on both the cosmic expansion rate and the duration of cosmic expansion (see "Expansion Time for Stable Stars and Planets").

Table 14: Latest Precision Measurements of the Cosmic Expansion Rate

Measuring Method	**Cosmic Expansion Rate** (kilometers/second/megaparsec)
masers in UGC 3789 (direct distance method)[15]	68.9 ± 7.1
masers in NGC 6264 (direct distance method)[16]	68 ± 9
cosmic background radiation temp. fluctuations (WMAP)[17]	69.32 ± 0.80
cosmic background radiation temp. fluctuations (Planck)[18]	67.3 ± 1.2
Cepheids/Type Ia supernovae[19]	67.97 ± 2.27
mean value	**68.30 ± 0.81**
inferred age of the universe (WMAP)[20]	13.772 ± 0.059 Gyr
inferred age of the universe (Planck)[21]	13.813 ± 0.047 Gyr

Cosmic Background Radiation Temperatures

Astronomers can calculate how long the universe has been expanding by measuring the degree to which radiation from the creation event (called the cosmic microwave background radiation, or CMB) has cooled down (see chapter 13, item #10 in the list of big bang fundamentals and figure 13).

For example, picture an array of thermometers placed a certain distance from an open 400° oven, now turned off. The temperature measurements and the temperature differences from one thermometer to the next would tell us how long the oven door has been open. In the same way, astronomers can determine cosmic age by measuring radiation temperatures.

Suppose thousands of thermometers surrounded the oven—each one placed

exactly 10 feet from the center of the oven cavity. Suppose also that sometime after the oven had been heated, turned off, and its door opened, each thermometer indicated exactly the same temperature. The only reasonable conclusion would be that the heat flow from the oven cavity to the room totally dominated the normal, temperature-disturbing airflows in the room. Such dominance would imply that the original temperature of the oven cavity must have been *much* greater than the room's temperature. If all those thousands of thermometers indicated a very low temperature, we would conclude that considerable time had passed since the opening of the oven door.

Cosmic Expansion Time

The cosmic expansion rate determines the universe's age. The cosmic expansion time, or age of the universe, equals the distance to any faraway galaxy divided by the velocity indicated by its redshift. However, the gravitational pull of different massive bodies on one another acts as a slight brake on cosmic expansion. This braking effect gets weaker as the universe gets older and as the massive bodies move farther apart from one another. On the other hand, the space-energy density (aka dark energy density) that slightly accelerates cosmic expansion gets stronger as the universe gets older and as the space surface of the universe grows larger. The geometry of the universe also affects (slightly) cosmic expansion as the universe ages. Only recently have astronomers successfully determined these tiny correction factors so that they can convert cosmic expansion measures into a very accurate measure of the universe's age.[22]

Expansion Time for Stable Stars and Planets

Planetary stability under gravity's influence demands that the three dynamic space dimensions (length, width, and height) reach a certain size—significantly unwound from their original tight curl.[23] Otherwise, galaxies would be so close together as to wreak havoc on stellar orbits, and stars would be so close together as to wreak havoc on their planets' orbits. Galaxies too close together collide, and close encounters catastrophically disturb stars' orbits. Likewise, when stars are too close together, their mutual gravitational tugs catastrophically disturb the orbits of any planets that may surround them.

The three dimensions of space must expand at a particular rate. A universe that expands too slowly will produce only neutron stars and black holes.[24] A universe that expands too rapidly will produce no stars at all and thus no planets

and, of course, no stable orbits.[25]

The simple fact is this: we observe that galaxies, stars, and planets exist, and with adequate stability in at least one place to allow humans to exist and observe them. This stability, in itself, argues for a universe that has been expanding for at least 10 billion years.

Now, like the temperatures of our room thermometers, the CMB temperature is the same, varying less than 1 part in 10,000. Tiny irregular temperature differences do show up at levels of 1 part in 1,000,000 to 1 part in 100,000. Recently, astronomers measured these slight CMB temperature fluctuations (both their angular sizes and amplitudes) with great precision. In doing so, they first refined the accuracy of their cosmic age determinations to ± 0.435 percent.[26] Such calculations show that the universe was created 13.79 ± 0.06 billion years ago.[27]

There is no escaping the precision, rigor, and trustworthiness of this cosmic age determination. The only condition upon which it rests is that the universe departs by no more than a percent or two from a perfectly flat geometry. The CMB temperature fluctuations themselves establish that the universe manifests a flat geometry (see figure 14.2). The fifteen-month data from the Planck measurements and the nine-year data from the WMAP measurements of the CMB set the following limits on the curvature density of the universe, Ω_k, where $\Omega_k = 0$ defines perfect flatness:

$$-0.0075 < \Omega_k(\text{Planck}) < 0.0052$$[28]

$$-0.0011 < \Omega_k(\text{WMAP}) < 0.0066$$[29]

Data from measurements of the cosmic expansion rates as well as from the Sloan Digital Sky Survey and the Six Degree Field Galaxy Survey enable astronomers to place much tighter limits on the geometric shape of the universe. In 2011, the Supernova Legacy Survey team demonstrated that $\Omega_k = -0.002 \pm 0.006$.[30] In 2012, the Hubble Space Telescope Cluster Supernova Survey team determined that $\Omega_k = 0.002 \pm 0.005$.[31] A combination of these two results establishes (within three places of the decimal) that the universe possesses a flat geometry. Thus, astronomers can say with considerable certainty that the universe was created about 13.79 billion years ago.

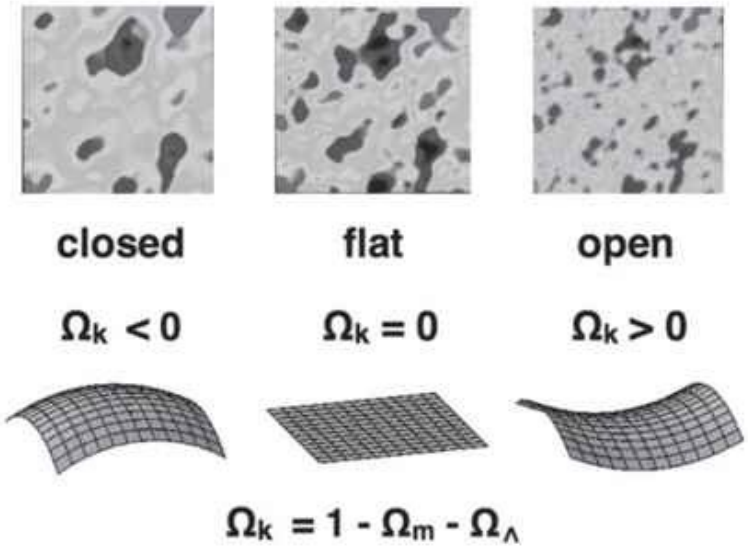


Figure 14.2: Geometric Shape of the Universe
The angular size of the temperature fluctuations in the CMB radiation reveals the shape of the universe's space surface. For a closed geometry (akin to a spherical shape) the spots would be larger than about one degree across. For a flat geometry the brightest (hottest) microwave background temperature fluctuations (spots) would be about one degree across. For an open geometry (akin to a hyperbolic shape) the spots would be smaller than about one degree across. The geometry of the universe is defined by the curvature density parameter, Ω_k, which is 1 minus the sum of the cosmic mass density, Ω_m, and the cosmic space-energy density, Ω_Λ (aka dark energy density). Galaxy survey maps and measurements of cosmic expansion rates independently establish the universe's geometry by determining the values of Ω_m and Ω_Λ. Credit: NASA

A method for measuring the time back to the cosmic creation event that is less precise, but much more understandable for most laypeople, is watching the radiation from the creation event cool down. That CMB temperature for the present epoch is 2.72548 ± 0.00057°C above absolute zero (or about -455°F).[32] The fact that the CMB is now so cold implies that the universe must have been cooling down for billions of years. Recently, astronomers measured the CMB temperatures in several distant gas clouds and galaxy clusters. They note that the more distant the gas cloud or galaxy cluster, the hotter the CMB temperature. Since greater distance corresponds to a greater look-back time, astronomers can directly observe how the universe is getting colder and colder as it gets older and older. Seven temperature measurements span look-back times from 98 to less than 25 percent of the universe's present age. The temperature curve is consistent with a cosmic creation event dated at about 14 billion years ago.[33]

Stellar Burning

When we light a fire in a wood-burning stove, smoke without flames tells us that

an infant fire is struggling to ignite. As the fire catches and grows hotter, the smoke clears and bright yellowish-orange flames appear. As the remaining wood burns, the flames begin to die, leaving charred black chunks and glowing embers, indicators that the fire is going out. With good information about the characteristics of the wood, ambient humidity, air pressure, air temperature, and air circulation, a crude estimate can be made (based on the color, brightness, and temperature of the fire) about how long the fire has been burning.

The duration of stellar burning can be measured with far greater precision. A star's composition is much simpler than that of wood. A star is 97 to 98 percent hydrogen and helium and contains no molecules. It is 100 percent gas—no liquids or solids. A star's external environment is a near-perfect vacuum. Its burning mechanism (nuclear fusion) is well understood and experimentally confirmed. Unlike a piece of burning wood, stars strictly obey thermal and hydrostatic equilibrium. Because stars are such simple systems, if astronomers know the mass of a star, they can determine its age with high precision based on measurements of the star's color and brightness.

Astronomers have measured the colors and brightness of millions of stars. Through these observations, they've found the range of ages for stars from the youngest to the oldest. With straightforward determination of how long the universe would need to expand before stars could begin to form, astronomers add the age of the oldest stars to the time necessary for the onset of star formation (95–470 million years, depending on the star mass and the local gas density[34]) to discover the universe's age. The latest cosmic age determination based on stellar burning alone is 13.7 ± 0.4 billion years.[35] The largest uncertainty in this cosmic age figure lies in the measurements of distances to the relevant star clusters. An observing program is under way to reduce this uncertainty.[36]

A significant clue that the universe must be much older than several thousand years comes from the instability of young stars. A star begins when a gas cloud collapses under gravity's influence. During the collapse phase, the star at times accretes (gathers) gas and dust and at other times loses gas and dust to outer space. During this time, certain nuclear reactions can turn on and off at different places on and within the star. Also, large unstable spots can form on the star's surface. Thus, in this infant period (which for a star as massive as the Sun lasts 50 million years), the star's luminosity remains highly unstable.[37] During the next few hundred million years, a solar-type star's luminosity variability substantially subsides but still persists.[38] Also, its ionizing radiation (hard UV and soft X-rays) remains at a deadly level—50 times higher than that of a

middle-aged star.[39] (The extreme instability of the infant Sun's luminosity and the intensity of the juvenile Sun's ionizing radiation are two of several reasons why life could not have survived on Earth until the Sun was at least a few hundred million years old.)

Some young-earth creationist leaders argue that God must have created all stars in a mature state.[40] This concept manifests two problems. First, it insinuates that God created stars already partly burnt with all the ashes and decay characteristics of stars hundreds of millions of years old. God would thus be deceiving us into thinking the universe is old when in fact it is young. Second, astronomers observe stars in various stages of infant and juvenile development throughout our galaxy and in other galaxies. In fact, astronomers observe the entire range of star development—from newborn to infant, to juvenile, to middle-aged, to old, to completely burnt out—with ages ranging from a few days to nearly 13.5 billion years. They even see preborn stars.[41]

Another indicator that the universe is older than a few thousand years is that all the galaxies astronomers see, adding the look-back times, fall within the same relatively narrow age range: 9 to 13 billion years old. (The universe is slightly older than the oldest galaxies because it took those galaxies some time to form.) Nearly 30 years ago, American astronomer Donald Hamilton determined that all the galaxies formed in roughly the same era.[42] Except for the aftermath of collisions between mature galaxies, astronomers see no newborn or young galaxies nearby (corresponding to the recent era). Neither do they see any extinct galaxies.

Stellar Cooling

A wood-burning fire reaches a point at which all the fuel in the wood has been exhausted. That's when the fire transforms from dancing yellow flames to slowly cooling embers. As the embers cool, their color changes from orange to red to infrared and finally to none. Meanwhile, the luminosity of the embers slowly diminishes.

Stars behave in the same way. When they run out of nuclear fuel, they cool down and their luminosity lessens. As with embers of a once-burning wood fiber, the color and luminosity of the most common kind of burnt-out star tells astronomers how long the cooling has continued.

Astronomers observe three kinds of burnt-out stars: black holes, neutron stars, and white dwarfs. White dwarfs are the final state of all stars possessing less than enough mass to become either black holes or neutron stars.

Four factors combine to make white dwarfs excellent chronometers. First,

they represent the general stellar population. Most stars—97 percent—have or will become white dwarfs. Second, they are a homogeneous population within a narrow mass range (between 0.4 and 1.1 solar masses). Most possess a dominant carbon-oxygen core overlayed with thin surface layers of helium and hydrogen (some have a helium core overlayed with a thin hydrogen surface layer). Third, they manifest high surface gravity, low rotation rates, small magnetic fields, and nuclear and gravitational energy generation rates near zero. Fourth, the absence of energy sources other than residual thermal energy implies that the evolution of a white dwarf is a simple cooling problem. The resultant cooling curves (plots of white dwarf surface temperature over time, specific to mass) give astronomers trustworthy clocks they then can use to date the ages of star clusters and galaxies.

The fact that white dwarf stars exist at all attests to the great age of the universe. A star takes millions of years, minimum, to burn up all of its nuclear fuel and become a white dwarf. On the other hand, the complete lack of any black dwarf stars anywhere in the universe indicates that the universe must be younger than a hundred billion years. Evidently, the universe is not yet old enough for any white dwarf star to cool completely.

Seven to eleven percent of all stars within the local volume are white dwarfs.[43] The percentages in globular star clusters are typically higher.[44]

Astronomers can determine the ages of both globular and open clusters by measuring the "bottom of the white dwarf cooling sequence"[45] for the star clusters. That is, by measuring the luminosity and color of the coolest white dwarfs in the clusters astronomers can ascertain how long the white dwarfs have been cooling.

The cool-down time for the oldest white dwarfs exceeds 10 billion years. Measurements of the bottom of the white dwarf cooling sequences for the globular clusters M4 and NGC 6397 tells us that they are 11.6 ± 0.6 and 11.47 ± 0.47 billion years old, respectively.[46] These ages are consistent with those derived from stellar burning for both clusters. Adding the formation times for both clusters relative to the cosmic creation event yields an age for the universe equal to about 13.8 billion years.

Recently, astronomers determined the rate of cooling for the white dwarf ZZ Ceti.[47] Measuring the physical features of an individual white dwarf plus its cooling rate yields its age. In the case of ZZ Ceti the results are consistent with measurements of the bottoms of white dwarf cooling sequences in star clusters.

Observational and theoretical programs currently under way promise to deliver high precision age determinations based on white dwarf cooling

sequences for several globular star clusters and for white dwarfs found in the Sloan Digital Sky Survey.[48] The goal is to provide a measure of the universe's age that would be of equivalent accuracy and reliability to that derived from the temperature fluctuations in the cosmic background radiation and from measurements of cosmic flatness.[49]

Like white dwarfs, neutron stars are burnt-out stars. As with white dwarfs, the very existence of neutron stars establishes that the universe must be old. Like white dwarves, neutron stars cool as they continue to age. For stars that have recently collapsed to become neutron stars, magnetospheric emission is observed to be dominant. Middle-aged neutron stars that have been spinning down for 10,000 to 1,000,000 years manifest significant surface thermal emission. Old neutron stars are too cold to have thermal X-ray emission from the stellar surface. Recently, astronomers reported on X-ray observations and spin down rate measurements that established the radio pulsar, J0108-1431, to be 166 million years old.[50]

Abundances of Radioactive Isotopes

Supernovae—supergiant stars in their final, powerfully explosive stage of burning—occurred much more frequently in the past. They are the only entities in the universe (outside nuclear physics laboratories) with the matter and energy densities to produce radioactive isotopes (the isotopes of a certain element all possessing the same number of protons per atom but different numbers of neutrons) heavier than iron.

Since radioactive decay proceeds according to well understood measurable processes, scientists can use the relative quantities (abundances) of various radioactive isotopes in the universe to estimate how much time has passed since they were produced in that period of greatest supernova activity. (Each supernova produces a fixed amount of radioactive isotopes.) Scientists know the universe cannot be older than a certain age because some radioactive isotopes still exist. Uranium-238 and thorium-232, for example, each with a radioactive half-life (the time required for half of the existing available atoms of a radioactive isotope to break down or decay into lighter isotopes) of several billion years, are still abundant. Therefore, scientists know the universe cannot be older than a few hundred billion years. If it were, all this uranium and thorium would have decayed into lighter elements.

On the other hand, the universe cannot be very young because most radioactive isotopes have decayed away. Those isotopes with half-lives of millions of years or less are gone. (The exceptions are decay products of long-

lived radioactive isotopes and short-lived radioactive isotopes generated by local or cosmic radiation.) For example, the longest-lasting isotopes of technetium have half-lives of 2.6 and 4.2 million years. Technetium has been detected in a few young stars and in some recently exploded supernovae. This element and many other radio isotopes with half-lives less than 50 million years are completely gone,[51] however, from both the Sun and Earth.

Other radiometric elements missing on Earth include protactinium, neptunium, plutonium, americium, and curium and the isotopes aluminum-26, calcium-41, and iodine-129. Missing radioactive elements and isotopes (see the next chapter) tell us that enough time has elapsed for these elements and isotopes to decay away. Therefore, the Sun and Earth must be at least a billion years old. The holes in Earth's periodic table fall precisely where such an age predicts they would.

The amount of each radioactive element produced by the early supernovae can be precisely determined by measuring the identical processes in nuclear physics experiments. And by comparing the relative elemental abundances of very distant supernovae with those of nearby supernovae, astronomers can confirm that the quantities of radioactive elements produced in past events are the same as in recent events. By comparing how much of each radioactive element still exists with the amounts that must have been produced by supernovae during the epoch when so many exploded, scientists can tell how much time has passed. As in the case of stellar burning, astrophysicists simply add that time to the time required for the first supergiant stars to form (about 300 million years[52]) to get a date for the beginning of the universe.

Astronomers obtain their most accurate radiometric dates for the universe by measuring the amounts of uranium and thorium in very metal-poor, low-mass stars. Since metals are manufactured only in supernovae, a very low metal abundance implies that the star must have formed at the same time as the first supernova eruptions. (See "Why Metals in the First Small Stars?") Since low-mass stars take 20 billion years or more to burn up all their fuel, astronomers expect to still see them today, and they do. The presence of both uranium and thorium in such stars gives astronomers two independent chronometers. For the star HE 1523-0901 astronomers used measurements of the ratios of uranium to thorium, uranium to iridium, thorium to europium, and thorium to osmium to establish an age for the star = 13.4 ± 0.8 billion years.[53] Adding the calculated 300–400 million years for this star to form (after the cosmic creation event) yields an age for the universe consistent with determinations based on the cosmic background radiation, cosmic expansion measures, distribution of

luminous red galaxies, stellar burning, and stellar cooling.

Why Metals in the First Small Stars?

The first stars formed from gas that was entirely metal free. (Astronomers refer to all elements heavier than hydrogen and helium as “metals.”) Among these, supermassive stars formed much more rapidly than smaller ones. The largest first-generation stars condensed out of gas clouds, ignited, burned, exploded, and ended up as black holes in a total time span briefer than a few hundred thousand years. However, the smaller first-generation stars took several million years just to condense from their gas clouds. Therefore, even though the primordial gas clouds started off devoid of any metals, by the time they had collapsed enough to form small stars, they had already been sprinkled with the ashes of those first supermassive stars.

These initial ashes have a well-defined signature of metallicity (very low abundance of metals relative to stars that form later) that makes it easy for astronomers to identify these first-formed stars. Because small stars can burn for 20 billion years, they are still visible today. The big bang model predicts that about 10 of these stars should exist within 1,600 light-years of the Sun.[54] Astronomers, indeed, are discovering the predicted number of stars with the predicted very metal-poor signature.[55]

The new generation of super telescopes will enable astronomers not only to make radiometric age measurements on dozens of extremely metal-poor stars but also to determine more accurately the formation times for the respective stars relative to the cosmic creation event. Once astronomers achieve those measurements and determinations, they will possess a radiometric age for the universe as accurate as the one based on the temperature fluctuations in the cosmic background radiation and demonstrations of the universe’s flat geometry.

Age of the Universe

How does the current creation date measurement compare with earlier age determinations? In 1991, the best available measurements produced a date of 16 ± 3 billion years.[56] In 2001, scientists updated the measurement to a date of 14 ± 1 billion years[57] Today, they measure it to be 13.79 ± 0.06 billion years old.[58] The increasingly precise dates determined by astronomers trouble atheists intent on explaining life by natural means alone. The dates are too recent.[59] But at the same time, they’re far too ancient to help creationists intent on defending a six-

consecutive-24-hour-creation-days interpretation of Genesis 1.

For an independent evaluation of scientific evidence for a billions-of-years-old versus a thousands-of-years-old universe by a panel of evangelical Christian astronomers agreed upon by both a young-earth and an old-earth astronomer, see chapter 22. The rigor and consistency of all this scientific evidence for an ancient universe and Earth make it difficult, most would say impossible, for young-earth creationist scientists to hold their ground. However, when confronted with this evidence, their typical approach is to stir up doubt that old-earth scientists are competent in understanding their measurements. The next chapter gives a sampling of their challenges—and of old-earth scientists' replies.

Chapter 15

Challenges to an Old Cosmos

Most astronomers and physicists consider the scientific evidence (summarized in the previous chapter) for a billions-of-years-old universe and Earth so compelling that they wonder how anyone could believe the universe or Earth is young. They probably aren't aware of how often and emphatically young-earth creationist seminars, speakers, and writings bombard church and school audiences with their eleven challenges to an ancient cosmos. These challenges are described below, along with replies from science.

Common Challenges

Challenge 1: **Astronomers lack reliable distances to stars and galaxies.**

Reply: This charge implies that astronomers determine distances to galaxies and faraway stars by unreliable, *indirect* means only. Young-earth creationists claim Earth-based trigonometric parallaxes (a direct triangulation distance-measuring method similar to that used by surveyors, see "Triangulation Distance Measures") provide accurate distance measurements out to only a few hundred light-years. Thus, they conclude that astronomers cannot use their distance measurements to reliably determine the age of the universe.[1]

Contrary to these assertions, however, astronomers' direct distance-measuring capabilities do not stop at a few hundred light-years. Thanks to the Hipparcos satellite, astronomers have obtained precise trigonometric parallaxes to several globular clusters.[2] These clusters are thousands to tens of thousands of light-years away. Similarly, radio astronomers have used very long baseline interferometry (a technique employing multiple telescopes in unison) to measure accurate trigonometric parallaxes to pulsars as far away as 23,500 light-years[3] and to water and methanol masers as distant as 17,200 light-years.[4] Astronomers have used the Very Large Array and the Hubble Space Telescope to measure expansion parallaxes to planetary nebulae as distant as 22,500 light-years.[5] The potential exists to use planetary nebulae in the Virgo Cluster core to extend

expansion parallaxes out to 50 million light-years.[6]

Triangulation Distance Measures

All triangulation distance-measuring methods are based on the familiar plane geometry theorem: knowledge of the length of a triangle's base and of the angles at both ends of it yields the distance to the triangle's vertex (point) opposite the base. For trigonometric parallax measurements, the triangle's base is the diameter of Earth's orbit. For other astronomical triangulation distance measurements, the triangle's base is (for example) the diameter of a star's orbit around another star, the diameter of a maser source's orbit about a galaxy's central supergiant black hole, or the diameter of a shell of gas exploded from a supernova. Accurate direct triangulation measures of the distances to four galaxies—the Large Magellanic Cloud,[7] NGC 4258,[8] NGC 1637,[9] and M100[10]—show that the light from these galaxies has taken 160,000 years, 23.5 million years, 24.6 million years, and 54 millions years, respectively, to reach us. In 2013, the Megamaser Cosmology Project published direct distance measurements to the galaxies UGC 3789 and NGC 6264. Researchers determined that UGC 3789 and NGC 6264 are 162 million light-years[11] and 470 million light-years[12] away, respectively, and thus their light took 163 million years and 470 million years, respectively, to reach their radio telescopes. These measurements confirm the accuracy of redshift measurements indicating the distance and cosmic expansion velocity of ancient galaxies and quasars. A triangulation measure for the quasar 3C 279 shows the light from that quasar took at least 5.9 billion years to reach us.[13]

As described in the box above, indirect distance-measuring methods, such as the redshifts of spectral lines and the brightness of Type Ia supernovae and Cepheid variable stars, are sufficiently well calibrated by direct methods to be considered reliable. Astronomers still argue over which indirect method is the *most* reliable, but direct-method calibrations keep the uncertainties of indirect methods below 5 percent (see table 14).

Star size represents another consideration—an important one in this question of true distances. If all stars really are near rather than distant, their faintness would indicate that many are tiny—much tinier than the minimum size necessary for stars to burn.[14] If stars were not distant and yet large enough to burn, another problem would be evident: a "night" sky as bright as day—fine for angelic creatures, perhaps, but deadly for earthly ones and certainly not the

condition of Earth's sky.

Challenge 2: **God could have created light waves already in transit.**

Reply: Most young-universe creationist spokespersons concede that stars and galaxies really are at least approximately as distant as astronomers claim. However, some suggest that light waves did not actually come to us from the stars and galaxies but were set in motion from points along the way between their apparent sources and the earth.[15]

This argument belongs to the appearance-of-age proposition. The problem here is that starlight and galaxy light give direct indications of their travel distances. The spectral lines (light emissions or absorptions at various wavelengths) of stars and galaxies are broadened in direct proportion to the distance the light has traversed. Random motions of gas clouds situated between us and the stars and galaxies cause this effect. The greater the distance, the larger the number of intervening gas clouds and the greater the broadening. Radiation between the spectral lines, called the continuum, grows redder as it travels through interstellar and intergalactic dust. This reddening effect (like seeing the Sun through the smoke of a forest fire) is directly proportional to the amount of dust the light has traveled through and hence indicates the distance light has traveled.

Both theory and observations confirm that the broadening and reddening effects are reliable indicators of light-travel time *and distance*, even up to billions of light-years. If God sent the light of stars and galaxies from points only about 10,000 light-years away (not from the objects themselves), we'd see a broadening and reddening indicative of 10,000 light-years. We do not. What we see indicates light-travel times as great as 12 or 13 billion years.

To suggest that God artificially fixed the broadening and reddening of the light individually from 50 billion trillion stars and over 100 billion galaxies is to imply intentional deceit on a vast scale. As chapter 8 discusses, such action would be contradictory to His revealed character and purpose and to His declaration that creation is a truthful witness.

Challenge 3: **Light may have traveled faster a few thousand years ago.**

Reply: This challenge is among the most popular rebuttals to the voluminous evidence for a billions-of-years-old universe. It has an unusual origin.

An Australian amateur scientist named Barry Setterfield claims that on January 11, 1973, he had a four-hour conversation with God on science-faith issues. The next morning, still puzzled by how long it takes light from distant galaxies to reach us, Setterfield supposedly heard from God again, in the same

voice: “Barry, why do you assume that the speed of light has remained constant?”[16] After more than a dozen years of research and speculation about light’s velocity, Setterfield teamed up with Trevor Norman, a math teacher, to produce a 107-page treatise proposing the following idea: the reason the universe *appears* old is that in the past light traveled much faster than it does today.[17] Given the slowing of light’s velocity, calculations based on the currently observed speed would yield inaccurate measures of the universe’s size and age.

Setterfield and Norman, seeking scientific verification, found it in the data from speed-of-light measurements made over many years. They saw what seemed a slight velocity increase and seized upon it as confirming evidence. However, the data points actually reflect an increasing refinement in the measurements, not a change in light’s velocity.

Ole Rømer, a Danish astronomer, attempted the first calculation of light’s speed in 1675. The figure he arrived at was about 3 percent greater than what modern measurements show. But his calculation’s error bar exceeded 3 percent. Recently, a team of American physicists reworked Rømer’s calculations. They found that if Rømer had obtained more precise data for one part of his calculation, his speed-of-light figure would have agreed with modern measurements to within 0.5 percent.[18]

Setterfield apparently misunderstood the American physicists’ correction. He took their accuracy figure (0.5 percent) as evidence for light velocity’s having decreased by 0.5 percent since 1675.[19] Since Rømer’s day, more than 50 measurements of the velocity of light have been made, and when the uncertainties for each (including Rømer’s) are taken into account, the velocity shows itself constant through the more than 325 years of ground-based measurements.

Velocity-of-light measures actually extend much further back than 325 years ago. When astronomers measure wavelength positions of certain spectral lines in a distant star or galaxy, they are determining the value of the fine-structure constant when the light left that star or galaxy. The fine-structure constant value depends inversely on the value of light’s velocity. Astronomers’ measurements show that the fine-structure constant in galaxies up to 12 billion light-years away differs by no more than 2 parts in 1,000,000 from Earth-based measurements.[20] Astronomers’ measurements, in sum, establish that the velocity of light has remained constant to within 2 parts in 1,000,000 over the past 12 billion years.

Years ago, I published this evidence against a change in light’s velocity.[21] Since then, some young-earth creationist leaders have attempted to escape the evidence against their position by pointing out that the fine-structure constant

also depends on the square of the electron charge value. Thus, they propose that in the past, when light's velocity was supposedly a million times greater than the modern value, the electron charge was a trillion times smaller. Light's velocity, therefore, could change dramatically while the fine-structure constant remained the same, or so they suggest.

Light's Velocity and Life

The possibility of physical life requires the existence of at least one stable star with the mass of the Sun, and the possibility for such a star's existence depends on the constancy of the speed of light. For two other reasons, physical life would be impossible if light's velocity changed significantly during cosmic history. First, even a small change in the velocity of light would radically disturb either the luminosities of stars or the relative abundances of various elements. Since the c in Einstein's famous equation, $E = mc^2$, stands for the speed of light, a change in that value would mean changes in the m (matter) or E (energy) factors or both. If Setterfield and Norman were right, either Adam and Eve would have been incinerated by the Sun's trillionfold increase in heat or the elements essential for building their human bodies would not exist.[22]

An additional reason for rejecting any slowdown in light's velocity comes from the fact that certain life-essential proteins depend on incorporating copper and vanadium, and the process by which these elements are incorporated depends on the stability of light's velocity. Specifically, the manufacture of certain copper and vanadium proteins depends critically on the value of the relativistic dilation factor ({1 − v2/c2}-0.5), which depends critically on the value of the velocity of light. Relativistic time dilation, not too great and not too small, is essential for copper and vanadium to fulfill their critical roles in nervous system functioning and bone development in higher animals.[23]

This escape attempt fails, however, for at least three reasons. First, any change in the electron charge forces a violation in the second law of thermodynamics.[24] Second, the stability of stars depends on a delicate balance between gravity and electromagnetism (and hence the electron charge).[25] Third, the fine-structure constant also inversely depends on the value of Planck's constant (a constant that relates the energy of a photon to its frequency). Any significant change in Planck's constant disturbs the dynamics of stars, making the formation of stable stars either of mass greater than 0.8 solar masses or

smaller than 1.4 solar masses impossible.[26]

Challenge 4: **Light may have taken a shortcut through space.**

Reply: This argument came from young-universe creationist Harold Slusher,[27] who picked up an idea from Parry Moon and Dominae Pencer.[28] In 1953, Moon and Pencer tried to overthrow Einstein's relativity theory. They suggested that while stellar and galactic space is Euclidean (that is, relatively flat geometrically), light, on the other hand, travels in highly curved Riemannian space. In this hypothesized geometric system, light from the most distant galaxies would reach us in just 16 years. Thus, Slusher claimed, the light-travel times of distant stars and galaxies could be consistent with a universe only thousands of years old.

Unfortunately for Slusher, Moon and Pencer never produced the mathematics to support their assumptions.[29] Neither did they address numerous difficulties in their hypothesis. For example, their system implies that light travels to us from stars and galaxies in two different directions. This means we'd see duplicate images of all stars and galaxies. This is not what astronomers observe. In fairness to Moon and Pencer, their paper came out before Einstein's theory of relativity had become as firmly verified and established as it is today.[30]

Challenge 5: **Distant clocks run at faster rates.**

Reply: This challenge seems to have superseded all others in popularity as a rebuttal to the astronomical evidence for an old universe. One reason for its notoriety is that so few understand its complexities.

In 1994, applied physicist and young-universe creationist Russell Humphreys published *Starlight and Time*, in which he proposed that Earth is located at the geographical center of a bounded universe (a universe with finite spatial limits).[31] He described this bounded universe as a collapsing black hole that became an expanding white hole, the aftermath of a black hole so collapsed that all its trapped energy begins to escape via quantum tunneling, (see "Black-and-White Hole Universe?"). Humphreys used Stephen Hawking's popular-level treatment of general relativity[32] (specifically, his discussion of gravitational time dilation) to infer that with Earth at the hole's center Earth clocks would be static or run very slowly relative to clocks in distant parts of the universe. As Humphreys elaborated, an observer on Earth would see billions of years elapsing on clocks in distant parts of the universe while only 144 hours elapse on Earth or in Earth's vicinity.[33] (Later alterations made by Humphreys to his initial models still retain this fundamental feature.)

Humphreys' attempts to build cosmic models wherein distant clocks run much more rapidly than Earth clocks seemed promising at first, but it ultimately failed several tests of plausibility. As experts in general relativity have pointed out, Humphreys' cosmic model and its subsequent revisions simply do not yield the required gravitational time dilation. [34]When Humphreys' mathematical errors are corrected, his model becomes a big bang model consistent with a cosmic creation date billions of years ago.

Another problem for Humphreys' model is that astronomers observe "clocks" all over the universe, both near and far, running at nearly the same rate. For example, the light cycle times of Cepheid variable stars, nova and supernova eruption times, gamma-ray bursts, star formation times, stellar burning rates, and galaxy rotation periods measure nearly the same in our galaxy as in distant galaxies. I say nearly the same because astronomers do see the relativistic velocity dilation effect (on time) predicted by the expansion of the universe in big bang cosmology.

Black-and-White Hole Universe?

Humphreys' cosmic model, in which a black hole becomes a white hole, looks like this: an initial "ball of liquid water…two light-years in diameter [that contains]…all the mass of the universe"[35] became a black hole, then in a relatively brief period (a few thousand years) "evaporated" to become a white hole, an explosion of energy and particles radiating outward.

Such a scenario violates nearly every law of physics God established for the cosmos. First, a ball of liquid water two light-years in diameter is physically impossible. (The gravity at its core would generate so much heat and pressure as to ignite nuclear fusion long before a ball of water that big could be assembled.) Second, the evaporation time of this "hole" would be orders of magnitude greater than the 14-billion-year age astronomers measure for the universe. Even the tiniest black hole that the laws of physics permits (roughly equal to the mass of Mount Everest) would take about 15 billion years to become a white hole. Black holes as small as the smallest ones astronomers actually observe (a few times the mass of the Sun) would require 10^{66} years (a million trillion trillion trillion trillion trillion years) to become white holes. A black hole as massive as the observable universe needs orders of magnitude longer than 10^{66} years to turn into a white hole.

This cosmic expansion implies that the more distant a galaxy is from Earth, the faster it will be moving away from Earth. According to Einstein's special relativity theory, the faster the recession velocity of a galaxy relative to Earth, the slower, to observers on Earth, clocks in that galaxy will appear to run.

Several teams of astronomers have observed that Type Ia supernovae (supernovae that manifest identical intrinsic time periods for their light curves) located in galaxies billions of light-years away do indeed take extra time, as seen from Earth, to proceed through their eruption phases (normal to maximum to minimum light).[36] The extra time each such supernova takes is the time dilation amount predicted by Einstein's special relativity theory, big bang cosmology, and the measured recession velocity of the host galaxy. By comparison, Humphreys' models predict a relativistic gravitational time *compression* that would cause the same supernovae to manifest eruption light curves a million times *briefer*!

Astronomers see no time dilation for Cepheid variables, novae, star histories, or galaxy rotation rates. These clocks are too faint to be seen at the great distances where the velocity time-dilation effect can be detected. (In a big bang universe, only objects at great distances would move away from us at velocities equal to a significant fraction of light's velocity.) If correct about time compression, Humphreys' models predict that astronomers would see Cepheid star variations, novae, galaxy rotations, and stellar burning occurring up to 500,000 times faster than the rates they actually observe.

Humphreys' models also predict that astronomers will measure the solar system to be much younger (only thousands of years old because of slower running clocks) than distant stars and galaxies (billions of years old because of faster running clocks). However, Earth, the Sun, the Moon, and other solar system bodies show evidence of billions of years of natural history. None of the short-lived radiometric elements remain on or in solar system bodies. Most of the Moon's craters reveal 4 billion years' worth of erosion. The asteroid belts show billions of years of dynamic aging. The Sun has all the characteristics of a star that has been burning for 4.5 billion years. Two solar age determinations based on helioseismic data showed the Sun to be 4.60 ± 0.04 billion years old[37] and 4.57 ± 0.11 billion years old,[38] respectively—ages consistent with one another and with all other dating methods.

The universe measures hotter the farther away (thus, earlier in time) that astronomers look. The rate at which the universe has cooled is consistent not with clocks throughout the universe running at the rates Humphreys proposes, but rather with a big bang universe nearly 14 billion years old.

In proposing that the cosmos has expanded in just thousands rather than billions of years, Humphreys also crashes into the observed invariance of galaxy redshifts. Over the past 80 years, astronomers have repeated redshift measurements on thousands of galaxies. These measurements have been made at various intervals, from a few years to several decades. In all cases, the differences between the original redshift measurements and the repeated ones lie below the detection limits of astronomers' instruments. Since these limits are so small, down in the ninth decimal place (a change of less than 3×10^{-9}),[39] no room exists for Humphreys' hyper-accelerated cosmic expansion. (Eighty years of cosmic expansion would account for 0.08 percent of all cosmic expansion in a 10,000-year-old universe, but only 0.00000006 percent in a 14-billion-year-old universe.) This conclusion stands whether the cosmic expansion is smooth or occurs in discontinuous jumps.[40]

Is the Milky Way Galaxy at the Cosmic Center? In big bang cosmology all galaxies, stars, planets, gas, and dust reside on the three-dimensional surface of the universe's four expanding space-time dimensions. Just as no city resides in a place that can be considered central to all Earth's surface, so no star or planet can be situated at the universe's center.

Some creationists claim that galaxy redshifts are quantized and thus support a "galactocentric" model of the universe.[41] In this model, the Milky Way Galaxy (MWG) resides at the physical center of the universe. "Quantized" redshifts refer to redshift values clustered into distinct groups. Humphreys argues that such clustering establishes that galaxies are grouped into concentric spherical shells surrounding the MWG.

While these individuals imply that quantization of galaxy redshifts is an established fact, in truth only a handful of astronomers have ever suggested that galaxy redshifts may be quantized.[42] The vast majority have consistently rejected the suggestion for one or more of these three reasons.[43] First, the star formation histories of galaxies make some galaxy redshifts easier to detect than others. Second, most galaxies are located in clusters, and most clusters are distributed along enormous cosmic "walls" surrounding "voids" (that is, galaxies are not randomly dispersed throughout the universe). Third, until recently, astronomers lacked galaxy surveys that could probe deep enough to eliminate all these selection effects.

A team of British astronomers achieved the first analysis of a large homogeneous sample of galaxy redshifts, the 2dF (Two Degree Deep Field) Galaxy Redshift Survey.[44] They found "no evidence for redshift periodicity"[45]

and concluded that "given that there are almost eight times as many data points in this sample as in the previous analysis by Geoffrey Burbidge and William Napier,[46] we must conclude that the previous detection of a periodic signal arose from the combination of noise and the effects of the window function [the upper and lower redshift limits chosen for the sample]."[47]

Burbidge and Napier made one last attempt to show that quasar redshifts in particular cluster around certain values.[48] Though in older, smaller surveys of galaxies and quasars they found indications of such redshift periodicities, they concluded in their paper that these indications vanish completely in the much larger, more complete, and better controlled Sloan Digital Sky Survey of galaxies and quasars. Even Halton Arp, the most avid proponent (outside of the young-earth community) for the clustering of quasar redshifts around certain values, admits that such a proposition is "at odds with a vast amount of straightforward evidence in the literature."[49]

One more problem with all galactocentric models is the lack of a concentration of galaxies around our home galaxy. The MWG is located in "the Local Group," a loose aggregation of about a hundred dwarf galaxies and two medium-large spiral galaxies. The Local Group resides on the extreme outer fringe of the Virgo Cluster of galaxies, which includes over 1,000 large galaxies and 10,000 dwarf galaxies. The Virgo Cluster is located on the outer fringe of the Great Attractor, while the Great Attractor sits on the outer fringe of the Monster Attractor. After removing the velocities attributable to the general expansion of the universe, researchers discover that our galaxy is being pulled toward the Virgo Cluster, which is being pulled toward the Great Attractor, which is being pulled toward the Monster Attractor. (This pulling explains why the cosmic background radiation looks hotter on one side of the sky than it does on the other.)[50] Thus, our galaxy cannot be the geographic center of the universe.

Challenge 6: **Earth-based clocks once ran at slower rates.**

Reply: One young-earth creationist leader, Australian physicist John Hartnett, has acknowledged publicly that Humphreys' gravitational time dilation scenario is contradicted by observations of distant astronomical clocks.[51] In an attempt to get around the observational evidence, Hartnett proposed a revision of Humphreys' model.[52] Hartnett hypothesizes that Earth-based clocks ran at the same rates as more distant cosmic clocks (with small adjustments to take into account relativistic velocity time dilations) until the end of the fourth creation day. During the first three creation days, Hartnett claims, all clocks on Earth ran ten trillion times more slowly than astronomical clocks; then, on creation day

four, Earth-based clocks sped up to the same rate as the astronomical clocks.

As Hartnett explains, the speeding up of Earth time during creation day four implies that Earth's rotation rate, relative to astronomical clocks, was ten trillion times faster at the close of creation day four than it was at the beginning of creation day four.[53] Such speeding up would also imply that protein folding and metabolic reaction rates in plants (created during creation day three) proceeded ten trillion times faster by the close of creation day four. Further, the accelerated rate of plate tectonic activity would have caused the continental landmasses (first formed on creation day three) to grow ten trillion times faster at the end of day four than at the beginning.

Hartnett's proposal for radically accelerated physics poses some intractable problems both biblical and scientific. Jeremiah 33:25 says that the laws that govern both the heavens and the earth are fixed. Genesis 1:14–18 describes the Sun, Moon, and stars as reliable time markers for life on Earth. That reliability is called into question if these "clocks" have sped up by 10 trillion times.

In claiming that Earth and probably the entire solar system once lived in an exotic time bubble, Hartnett believes he has accounted for all the scientific evidence that the universe and the MWG are several billion years old.[54] He has not. Nor has his model addressed the mountain of evidence that the solar system and Earth are some few billions of years old (see chapter 17). Hartnett offers no physical explanation for his hypothesized time bubble.

A further major problem is that physical life-forms cannot tolerate significant and rapid changes in the rates of protein folding and metabolic reactions. In fact, an extremely rapid acceleration of Earth's rotation and revolution rates and rates of plate tectonic activity would obliterate all life on Earth. A catastrophe of such magnitude would have left significant geological evidence. Not only does no such evidence exist, but neither is there any evidence anywhere for any time on Earth or in the solar system that this huge time discontinuity occurred.

A time discontinuity between Earth (or the solar system) and the rest of the universe cannot occur because Earth is dynamically connected to the rest of the universe. Newtonian mechanics links the rotation and revolutionary rates of Earth into the rotation and revolutionary rates of all other solar system bodies. The rotation and revolutionary rates of solar system planets are likewise linked to the rotation and revolutionary rates of comets and asteroids in the distant Kuiper Belt or Oort Cloud (see Exhibit J and Exhibit L in chapter 17). The revolutions of the earth, Sun, Moon, and other solar system bodies around the center of the MWG are also inseparably linked with the revolutions of other stars in the MWG, and the dynamics of our galaxy are linked with the dynamics of the

rest of the universe. In other words, the operation of Newtonian mechanics in the universe (which must be supernaturally fine-tuned for physical life to be possible) demands that clocks everywhere and for all time in the universe and on Earth run at the same rate (again, with minor adjustments to take into account relativistic velocity effects).

***Challenge 7*: Light travels faster in one direction than in the opposite.**

Reply: Young-earth astronomer Jason Lisle has pointed out that all laboratory methods for measuring the velocity of light are limited to determining the time for round-trip travel. Thus, Lisle claims it is conceivable that light travels at near-infinite velocities from distant stars and galaxies toward Earth but at velocities close to half the laboratory-measured speed (about 300,000 kilometers per second) when it travels in the opposite direction. With this conception, Lisle argues that galaxies billions of light-years away were created only about 6,000 years ago, on creation day four of Genesis 1, and that their light reached Earth instantaneously or, at most, only a few minutes later.

Lisle labels his conception of light travel the "anisotropic synchrony convention" (ASC). He presumes that it is impossible for astronomers to determine whether light travels at the same velocity everywhere toward Earth as it does away from Earth or whether, as he asserts, light travels everywhere much faster toward Earth than it does away from Earth. However, a simple observational test for Lisle's hypothesis exists. First, though, here's a response to Lisle's biblical justification for proposing ASC.

The Bible always treats light as if it moves instantaneously from its sources to its observers, Lisle notes. However, over terrestrial distances (in the context of pre-twentieth-century technology) this biblical treatment would be appropriate even if light traveled at only 150,000 kilometers per second.

In Genesis 1:15 Lisle claims that light from stars arrives instantly on Earth. The verse says, "Let them [stars] be lights in the expanse of the sky to give light on the earth. And it was so." This verse, though, says nothing explicit about the arrival time of starlight on Earth relative to its departure time from the stars. Lisle's claim presumes that creation day four is only 24 hours long and that God created the stars on the fourth creation day. The content of chapter 7 of this book responds to the first part of Lisle's claim while Genesis 1:16 addresses the latter. As explained later in chapter 21, the verb form in Genesis 1:16 implies only that the stars were completed entities *before* the fourth creation day.

It is important to note that there are two components to Lisle's hypothesis. In addition to an anisotropic synchrony, Lisle introduces a directional dependence. This directional dependence means that light must travel at infinite speed when

headed directly toward Earth.

While the anisotropic synchrony component of Lisle's ASC is truly a convention (just as isotropic synchrony is a convention) and can be observationally tested only indirectly (for example, via light echoes off the remnants of exploded stars,[55] time delays in the gravitational lensing of quasars by intervening galaxies,[56] and the timing of eclipses of Jupiter's four large moons,[57]), the directionality of Lisle's ASC can be tested directly.

By convention, one can choose a one-way speed of light that differs from the speed of light in the opposite direction without *any* observable effects only *if* the anisotropy in the speed of light does not change its direction of operation as its source moves from one location to another. However, one cannot choose a one-way speed of light in cases where the anisotropy changes its direction of operation (as its source moves from one place to another) *without* introducing local space curvature.[58] Because the anisotropy in light's speed is radially directed toward Earth (see figure 15), the anisotropy Lisle invokes indeed *does* change its direction of operation. Thus, Lisle's ASC is not a mere coordinate system redefinition (convention). His ASC requires Earth-centered space curvature, that is, a strong geocentric gravitational field independent of Earth's mass. Astronomers' measurements definitively rule out the possible existence of such a field. Consequently, Lisle's ASC is ruled out.

Lisle's ASC is observationally negated in a second way. He uses the directionality in his ASC to construct a young-universe model that yields, in his own words, the following falsifiable prediction:

> We should expect to see indications of the youth of the universe (in contrast to billions of years) at all distances. We should expect to find processes that cannot be easily extrapolated into a billions-of-years hypothetical past, and which consequently place an upper limit on the age of the process that is far less than big bang models would predict.[59]

A billions-of-years old universe can and will host some processes that require only several thousand years. The existence of a few young structures offers no support for Lisle's model. The test is whether any processes exist that require millions of years or more to run their course. The previous chapter documents the (observed) existence of astronomical processes known to occur over timescales ranging from thousands to millions to billions of years.

This range of timescales impacts the young-earth appearance-of-age argument. It is one thing to claim that God artificially added 13 billion years of

apparent aging to all cosmic structures that in reality are only thousands of years old. It is another matter again to say that he artificially aged various cosmic structures by different amounts to make them appear to human observers to possess ages ranging between a few thousand and 13 billion years. Such a proposition implies that God imposed not only a false age on the observable universe, but also a false history.

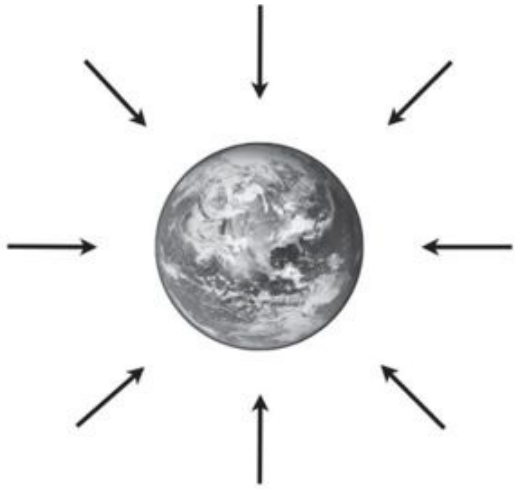


Figure 15: Observational Test of Lisle's ASC Hypothesis
The incoming velocity of light could differ from the outgoing velocity by a specified value without any observable consequences only for a one-directional path of light travel. Maintaining a specified value for the difference in light's velocity for a range of different directional pathways introduces local space curvature. In particular, directionality that focuses only on Earth requires a geocentric gravitational field independent of Earth's mass. Measurements establish that no such gravitational field exists. Credit: NASA

***Challenge 8*: Ultra-fast propagation of light occurs on creation day four—probably by rapid expansion of space.**

Reply: Young-earth astronomer Danny Faulkner points out that the light-travel-time problem is far worse than what most young-earth creationists acknowledge.[60] If the Genesis 1 creation days are six consecutive 24-hour periods, as all young-earth creationists assert, Adam would not have seen even the nearest star until more than four years after he was created. It would take an additional four-and-a-half years before he could see two stars in the sky, and another two years after that before he could see three. Yet Genesis 1 declares that from the fourth creation day forward the stars served as signs to mark seasons, days, and years. Faulkner concludes, "Any realistic solution to the light travel time problem must explain how Adam could have seen any stars on the evening following Day Six."[61]

Faulkner hypothesizes that during creation day four light propagated at least

billions of times faster than the present rate of about 300,000 kilometers per second. However, recognizing the insurmountable challenges to the hypothesis that the velocity of light was millions or billions of times faster in the past (see challenge 3), Faulkner suggests instead that the universe's space surface hyperexpanded during creation day four. To solve the light-travel-time problem, the cosmic surface would need to expand by several billion times during that day.

Ironically, Faulkner's model is a modified version of big bang cosmology, which all young-earth creationists, including Faulkner himself, strongly renounce.[62] The only differences are these: (1) in Faulkner's model the universe's space surface hyperexpands only several thousand years ago instead of 13.8 billion years ago; and (2) in the old-universe model there exists both observational support and a well understood theoretical cause for the hyperexpansion (see challenge 9) whereas in Faulkner's model there is neither.

Not only does Faulkner's model lack observational support but also a battery of observational evidence rules it out. The key theoretical distinctive between Faulkner's young-universe big bang model and the standard inflationary hot big bang model lies in the timing of the rapid expansion. For Faulkner's model virtually all of the cosmic expansion (more than 99.9999999 percent) takes place during the hyperexpansion event that occurs on creation day four. Meanwhile, in the standard inflationary hot big bang, the hyperexpansion (aka inflation) event, which occurs prior to creation day one, only grows the universe to about the size of a grapefruit. That expansion adds up to just 0.000000000000000000000001 percent of the total cosmic expansion astronomers measure.

This key theoretical distinctive generates many contrasting observable predictions. Five examples are:

1. For Faulkner's model, there would be no law of redshifts; that is, no correlation between the distances of galaxies and quasars and the redshifts of galaxies and quasars. In the standard inflationary hot big bang model a very strong correlation would be expected.
2. For Faulkner's model, there would be no temperature-redshift correlation for the cosmic background radiation; that is, the temperature of the cosmic background radiation (the radiation left over from the cosmic creation event) would not be observed to increase in proportion to the distance at which that radiation is observed. For the standard inflationary hot big bang model a very strong correlation is predicted.
3. For Faulkner's model, the spatial density of galaxies would be about the

same at all distances. In the standard inflationary hot big bang model, the farther away one observes the more crowded together the galaxies would appear, relative to one another.

4. For Faulkner's model, the observed morphological characteristics and the measured ages of galaxies would be about the same at all distances. In the standard inflationary hot big bang model, the farther away one observes the younger the galaxies will measure to be and the morphological features of galaxies and quasars will be strongly correlated with their distances.
5. For Faulkner's model, no time dilation effect will be observed for distant supernovae; that is, supernovae at all distances will take the same amount of time (about seven months) to proceed through their light curves: from normal luminosity before eruption, to maximum light, to post-eruption luminosity. On the other hand, in the standard inflationary hot big bang model a strong correlation exists between a supernova's distance and how long it takes to complete its light curve.

In every instance, astronomers have made extensive measurements that confirm the predictions of the standard inflationary hot big bang model and refute Faulkner's model.

***Challenge 9*: Old-earth creationists have their own light-travel-time problem called "inflation."**

Reply: Getting light from one side of the universe to the other means that the universe can manifest a uniform heat and a high degree of homogeneity. Both of these cosmic conditions are essential for advanced life to be possible in the universe.[63] However, it is not possible for the universe, given its current spatial dimensions, to possess such uniformity and homogeneity in only 13.79 billion years *unless* the universe experienced a very rapid, very brief hyperinflation event shortly after it was created. Without the inflation event the universe would need to be orders of magnitude older than billions of years to exhibit the uniformity and homogeneity that it does.

Young-earth creationists insist that cosmic inflation is both arbitrary and wrong.[64] To eliminate it, however, would be to show the universe much, much older, not younger.

To claim that cosmic inflation is merely an arbitrary hypothesis with problems of its own ignores a significant body of research. Only in a universe with a past inflation event will the scalar spectral index in the temperature fluctuations of the cosmic background radiation take on a value less than 1.0.

The fifteen-month data set from the Planck satellite map of the cosmic background radiation established that the cosmic scalar spectral index, n_s = 0.9603 ± 0.0073.[65] The nine-year data set from the Wilkinson Microwave Anisotropy Probe satellite determined that the cosmic scalar spectral index, n_s = 0.9608 ± 0.0080.[66]

Cosmic inflation also predicts that the geometry of the universe will be either perfectly flat or very nearly flat. As described in the preceding chapter, recent measurements from two different supernova survey teams determined that the cosmic curvature density parameter, $\Omega_k = 0.000 \pm 0.005$, where $\Omega_k = 0$, describes perfect flatness. A flat universe is exactly the kind of universe one would expect if God had designed it to serve the needs of human beings.

Cosmic inflation has a sound theoretical foundation. It occurs at one of the moments (very early on) of "symmetry breaking" in the history of the universe. The beginning of the universe is the beginning of space and time itself. At its inception, the universe was infinitely or near-infinitely compact and, consequently, infinitely or near-infinitely hot. As the universe cooled as it expanded from the cosmic creation event, it passed through temperature transitions that induced symmetry breaking.

At symmetry breaks, there is less order and more chaos. The universe at the cosmic creation event was a time of pure symmetry: all the forces of physics had equal strength and were blended together to operate as a single force, all the matter particles had equal mass; namely zero, and space-time was the same everywhere. As the forces of physics decoupled from one another as a consequence of cosmic cooling, they lost their symmetry and the universe became more disordered.

The first symmetry-breaking event occurred about 10^{-43} seconds after the cosmic creation event. There the universe cooled sufficiently such that the single cosmic force with which the universe began separated into two forces: the force of gravity and the strong-electroweak force. Along with this force-separation event, space-time transitioned to become a quantum fluctuating space-time foam.

The second symmetry-breaking event occurred about 10^{-34} seconds after the cosmic creation event. Now, the universe had cooled sufficiently for the strong-electroweak force to separate into the strong nuclear force and the electroweak force (a combination of the weak nuclear force and electromagnetism). During this symmetry-breaking event, mass and space-time separated and the energy released generated distinct particles. Also, an extremely rapid and extremely brief (less than 10^{-33} seconds) expansion of the cosmic space surface

accompanied this force-separation event.

In sharp contrast with young-earth creationist models, the old-earth creationist light-travel-time "problem" is not a problem. It has a demonstrated theoretically workable cause and observational measurements to establish the validity of the very early inflation event.

Challenge 10: **Radiometric decay was faster in the past.**

Reply: This challenge results from a misunderstanding or misapplication of various radiometric dating methods and the overlooking of radiometric decay measurements made in the past. These will be addressed in some depth and detail in the next chapter.

Challenge 11: **"You weren't there!"**

Reply: This assertion assumes that since no human was around to observe cosmic creation and God's transformation of the universe into its current condition, no human can have any factual basis for theories on cosmic origin and development. Thus, many young-earth creationist leaders insist on calling astronomers' observations and calculations about the universe's age "pure speculation." As Ken Ham of Answers in Genesis said,

> There were no observers to these long ago events.[67]
>
> No one was there to record these past events.…Scientists only have the present—they do not have the past.[68]

In one sense, the case is exactly the opposite. Astronomers don't have the present; they have only the past. They cannot observe or record present events. But they can observe and record all manner of past events. For instance, when astronomers observe the Sun, they're recording the physics of God's solar creation from eight minutes ago, when the light of the Sun began its journey to the astronomers' telescopes. When astronomers observe the Crab Nebula (6,300 light-years distant), they're recording the physics of God's creation 4,300 years before the birth of Jesus. In observing the Andromeda Galaxy, astronomers are witnessing physics from 2,500,000 years ago. In detecting the tiny temperature ripples in the cosmic background radiation, astronomers are measuring the universe when light first separated from darkness, when the universe was just 0.003 percent of its present age—just 375,000 years after the creation event. In measuring the polarization of the temperature ripples in the cosmic background

radiation, astronomers see the state of the universe when it was a mere 10^{-50} of its present age—just 10^{-34} seconds after the creation event.

Because of the time it takes for light to travel from stars, galaxies, and other sources to astronomers' telescopes, these telescopes operate like time machines carrying us into the past. Astronomers literally measure the heavens to see what God did in the past. In answer to the question "Were you there?" astronomers can reply, "Yes, God allows us to directly observe in real time what happened in the past."

The Science Community's Reply

A spokesman for the U.S. Geological Survey (a key witness in the 1981 Arkansas creation-evolution trial) equated the creationists' claims for a young Earth with "the flat Earth hypothesis and the hypothesis that the sun goes around the Earth."[69]

Writing for the American Association for the Advancement of Science, researchers Allen Hammond and Lynn Margulis made this comment about the young-universe view: "Adoption of creationist [that is, young-universe creationist] 'theory' requires, at a minimum, the abandonment of essentially all of modern astronomy, much of modern physics, and most of the earth sciences."[70]

I'm troubled to think what may happen when the connection between cosmic size and age becomes more widely understood. If taught that a young universe is the Bible's clear message, many seekers and nonbelievers will conclude, under the barrage of compelling scientific evidence for the universe's antiquity, that the Bible must be accepted on a purely subjective, nonfactual basis. Thus, they may turn away from considering Christ's claims. To put it another way, if the church demonstrates itself unreliable in interpreting scientific data, which are subject to objective verification, how can it be trusted to handle biblical statements on spiritual matters that cannot be objectively verified? Demonstrably false science gives people reasons to reject the gospel—reasons to disbelieve rather than reasons to believe.

As for sincere young-earth Christians, the tenets of young-earth creationism dictate that they must shut out science and its facts altogether to preserve their faith. How can they love the Lord our God with all their heart, soul, mind, and strength if they must separate their mind from their faith? Such a separation violates the meaning of biblical faith. (See appendix A.)

The next chapter gives us another opportunity to apply our minds to settling the creation-day question. Let's move on to explore challenges raised against

radiometric dating.

Chapter 16

The Reliability of Radiometric Dating

For years, erroneous weather predictions have prompted jokes about forecasting. The apparent lack of a dependable forecasting technique has often left people confused and frustrated. Controversies and misinformation have led to similar emotions over the techniques of radiometric dating, used by scientists to measure the age of the universe and Earth. Some young-earth creationist leaders believe that if they can disqualify these methods of dating, the young-earth view will be significantly closer to scientific acceptance.[1]

Can radiometric dating accurately determine age? Is the information produced by this technique reliable enough to help solve the creation-day controversy? Understanding how radiometric dating works, and the issues behind its reliability, can help a person decide.

How a Radiometric Clock Works

Radiometric clocks operate on the principle of half-life decay. Radioactive isotopes (nearly all atomic elements exist as a suite of isotopes, or atoms with the same number of protons but with different numbers of neutrons) disintegrate through time; that is, they decay into lighter elements. Plutonium-239, for example, decays into helium-4 and uranium-235. If we start with 10,000 plutonium-239 atoms and wait 24,110 years, we'll have only 5,000 left. In other words, 24,110 years is the half-life for plutonium-239. After 48,220 years, only 2,500 will remain. After 72,330 years, 1,250 will remain. After 15 half-lives (a total of 361,650 years), the entire sample of 10,000 plutonium-239 atoms will have decayed into lighter elements.

The lack of naturally occurring plutonium-239 anywhere in Earth's crust is one reason geologists and geophysicists are convinced Earth must be older than 361,650 years. In fact, Earth's crust is devoid of all short-lived radionuclides (short-half-life radioactive isotopes), except for the few that result from decay of long-lived radionuclides or from local or cosmic radiation. Geologists and geophysicists find no neptunium-237 (half-life = 2.14 million years), no

aluminum-26 (half-life = 720,000 years), no calcium-41 (half-life = 103,000 years), no iodine-129 (half-life = 17 million years), no technetium-98 (half-life = 4.2 million years), and no plutonium-244 (half-life = 82 million years).[2] They do find the isotopes of the decay products of these short-lived radionuclides (more on this later), which establishes that such radionuclides indeed were present on the early Earth. Therefore, the present-day lack of short-lived radionuclides in Earth, on the Sun, or in meteorites convinces scientists that Earth and the solar system must be older than a billion years (15 half-lives x 83 million = 1,245 million years).

The present-day lack of neptunium-237, aluminum-26, calcium-41, iodine-129, technetium-98, and plutonium-244 on Earth and in the Sun does not mean they do not exist. Astronomers have detected these radiometric elements in the spectra of stars or the interstellar medium (the gas and dust that exist between stars) that is demonstrably younger (by independent dating methods) than either Earth or the Sun.[3] The interstellar medium belongs to the ensemble of material from which a rocky planet such as ours is formed.

Conditions for Reliability

Just as thermometers, barometers, and radar all have specific applications and limits, so too do the more than 40 different radiometric decay dating methods. One limiting condition concerns the rock sample's age. The closer that age is to the radiometric half-life of the isotope being measured, the better. Accurate dates can be determined only for samples that are no younger than about one-sixth the half-life (of the isotope) and no older than about six times its half-life—unless one has a very large sample. Thus, carbon-14 (perhaps the most commonly known radiometric dating tool), with its half-life of 5,715 years,[4] provides reliable dates—with rare exceptions—specifically for samples of once-living material between 900 and 35,000 years old.

Attempts to date the Shroud of Turin offer an example of these radiometric dating limitations. Researchers at specialized laboratories in the United States, England, and Switzerland assured the shroud's protectors that if it were genuinely a 2,000-year-old article, a four-square-inch sample of fabric would suffice to establish that fact. The carbon-14 studies placed the shroud's origin in the thirteenth century AD, making it only about 800 years old—just outside the 900-year lower boundary for accuracy in carbon-14 dating. Those who wanted passionately to believe in the shroud's authenticity as the burial cloth of Christ tried to seize this "inaccuracy" as a way to sustain their hope, but the three research teams have expressed certainty that, even considering the error margin,

their carbon-14 measurement definitively rules out a first-century AD date, at least for that portion of the shroud. Each lab offered to provide a more precise and comprehensive date if they could test as much as a one-square-foot piece of the shroud and smaller pieces of other parts of the shroud. Their offers were declined.[5]

This case study reveals a second condition for accurate radiometric dating—sample size. The bigger the sample, the better. This condition explains why archaeologists can provide precise dates for large artifacts but typically only crude dates for tiny ones.

Sample purity is a third condition. The more a sample is contaminated by materials of different ages, the less reliable the radiometric date. When dealing with a seriously contaminated sample, investigators often report several different radiometric dates. The first will be a date for the whole sample. The second will be a date for what they hope is the isolated original sample. The third, fourth, and so on will be estimates for each of the contaminants. Typically, the error bars for each of these measurements indicate how successfully the investigator isolated the original sample from the different contaminants.

Proximity of the actual date to the half-life of the radiometric chronometer, adequate sample size, and adequate sample purity are the three most significant conditions for radiometric dating accuracy. The degree to which the sample has been subjected to pressure is much less significant. (The half-life dependence on pressure applies only to electron-capture decays, and the effect is small where applicable.) Heat, cold, gravitational impulses, vacuum conditions, and chemical environment have no significant effect on radiometric decay rates.

Misdirected Ridicule

Supposed “evidence” against the reliability of radiometric dating focuses on the method’s “flaws” or inaccuracies when applied outside its limitations. For example, uranium-238 radiometric dating, when applied to young samples, yields absurd dates. Why? With a half-life of 4.51 billion years, uranium-238 dating cannot be effective for measuring the age of any sample younger than a few hundred million years old. Similarly, carbon-14 dating will give absurd dates for extremely ancient samples. As noted already, carbon-14 dating ceases to be reliable for samples older than about 35,000 years. Carbon-14 has the added limitation that it is effective for dating organic (once-living) materials only.

Radiometric dating sometimes produces “discordant” dates. Such discrepancies are explained, however, by the nature and degree of contamination and by differences in sample size. Error bars offer helpful indicators for these variances. A piece of wood dated (by the carbon-14 method) as 6,000 ± 5,000

years old is a sample in which the investigator was unable to isolate the contaminants. A manuscript dated as 1,600 ± 200 years old is most likely a sample too small for greater precision. However, numerous large samples of uncontaminated charcoal from an ancient city dated to 1412 BC ± 1 year would yield a secure conclusion that the city burned sometime between 1414 and 1410 BC.

Have Decay Rates Changed?

Recognizing that radioisotope dating establishes both a several-billion-year-old Earth and universe, the Institute for Creation Research (ICR) formed the RATE (Radioisotopes and the Age of the Earth) research group in 1997 to search for ways to interpret radiometric decay in a young-earth context.[6] After eight years of research the RATE group acknowledged that if radiometric decay rates are truly constant, then the universe and Earth must be billions of years old.[7] The group argued that radiometric decay rates must have accelerated by at least a factor of several hundred million times either during the first few Genesis creation days, at the time of Adam's fall in Eden, during the flood of Noah, in the episode shortly after Noah's flood, or in some combination of these four brief epochs so as to accommodate their young-earth position.[8]

Measuring past decay rates can be indirect and difficult for geophysicists but direct and easy for astronomers. Because they routinely observe objects thousands, millions, and even billions of light-years distant, astronomers directly observe radiometric isotopes as they were some thousands, millions, and billions of years ago. (For evidence establishing light's constant velocity, see chapter 15, challenge 3.) The measured abundances of these isotopes show that radiometric decay rates have not varied through time.

The Bible describes the universe's laws of physics as unchanging from the beginning until God replaces the universe with the new creation described in Revelation 21–22. In Jeremiah 33:25 God declares that the laws governing the heavens and Earth are "fixed." Genesis 1–3, along with other Bible passages, affirms that starlight, sunlight, metabolism of food, and human work occurred both before and after the advent of human sin. As explained in chapter 9 (Romans 8 describes the continuous operation of the law of decay (aka second law of thermodynamics) from the cosmic creation event until the time when redeemed humans receive their glorified bodies. The slightest variation in any of the physical laws at any time in cosmic history would have rendered many life-critical functions impossible.

When astronomers have directly measured the values of physical constants,

including radiometric decay rates, at different look-back times (epochs) in cosmic history, they have determined that possible variations throughout the past 13 billion years are extremely tiny. In some cases the established limits are as low as 3 parts per 10,000,000,000,000,000 per year.[9] Laboratory measurements have placed limits as low as 2 parts per 10,000,000,000,000,000 per year.[10]

Physicists can show, not only out in the distant universe but also here on Earth, that radiometric decay rates have experienced no significant change. Both uranium-238 (half-life = 4,450 million years) and plutonium-244 (half-life = 82 million years) decay into xenon-136. Geophysicists have noted that eight zircons dated by uranium-lead radiometric clocks to be 4.12–4.22 billion years old exhibited different ratios of xenon-131 compared to xenon-136 than a zircon dated by the same methods to be 3.6 billion years old.[11] The difference in the xenon isotope ratios establishes that plutonium-244 indeed was present on the early Earth and that the rate of decay of plutonium-244 between 3.6–4.22 billion years ago was the same as it is today.[12] Therefore, Earth cannot be younger than 600 million years.

To say that accelerated radiometric decay is impossible would be a bit of an overstatement. Physicists have observed accelerated radiometric decay in those *rare* instances where decay occurs as electrons stray into the nucleus. In one experiment physicists forced an accelerated decay rate by encasing some radiometric atoms inside buckeyballs (soccer-ball-like lattices of sixty carbon atoms), which surrounded the atoms with a dense field of electrons.[13] However, even for this highly contrived circumstance, the radiometric decay rate was sped up by only 0.8 percent. This extraordinary experiment in no way alters any radiometric dates for Earth's age.

Dire Consequences

From an anthropic perspective (the fine-tuning of the universe's characteristics so as to permit the possibility of human life), constancy of radiometric decay rates is essential. The radiation intensity from decay rates thousands or millions of times more rapid at any point in history (even before Adam and Eve's creation) would destroy the possibility of life on Earth. In addition to the radiation damage, the heat released from such increased decay rates would evaporate Earth's water and melt its rocks. That same heat would drive enormous circulation eddies in Earth's mantle, keeping the planet's surface in a state of chaos.

Radiometric decay rates are a function of the weak nuclear force. Any significant change, plus or minus, in the value of the weak-nuclear-force

coupling constant would keep supernovae from expelling essential planet-building and life-building heavy elements, rendering physical life impossible. A substantial increase in the value of that coupling constant (from increased radiometric decay rates) would leave the universe and Earth with virtually no neutrons. Without neutrons, hydrogen would be the only element in the cosmos.

Questionable Decay Products

One particular radiometric decay product has fostered doubts among young-earth proponents about the reliability of radiometric dating: helium. Some young-earth creationist leaders claim that too much helium remains in zircon crystals (inside igneous rocks), and too little helium remains in the atmosphere, to account for billions of years of uranium and thorium decay.[14]

This argument runs to cross-purposes. On one hand, it posits that if Earth were billions of years old, nearly all the helium produced by radiometric decay would have diffused out of the zircon crystals (diffusion would be too fast). On the other hand, it claims that in billions of years not so much helium would have diffused out of Earth's atmosphere (diffusion would be too slow).

As some young-earth creationist authors have noted, helium is a "slippery atom" that "can diffuse through solids relatively fast."[15] The helium diffusion they acknowledge is thermal escape. In addition, geophysicists note a number of significant nonthermal escape processes.[16]

Helium, the second most abundant element in the universe (comprising 25 percent of the cosmos's ordinary matter), comes primarily from sources other than radiometric decay. Given that helium easily slips in and out of "containers" (crystals, rocks, atmospheres, meteors, and so forth), both thermally and nonthermally, and given that so little of the universe's helium is radiogenic, helium abundances are virtually useless as chronometers.

However, argon (another nonchemically reacting gas in Earth's atmosphere) *is* a useful age indicator. Argon-40 arises only from radiometric decay of potassium-40. With an atomic weight of 40 (10 times heavier than helium), very little argon escapes Earth's atmosphere. The amount of argon-40 in Earth's atmosphere matches well what would be expected from 4.5 billion years of potassium-40 decay (half-life = 1.25 billion years). Likewise, the amount of argon-40 in the Moon's and Mercury's atmosphere is consistent with those bodies being 4.5 billion years old.

Lead makes an even better chronometer. Unlike helium, lead does not diffuse easily. Virtually all lead—four different isotopes—results from radiometric decay.

The end product of uranium-238 decay (half-life = 4.46 billion years) is lead-206. For uranium-235 (half-life = 0.704 billion years), the end product is lead-207, and for thorium-232 (half-life = 14.1 billion years), it's lead-208. Therefore, any sample that contains these uranium and thorium isotopes and the three different lead isotope end products gives an investigator three independent tools for determining the sample's age. Moreover, the three different lead isotopes escape from rocks at different rates. Thus, in those instances where small amounts of lead may have escaped from crystal samples, the ratios of the different lead isotopes relative to one another provide the three rates of escape. The abundances of different lead isotopes relative to other nonradioactive elements in rocks devoid of thorium and uranium tell scientists the original quantities of the different lead isotopes in primordial Earth's crust.

Ratios of different radiometric elements relative to the lead end products and the ratios of the different lead end products relative to one another provide consistent, accurate dates—all saying that the earth is billions of years old. Specifically, geophysicists have found zircon crystals, in which the measured abundances of the different isotopes of uranium, thorium, and lead all bear the identical signatures of crystals, formed at dates ranging from 4.1 to 4.4 billion years ago.[17]

Residual Carbon-14

Young-earth creation scientists assert that tiny amounts of carbon-14 found in coal deposits and diamonds prove that the earth cannot be any older than about 50,000 years.[18] While some fossil fuel deposits possess no detectable traces of carbon-14[19] (establishing that they must be much older than 100,000 years), far more commonly, deposits—that by independent dating methods measure to be hundreds of millions of years old—contain carbon-14 abundances indicative of just 40,000–58,000 years of decay. Similar levels of carbon-14 are also found in other ancient carbon sources such as marble, limestone, and diamonds.

Geophysicists have concluded that the ubiquitous nature of such tiny abundance levels of carbon-14 means that processes independent of the actual ages of the carbon samples are responsible for the background signal. They have determined that small amounts of carbon-14 are continually produced anew in these carbon deposits by at least three different means:

- The radioactive decay of uranium and thorium isotopes that are naturally present in these deposits will generate small amounts of carbon-14. The

differing quantities of these radioactive isotopes in coal deposits, for example, explain the variation in the amounts of carbon-14 found in theses deposits.

- Microorganisms and fungi currently and previously living and dying in certain carbon deposits will produce a carbon-14 signal.
- Any exposure of a carbon deposit to the atmosphere can generate a carbon-14 signal.

The background levels of carbon-14 found in most carbon deposits is one reason why carbon-14 dating is not used to date material likely to be older than 40,000 years.

All in the Family

A frequent young-earth creationist charge leveled against radiometric dates in the millions and billions of years is that investigators are ignorant of the original, or starting, abundances for both the parent (radiometric) and daughter (decay end product) isotopes. As noted in the previous section, the original abundances of the daughter isotopes are determined simply by measuring the abundances of daughter isotopes in adjacent samples that are devoid of the parent isotopes. For other radiometric dating methods, the original abundances can be determined even if no samples devoid of the parent isotopes are available.

The rubidium-strontium "isochron" method, for example, leaves no question about the original abundances of these elements in all situations. Earth's crust contains abundant crystalline minerals in which ions of potassium or calcium form the cornerstone of the crystalline structure. In such minerals, rubidium can easily substitute for the potassium, and strontium can substitute for the calcium. Rubidium-87 decays into strontium-87 with a half-life of 48.8 billion years.

Strontium-86, on the other hand, is neither radioactive nor the product of radioactive decay. A rock with a high original abundance of rubidium-87 will produce more strontium-87 than a rock with a low original abundance of rubidium-87. Thus, even if the two rocks start with the same strontium-87 to strontium-86 ratio, the one with higher rubidium-87 abundance will end up with a higher strontium-87 to strontium-86 ratio. So, if the ratios of rubidium-87 to strontium 86 and strontium-87 to strontium-86 of several different samples of an igneous rock formation are measured, the researcher can graphically plot the ratios against one another so as to determine the original strontium-87 to strontium-86 ratio in the formation (see figure 16.1).

For many rock samples, a variety of radiometric tools can be used to

determine their ages. When different methods using different decay processes, half-lives, isotope ratios, and isochrons are applied to a particular sample and all produce the same age, they calibrate one another, removing ambiguity or uncertainty to the extent that the methods can be considered assumption-free.

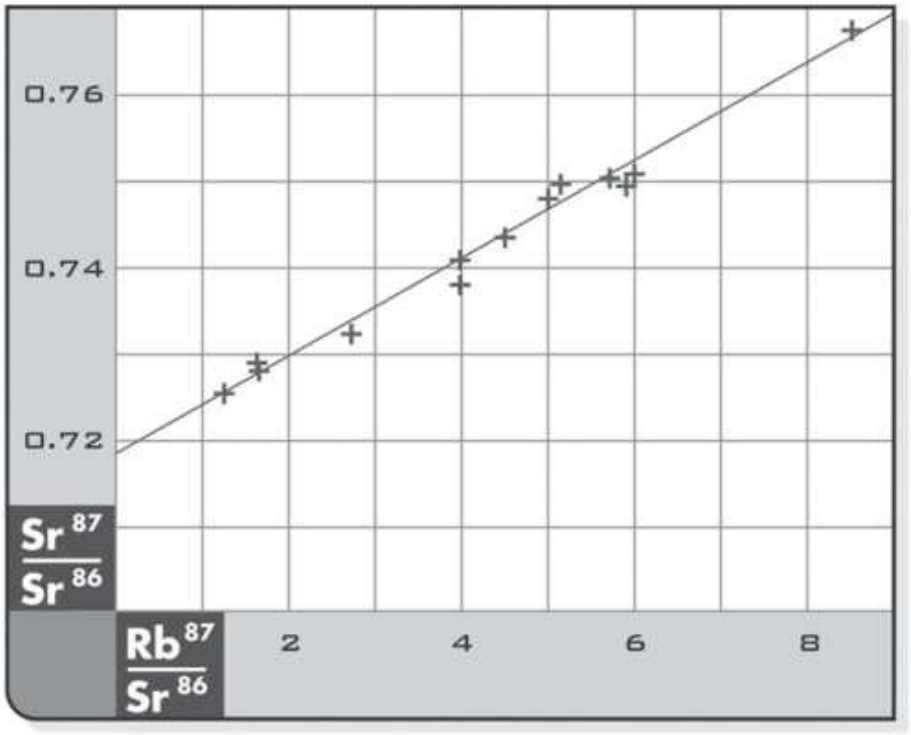


Figure 16.1: Rubidium-Strontium Isochron Plot
Each data point on the graph (marked with a +) plots a measurement of two isotopes' ratios, the strontium-87 to strontium-86 ratio (on the vertical axis) and the rubidium-87 to strontium-86 ratio (on the horizontal axis) in different samples from the same igneous rock formation. The slope of the line (isochron) through the data points is a function of the formation's age. Thus, where the rubidium-strontium isotope ratio drops to zero, the graph shows the ratio of the two strontium isotopes at the time this particular formation first crystallized. Credit: Phil Chien

Nature's Calendars

Tree rings, coral reefs, ice deposits in Antarctica and Greenland, and sedimentary layers in lakes and seas are like calendars in that they record the passing of years. Each year another ring or layer is added. By counting the rings or layers, an investigator can determine for how many years the tree, reef, ice deposit, or sediment has been in existence.

These rings and layers cover different time periods but overlap considerably. The overlap is sufficient to connect the present to the past in a complete and continuous manner over the past several million years. The sequence of layers and rings confirms the constancy of the radiometric decay rates and the

reliability of radiometric dating in the following ways.

Ice and sediment core evidence. Three ice cores from Antarctica—Dome C, Dome F, and Vostok—provide a continuous record of the past 800,000, 720,000, and 420,000 years, respectively.[20] Two ice cores in Northern Greenland, NEEM and NGRIP, and two ice cores in central Greenland, GRIP and GISP2, yield a continuous record of the past 135,000, 123,000, 105,000, and 105,000 years, respectively.[21]

The annual layers of the ice cores contain radiometric isotopes. Analysis of those isotopes established that radiometric decay constants indeed did not vary at any time throughout the past 800,000 years.[22] Also, the layers demonstrated that Antarctica and Greenland were not, within the past 800,000 years, inundated by a massive flood.

For most scientists and laypeople such compelling and straightforwardly simple evidence confirms that Earth is more than a few tens of thousands of years old. Young-earth creation scientists, however, insist that geophysicists are wrong in presuming that the core layers are annual deposits. They claim that all, or virtually all, the ice residing over Antarctica and Greenland was laid down after the flood of Noah's time and that only one major ice age has ever occurred.[23] As "proof," they cite the ice burial of World War II fighter planes in Greenland to a depth of 250 feet in only fifty years.[24]

According to these individuals, layers in the ice cores represent multiple meltings and freezings that occur throughout a single year. Thus, rather than 10,000 layers testifying of the passage of 10,000 years, they might instead attest to the passing of only a hundred or ten years or even less.

Their claim has some validity for the fighter planes buried in ice in southern Greenland. Southern Greenland does have multiple melt and freezing episodes within a single year. For this reason the ice cores mentioned above were all drilled in high altitude areas of central Antarctica and northern and central Greenland, hundreds of miles from the nearest sea coasts. There, multiple melt and freezing episodes do not occur.

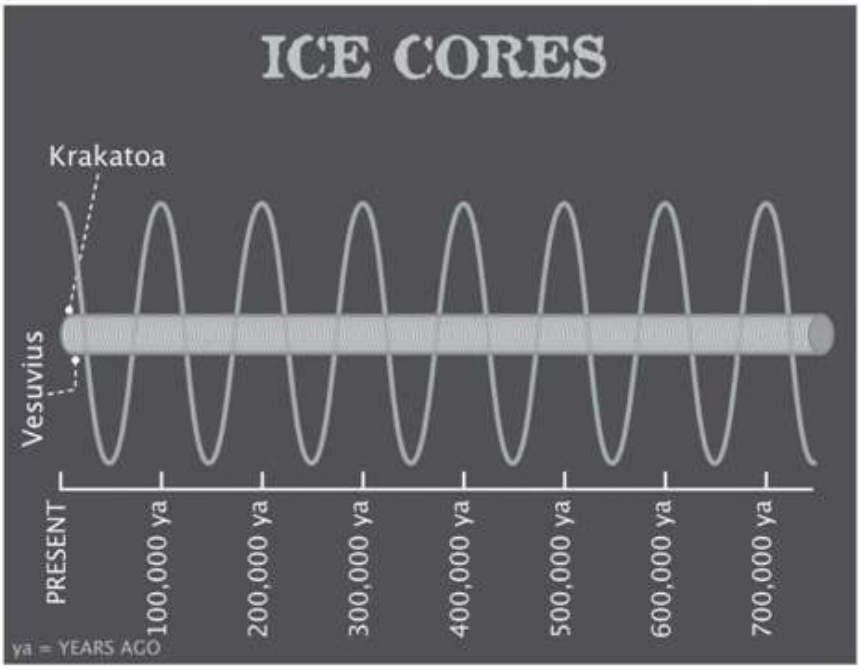


Figure 16.2: Earth's Eccentricity Cycles Seen in an Ice Core
The 800,000 layers in the Dome C Antarctic ice core reveal layer thickness variations (schematically drawn) driven by the 100,000-year periodic variation in the eccentricity of Earth's orbit. Also evident in the annual layers are dust signatures of volcanic eruptions that occurred throughout recorded history. Credit: Phil Chien

Additional evidence that the ice core layers really are annual events arises from three sources. First, embedded within the layers are dust signatures of known volcanic eruptions. For example, we know the Krakatoa eruption took place in 1883, and the Vesuvius eruptions occurred in AD 79, 472, 512, 968, 1037, 1139, 1631, and 1944. Counting the layers between layers that contain the dust signatures of these eruption events, researchers have confirmed that each layer indeed corresponds to one year.[25]

Second, variation in the eccentricity (a measure of the noncircularity) of Earth's orbit about the Sun is clearly seen in the Antarctica ice cores (see figure 16.2). Seasonal changes affect layer thickness. As Earth's eccentricity increases, the seasonal changes increase in direct proportion. Earth's eccentricity changes are driven primarily by Earth's interactions with the gravitational fields of Jupiter and Saturn. Those interactions generate a 100,000-year periodic cycle in the eccentricity of Earth's orbit, and that cycle is clearly visible in the thickness variations.

The 800,000 Dome C ice core layers show eight complete cycles of variation in Earth's eccentricity. The Dome F and Vostok ice cores show seven and four complete cycles, respectively. Thus, the law of gravity dictates that the

Antarctica ice core layers are annually deposited layers, that Earth is at least 800,000 years old, and that radiometric dating yields reliable dates throughout the past 800,000 years.

Third, a marine sediment core off the coast of South Island, New Zealand, reveals southern hemisphere climate changes throughout the past 3.9 million years.[26] The sediment layers in this core show the same cycles in the periodic variation of Earth's eccentricity as do the three deep Antarctic ice cores, thereby confirming that the three ice cores really do provide a faithful record of the past 800,000 years of Earth's history. Conversely, the Antarctic ice cores indicate that the New Zealand sediment core can be trusted in showing that Earth is at least 3.9 million years old and that radiometric dating provides trustworthy dates throughout the past 3.9 million years.

Tree ring evidence. Tree-ring dating is based on analyzing ring patterns in trunks of trees that live for thousands of years. Some living bristlecone pines, for example, possess 5,000 annual rings. By overlapping ring data of living trees with data from dead trees found in the same locations, dendrochronologists can establish a reliable record of Earth's recent history.

The bristlecone pine chronology of the American Southwest now exceeds 8,500 years with the possibility that 3,000 years may be added in the near future.[27] The European oak and pine chronology, a composite of work done in Germany and Northern Ireland, now reveals over 11,000 years.[28] Botanists have shown that a Palmer's oak in the Jurupa Hills of Rubidoux, California, reproduces solely through generating exact clones near its original trunk. Tree ring counts and the dimensions of the clonal stand identify this particular oak tree as the world's oldest living plant at 15,600 ± 2,500 years.[29] Here again, volcanic eruptions in recorded history have left their signatures on certain tree rings, verifying that the rings are annual growths.

As with layers in the ice and sediment cores, the annual rings of these ancient trees contain radiometric isotopes. Analysis of these isotopes establishes that radiometric decay constants did not vary at any time throughout the past 15,000 years. Analysis of the tree rings also demonstrates that the American Southwest and Western Europe did not experience inundation by a massive flood within the past 15,000 and 11,000 years, respectively.

Coral reef layers. The record of coral reef layers extends back 400,000,000 years. Coral colonies produce not only annual layers but also daily bands. Therefore, ancient coral reefs faithfully record Earth's past rotation rates. Coral reefs dated to be 488,000,000 years old show Earth's rotation rate at that time was only about 21 hours long.[30] That rotation period is consistent with

488,000,000 years of tidal braking of Earth's rotation rate by the gravity of the Moon and Sun.

As with ice and sediment core layers and tree rings, the different coral layers and bands store radiometric isotopes. In this case, the law of gravity dictates that the Sun-Earth-Moon system is at least 488,000,000 years old and that radiometric dating gives a reliable measure of the past 488,000,000 years of Earth's history.

Varves. Initially used to describe annual layers in glacial lake sediments, varves now refer to any annually deposited freshwater sediments. Like the layers in ice cores, varves contain radioactive isotopes and the dust signatures of volcanoes that have erupted throughout recorded history.

While for some varve sites the layers are nonannual, in the great majority they are. In addition to the volcanic dust signatures, pollen counts, and idatom counts in the varve layers show that at most varve sites the layers are annual. This majority includes the six million laminae (two laminae = one annual layer) in the Green River shales of the Western United States. The Green River site reveals that Earth is at least 3 million years old, that radiometric decay rates have varied in no significant way over the past 3 million years, and that radiometric dating techniques yield reliable age determinations throughout the past 3 million years.

A Reliable Tool

Any method used for calculating time can be misused if its limitations are not taken into account. A stopwatch can't tell how many days are in a particular month. A calendar won't give an accurate record of time spent running a race. Each timepiece has its own purposes and limitations.

Radiometric dating is no different. When used outside of its intended purposes or limitations, any dating technique can produce incorrect and unreliable results. When used within its intended purposes and limitations, radiometric dating can and does serve as a reliable and trustworthy tool, just as satellite pictures and Doppler radar do in today's weather forecasts.

Radiometric dating is not the only dating method young-earth creation spokespersons call into question. Other scientific questions about the age of Earth and the universe need answers. The next chapter illuminates and evaluates these additional young-earth creationist challenges.

Chapter 17

The Scientific Case for a Young Cosmos

"Red sky in the morning, sailors take warning. Red sky at night, sailors delight." Sometimes weather is easy to read. One glance toward the sky at dawn can signal the need to carry an umbrella. Signs of age can be a bit more difficult to read, however, especially when it comes to the intricacies of science and the cosmos.

Young-earth creationist literature presents more than 100 (supposed) scientific evidences for a youthful Earth and universe.[1] Some appear so technical that most lay readers would never even try to evaluate them. Despite such difficulty, however, probing questions can help any reader evaluate claims in terms of the following issues:

1. **Understandability**. Is the claim explained in a way most people can understand? If the explanation becomes technical, can the logic be followed to a reasonable conclusion? Do any people outside of the young-earth community who possess the appropriate technical expertise confirm the explanation and conclusion?
2. **Assumptions**. Are the underlying assumptions clearly stated? Do scientists who disagree with the claims accept the validity of those assumptions?
3. **Supporting data**. How accurate and consistent are the supporting data? Do other measurements give different results?
4. **Application**. Does the claim demonstrate appropriate application of scientific principles, laws, and equations? How many in the scientific community would agree that these were applied properly? Are the equations balanced, with equal attention to factors that add and others that subtract?
5. **Contradictions**. Do any measurements, observations, or experiments contradict the claimed results and thus call into question the claims' conclusion?

6. **Error bars**. Does the claim take unfair advantage of error estimates? Are the quoted numbers always pushing the upper or lower limits of the error bars?
7. **Technology**. How advanced and reliable are the measuring tools on which the claim is based?

Space limitations do not permit an assessment of all claimed scientific evidences for a young universe and Earth. Access to such exhaustive assessments is provided elsewhere.[2] Here, we take a close look at the most common scientific challenges used to attempt to refute an old-earth view or to affirm the young-earth view.

Evidence Offered Against an Old Earth

Exhibit A: **The continents erode too quickly for Earth to be old.**

Erosion measurements show that the continents are lowered by wind, rain, hail, waves, and living creatures' activities at a rate of about 0.05 millimeters per year. At this rate, the continents, which average about 800 meters in elevation, would have disappeared in 16 million years. Since continents still have considerable elevation, Earth must be much younger than 16 million years.

Reply: This challenge focuses on one side of the equation only. It fails to acknowledge that lava flows, delta and continental shelf buildup (from eroded material), coral reef buildup, and uplift from colliding tectonic plates occur at rates roughly equivalent to, and in some cases far exceeding, the erosion rate. The Himalayas, for example, rise by about 15 millimeters per year from tectonic uplift. The San Gabriel Mountains north of Los Angeles rise at an average rate of 9 millimeters per year. Lava flows have increased Hawaii's land area by several square miles since the state's admission into the Union in 1959.

The scientific record and Scripture[3] agree that early Earth's surface was more fully covered by water (thus, was smoother) than at present.[4] Through divinely orchestrated volcanic activity, plate tectonics, and other continent-building phenomena, Earth's surface changed from 100 percent oceans and 0 percent continents to about 70 percent oceans and 30 percent continents. Today, this ratio of continents to oceans increases at a much slower rate. Continental land area increases less rapidly today because the continents are being eroded at nearly the same rate as volcanoes, plate tectonics, and other phenomena are building them up.

Volcanic and tectonic activity does not depend on total continental land area,

but erosion does. Therefore, continental land area has continued to increase until the erosion rate now almost equals the buildup rate. Continental buildup from 0 percent of the global surface area to 30 percent requires more than 3 billion years.[5] (If God were to supernaturally accelerate the buildup by a factor of a million, all life would perish.) Thus, continental erosion is an argument for an old, rather than a young, earth.

Exhibit B: **Lunar dust accumulates too quickly to allow for an old earth.**

In the 1950s, before satellites were available, geophysicist Hans Pettersson estimated how much material meteorites deposit on Earth. He did so by measuring the quantity of nickel passing through dust filters on top of Hawaii's Mount Mauna Loa.[6] Since nickel is rarer in Earth's dust than in meteorites, he assumed *all* the nickel he collected came from space. Since nickel accounts for 2.5 percent of meteoritic material, he used the amount of nickel collected to extrapolate the amount of space dust that settles on Earth every year, coming up with a figure of 5 million tons. Given the Moon's gravitational pull and surface area, he then calculated that a 4-billion-year-old Moon would be covered with a layer of space dust 35 feet deep. However, different regions on the Moon's surface have between one-eighth of an inch and three inches of loose surface dust. This lack of dust implies a lunar age of only a few million years. But Pettersson's error bars were so large that by using the edge of each error limit most favorable to a young lunar age, some young-earth advocates whittled the few million years down to about 10,000 years.[7]

Reply: This challenge draws on crude estimates and questionable assumptions, and it ignores subsequent precise measurements made without those assumptions. Pettersson acknowledged that his ground-based instrument measured not only the dust falling from outer space but also Earth material in the atmosphere stirred up by wind erosion and volcanic eruptions. A decade after Pettersson published his estimates, scientists made direct satellite measurements of cosmic dust inflow. Instead of a 5-million-ton annual accumulation on Earth, only 23,000 tons were indicated (1,700 tons per year for the Moon).[8]

The most accurate measurements of meteorite dust influx to date were performed in 1993. These showed 40,000 tons of annual accumulation for Earth and 3,000 tons for the Moon.[9] This tonnage translates into 1.2 inches of surface dust for a 4.5-billion-year-old Moon. When other sources of inflow and outflow (decomposition from ultraviolet radiation, other erosion sources, compactification of older dust, inflow from larger meteorites and comets, and outflow from asteroid and meteorite impacts large enough to expel

debris beyond the pull of the Moon's gravity) are considered, the measured one-eighth to three inches of lunar dust adds up to a lunar surface age of about 4.5 billion years. Erosion of lunar craters, the abundance of argon in the lunar atmosphere and rocks, and radiometric dating of lunar rocks all agree with this age estimate.[10]

Some young-earth creationist leaders now admit that the lack of deep lunar dust is not a good argument for a young solar system.[11] In the 1990s, both the Institute for Creation Research (ICR) and Answers in Genesis (AiG) made this admission publicly.

Since then, however, these organizations have raised an alternative challenge to the Moon's age. They hypothesize a tremendous bombardment of the Moon by asteroids and dust during the Genesis flood and/or at the time of Adam and Eve's sin as a way to account for the shallow layer of dust on the Moon today. They suggest that a recent catastrophe of enormous scope would adequately explain the extensive lunar cratering and the observed erosion of lunar craters.[12]

This explanation, however, contains several irreconcilable flaws. Because of Earth's greater mass and larger diameter, whatever widespread extraterrestrial impact catastrophes might befall the Moon, even larger catastrophes—roughly 30 times larger—would occur simultaneously on Earth. Such disasters would turn all of Earth's surface water to steam, melt its crust, and exterminate all life. Neither the Bible nor nature records any such event in human history. (Human beings and other forms of life have obviously survived.) Nor does such a disaster explain the argon in the Moon's atmosphere or the radiometric dates of lunar rocks.

Exhibit C: **Earth's magnetic field decays too rapidly to allow for an old Earth.**

Earth's magnetic field has decreased steadily since measurements were first taken less than 200 years ago. Based on the magnetic field strength of a typical magnetic star (which exceeds any conceivable value for Earth's) and on the observed rate of weakening, some creationists have calculated that the weakening process began on Earth no more than 20,000 years ago.[13] Thus, Earth's age cannot be greater than 20,000 years.

Reply: Earth's magnetic field does not undergo steady weakening but rather a variable alteration (following a semiperiodic "sinusoidal" pattern). The field weakens, builds up, weakens, builds up, and so on. Proof for this pattern lies in geologic strata found throughout the world. Over the past 400,000 years Earth's magnetic field strength has varied with cycles ranging from 10,000 to 100,000

years.[14] Over the past 12,000 years Earth's magnetic field strength has varied between 85 percent and 150 percent of its current value.[15] Rocks reveal that Earth's magnetic field often reverses its polarity. Geophysicists have discovered over 240 magnetic polarity reversals and excursions that have taken place over the past 40 million years.[16] Time between polarity reversals measures as brief as 5,000 years and as long as 1.2 million years.[17] (The actual reversal event takes about 1 percent of the cycle time to complete.[18]) The last peak in Earth's magnetic field strength occurred roughly 2,700 years ago.[19]

A few young-earth creationist leaders acknowledge that magnetic reversals indeed have occurred. They claim, however, that the old-earth model (based on a dynamo operating in Earth's core) "requires that such reversals occur over thousands of years and at intervals of many thousands of years, [while] the young earth model assumes that the reversals occurred rapidly, within weeks or days."[20] They then use evidence for rapid changes in the direction of magnetic north within cooling volcanic lava flows[21] as "proof" that the young-earth model has triumphed over the old-earth model.

No such triumph has occurred. Only a few of Earth's past magnetic reversals were rapid. Furthermore, those they cite were not global reversals but partial ones, specifically a 50° or less change in direction for magnetic north in rapidly moving material. To claim that a dynamo model cannot account for swift reversals and rapid shifts (by tens of degrees) ignores the computational challenges in building such models; additionally, it is out of date. The first numerical modeling of geomagnetic reversals that successfully predicted (in detail) the full range of paleomagnetic data appeared in 2002.[22] Since then, several research teams have produced models as good or better.[23] In essence, Earth's magnetic field is best described as a global, stable, long-lasting oscillation interrupted by rapid, local directional and amplitude changes.

Magnetic Reversal and the Genesis Flood

Young-earth creationist leaders who acknowledge the reality of magnetic reversals make other indefensible claims about Earth's geomagnetic history. They assert that except for rapid large oscillations during the 13 months of the Genesis flood, Earth's magnetic field has constantly, exponentially declined since the creation of Earth.[24] Specifically they claim that "strong flows of the fluid in Earth's core could produce rapid reversals of the field during and after the Genesis flood."[25] While such strong, rapid flows would be required if

virtually all of Earth's mountain building, continental drift, and volcanic and plate tectonic activity had taken place during the Genesis flood, as young-earth creationists claim, it would have been physically impossible for Noah's ark and its inhabitants to have survived such enormous and sudden energy (seismic, magnetic, and heat) releases.[26] Such sudden and violent energy releases also run counter to the biblical descriptions of the flood and postflood circumstances.

Exhibit D: **The Sun burns by gravitational contraction, so it cannot be billions of years old.**

Before the discovery of nuclear energy, astronomers knew of only one explanation for the Sun's huge energy output: gravitational contraction. If the Sun were indeed generating energy only by this process, its current diameter and energy release would indicate an age of about 100 million years *or less*. Later, when some measurements seemed to confirm a slight decrease in the solar diameter, young-earth creationist leaders claimed this as proof that the Sun is young. This burning-by-contraction conclusion gained even more support among young-earth creationists when astronomers noted a lack of neutrinos in the Sun's radiation. (Burning by nuclear fusion predicts abundant neutrino emission.) Thus, young-earth leaders claimed solid evidence for a Sun younger than 100 million years old.[27]

Reply: This argument overlooks significant data. First, if a Sun-sized body were to experience gravitational contraction, its core temperature and pressure would be so great as to ignite nuclear fusion.[28] Furthermore, various measured characteristics of the Sun—including its effective temperature, luminosity, spectra, radius, outflow of neutrinos (even at a low level), and mass—all establish that the Sun is burning by nuclear fusion and that this fusion has been proceeding for 4.5 billion years. Additional experimental verification comes from several dozen exploded hydrogen bombs and from hundreds of experiments performed in the world's plasma physics laboratories.

As for the observed decrease in the Sun's diameter, the measurements cited were based on photo images taken through ground-based telescopes. The supposed decrease, measuring about one arcsecond per century (the Sun's angular diameter is about 1,800 arcseconds), actually falls within the range of the observations' error bars and was contradicted by other ground-based measurements. The claimed decrease has since been invalidated by results from the Michelson Doppler Imager (MDI) onboard the Solar and Heliospheric Observatory (SOHO) satellite. This amazing instrument supersedes the precision

of ground-based telescopes by several hundred times. It can measure the solar diameter to an accuracy of better than one milliarcsecond (better than 1 part in 1.8 million).

Astronomers had hoped that MDI-SOHO would find a tiny oscillation in the Sun's diameter that would correlate with the 11-year sunspot cycle. In contrast, the young-earth model demands a steady decrease, not an oscillation. Two research teams detected a hint of what they presumed might be the expected oscillation at a level of about 20 milliarcseconds.[29] More recent research efforts, however, determined that variations in the solar diameter must be less than five milliarcseconds.[30] A reanalysis by the French astronomer Luc Damé of the entire seven years of data collected by MDI-SOHO using three distinct sampling and computational methods has established that the solar diameter has not varied by any more than 1.6 milliarcseconds.[31] Damé concluded:

> There is no evidence for any variation in the solar radius. There were no theoretical reasons for large solar radius variations and there is no observational evidence for them with consistent space observations made with 3 different approaches.[32]

Damé's limit falls dramatically short of the decrease required by young-earth models.[33]

Recent scientific research also explains the young-earth creationist claim of a neutrino shortage.[34] For three decades, astronomers puzzled over why they detected only a third of the neutrinos nuclear burning should produce. (They never doubted, though, that the Sun's primary energy source was nuclear burning.) Production of any neutrinos at all was proof enough that significant nuclear burning was occurring. Physicists knew all along that neutrinos come in three "flavors." They also knew that nuclear burning produces only one of the neutrino flavors. Thus, initially, solar neutrino detectors were tuned to just that one neutrino flavor. Recently, however, physicists discovered that neutrinos can oscillate from one flavor to another.[35] This finding has led to the building of a new generation of detectors for solar neutrino telescopes designed to detect all three neutrino flavors.

In 2001, physicists at the Sudbury Neutrino Observatory in Canada and at the Super-Kamiokande Detector in Japan found enough solar neutrinos to confirm that nuclear burning accounts for all or virtually all of the Sun's energy output.[36]

The solar neutrino output and the observed radical oscillations establish that

the Sun is currently in an extremely stable state. Its light emission has remained exceptionally steady over the past 50,000 years and will continue to remain exceptionally steady for the next 50,000. Given the observed structure of the Sun, this circumstance (essential for global human civilization) is physically impossible unless the Sun is "middle-aged," that is, unless it has experienced nuclear burning for the past 4.5 billion years.

It bears repeating (see "Stellar Burning" in chapter 14) that all the young stars observed by astronomers, regardless of mass, burn erratically. All stars of approximately the same mass as the Sun manifest unstable luminosities for their first 50 million years and intense X-ray radiation for their first few hundred million years.

Exhibit E: **Galaxy clusters would be more widely dispersed if the universe were old.**

A cluster of heavenly bodies will remain together (contained) only if the system's gravity is sufficient to overcome the velocities of the individual bodies within the cluster. Armed with measurements of velocities and masses for all the bodies in a cluster, astronomers can calculate either (1) dispersal time (the time it takes for all the bodies to leave the cluster) for clusters with too little mass for gravitational containment, or (2) the relaxation time (time required for the bodies to assume randomized velocities) for clusters with sufficient total mass for gravitational containment. Some creationists point out that when these calculations are applied to galaxy clusters, they show (by the lack of dispersal) ages younger than a billion years.[37]

Reply: This argument rests, first, on an incorrect assumption. It assumes that all the mass within galaxy clusters is luminous. Recent findings, however, show that *most* of the mass is nonluminous (that is, not "shining" by light radiation).[38] In fact, only one-sixth of the universe's total mass is made up of protons, neutrons, and electrons. Astrophysicists call the remaining five-sixths "exotic matter." (See "Finding the Missing Mass.")

Second, this argument rests on a misapplication of the math. Galaxies cannot be treated as mathematical points. Typical diameters for galaxies are only about 10 times smaller than the average distances between them within galaxy clusters. Therefore, dispersal time calculations (which assume galaxies can be treated as mathematical points) fail to yield precise results.

Finding the Missing Mass

Seven different measurements allow astronomers to determine the proportion of luminous matter relative to total matter: (1) angular sizes of the hot and cold spots in the cosmic background radiation; (2) velocities of distant galaxies relative to cosmic expansion; (3) extended rotation curves of galaxies; (4) X-ray gas fraction of mass for clusters of galaxies; (5) relative velocities for pairs of galaxies; (6) clustering of galaxies; and (7) degree of gravitational lensing exhibited by cosmic sources.[39] These measurements show that the mass of dark ordinary matter (brown dwarfs, planets, asteroids, rocks, dust, and cold gas) is four and a half times greater than that of the luminous matter. The total mass (exotic plus ordinary matter) of a galaxy cluster is about 28 times greater than the mass of the luminous matter. This extra mass greatly lengthens galaxy cluster dispersal times. Thus, the dispersals astronomers see in galaxy clusters indicate that those clusters are 10 to 13 billion years old.

By comparison, however, essentially all the mass within star clusters is visible, and the stars within the clusters can be treated as mathematical points. The average distances between them are at least seven orders of magnitude greater (that is, about 10 million times greater) than their average diameters. When dispersal, relaxation time, tidal disruption, orbital decay, and core collapse timescale calculations are applied to star clusters, the math shows several open clusters to be older than 1 billion years and all globular clusters to be older than 2 billion years.[40]

Exhibit F: **The crystal halos that arise from radioactive polonium (^{218}Po) decay indicate that the earth is young.**

Polonium-218 is a radioactive isotope with a half-life[41] of only three minutes. Yet granite crystal “halos” (ring-shaped configurations in the crystals) apparently produced by polonium-218 decay show up in what seem to be “basement,” or primordial, rock deposits. If these halos arise from primordial polonium decay, how did the surrounding rocks crystallize so rapidly?

Young-earth creationist Robert Gentry, among others, claims geologists are wrong in their understanding of the processes shaping Earth’s crust shortly after its formation.[42] He proposes that God imposed Earth’s geological structures instantaneously. If He did this for all structures, then perhaps geological measurements do *not* prove Earth is old.

Reply: *If* the granite crystal halo evidence proves reliable, it simply indicates rapid formation of *certain* rocks, not the entire planet. Old-earth proponents

freely acknowledge that some geological processes occur rapidly. Asteroid collisions, volcanic eruptions, and extraterrestrial radiation bursts, for example, cause sudden geologic effects, and these events occurred much more frequently in Earth's past than they do today.

Gentry remains vague about where he obtained his granite crystal samples. However, phone conversations with Gentry helped geologist Jeffrey Wakefield pinpoint each of the sample sites. Wakefield then visited each location, accompanied by Gentry at one site. Wakefield discovered that Gentry's samples came not from primordial granite, as claimed, but rather from young "dikes" (igneous rock infusions into vertical fissures) that crosscut older igneous and sedimentary rocks.[43] These dikes would have formed much more rapidly (though probably not rapidly enough to explain polonium-218 halos) than the primordial granite.

Even if Gentry's granite crystal halos do result from polonium-218 decay (a possibility most geologists question),[44] Gentry has merely exposed a phenomenon that requires further study, a phenomenon that geologists' current understanding does not explain. He has *not* proven that polonium-218 decay in rocks is a "miracle," a phenomenon outside the laws of physics. Further, Gentry focuses on only one kind of halo. As young-earth creationists admit, polonium-218 halos in rocks occur very rarely.[45] Far more common are uranium-238 and thorium-232 halos. These halos require long time periods to form (over 100 million years) since both have radiometric half-lives in the billions of years.[46]

Some young-earth creationist leaders admit that data on uranium-238 and thorium-232 halos really does appear to establish an old Earth.[47] They suggest, however, that radiometric decay rates may have been greatly accelerated during the 13-month Genesis flood.[48] The problem with this hypothesis is that such an acceleration would have destroyed all life on Earth and devastated both the planet and the universe. (See "Could Radiometric Decay Have Been Greatly Accelerated during the Flood?")

Exhibit G: **Rapid sedimentation and peat deposition following the 1980 Mount St. Helens eruption demonstrate that geological processes are rapid, not gradual. So Earth could be young.**

Within a brief time period (a few months to a few years) following the Mount St. Helens eruption, peat layers and sedimentary rock formed in the volcano's vicinity. Many young-earth creationist leaders claimed these phenomena as proof *against* the theory that geologic layers are deposited according to gradual uniformitarian processes over millions and hundreds of

millions of years. They also declared these findings as proof *for* the geologic viability of a young-earth scenario.[49] They concluded that geological processes provide evidence for a young Earth, not for an old Earth.

Could Radiometric Decay Have Been Greatly Accelerated during the Flood?

Squeezing billions of years of normal radiometric decay into the five months that Noah's ark floated above the floodwaters would have generated an energy pulse intense enough to destroy the ark and all its passengers. Several of the following catastrophes would have occurred: (1) all of Earth's water would have turned to steam and many of its rocks into magma; (2) Earth's crustal plates would have been subjected to sudden tectonic movements adding up to thousands of horizontal miles and tens of thousands of vertical feet; (3) radioisotopes in the bones and organs of animals would have killed the animals; and/or (4) the stability of the Sun's luminosity would have been disrupted.

Astronomers see no evidence of this event. As noted in the previous chapter (see "Nature's Calendars"), radioisotopes embedded in the annual layers of ice and sediment cores, tree rings, coral reefs, and varves confirm that radiometric decay rates have remained constant year-to-year throughout the past few million years, at least. Furthermore, the hypothesis cannot explain why radiometric decay measurements show Earth to be only one-third the age of the universe. If God miraculously accelerated radiometric decay during the Genesis flood, the same number of billions of years would have been added to the apparent age of all bodies in the universe. If, then, Earth and the universe are only thousands of years old, and hyper-accelerated radiometric decay took place during the Genesis flood, no object in the universe would measure as significantly older than Earth.

Reply: The problem lies in what rhetoricians call the "either-or" fallacy—the assumption that *all* geological processes occur either gradually (at relatively uniform constant rates) or rapidly (at rates pulsed by major catastrophes). The young-earth versus old-earth debate is pictured in this context as a battle between the principles of uniformitarianism and the principles of catastrophism, with one significant difference. Catastrophism, as defined by geologists, refers to the formation of geologic structures through a variety of catastrophes occurring at different times. Young-earth creationists define catastrophism as the formation of *all* Earth's major geologic structures by a single catastrophic event, namely the Genesis flood, an event lasting only several months that occurred, according to

them, 5,000 to 10,000 years ago.

As geology and geophysics textbooks explain, both slow and rapid processes contributed to the formation of Earth's crust. Some geological features can be explained only by gradual processes occurring at relatively fixed rates over many millions of years, and others can be explained only by rapid processes.[50] Examples of gradually formed features include coral atolls (islands), layers of ice and rock sediments, varves (two-toned sediment layers that mark the passing of seasons), anthracite coal, and certain conglomerate and metamorphic deposits.

In the case of coral atolls, scientists can measure the daily accumulation of bandlike deposits over millions of years. From these deposits they can make many determinations, including the rate at which Earth's rotation has slowed over the years. Such deposits show that Earth's rotation period has been declining at the same gradual rate for the last 400 million years.[51]

Other geological formations can be explained *only* by rapid processes punctuating uniform processes. Examples include lava flows, avalanche scars, asteroid and meteorite impact craters, polar ice cap shifts, and geologic intrusions. Abundant evidence exists for repeated "disasters" such as these over the last few billion years. Astronomers can calculate, for example, the rate of asteroid and meteorite impacts and compare their findings with the numbers of craters and the degree of weathering observed at crater sites on Earth, Mercury, Venus, Mars, the Moon, and the moons of Jupiter and Saturn. The numbers and the weathering show that the craters did not result from one catastrophe but rather from many catastrophes throughout the last few billion years.

Many more geological formations clearly combine both gradual and rapid processes. The Grand Canyon, for example, reveals intrusions penetrating through several sedimentary layers. Evidence of rapid geological processes, such as those resulting from the Mount St. Helens eruption, fail to support the notion that every structure in Earth's crust formed quickly and simultaneously. It simply illustrates that geology is a complex science.

Exhibit H: **Given that a spiral galaxy's spiral structure winds up and disappears after just three or four rotations of the galaxy, spiral galaxies must be relatively young.**[52]

Newton's laws of motion and astronomical observations both tell us that stars closer to the center of a galaxy will orbit the galaxy much faster than stars far from the galactic center. After a few galactic rotations, the difference in orbital rates would wind up the spiral structure so tightly that the spiral structure would cease to be recognizable. However, astronomers observe many galaxies with marked

spiral patterns, including our own Milky Way Galaxy (MWG). Therefore, these galaxies cannot be more than a few hundred million years old, which casts doubt on other claims astronomers make that these galaxies are billions of years old.[53] Astronomers' attempts to escape the winding-up dilemma by proposing a density wave theory fails to reproduce the detailed spiral structure that astronomers observe in the nearby spiral galaxy M51.[54]

Reply: Young-earth creationists would be correct about spiral arms' windup *if* the arms were material structures. But they are not. As first explained in 1964 by theoreticians Chia-Chiao Lin and Frank Shu, galaxy spiral arms are (to a first order approximation) density waves.[55] Stars within a galaxy constantly pass into and out of spiral arms. An analogy would be a dense knot of cars on a highway. The traffic jam may be fixed in its location on the highway. However, the cars in the jam are not. As cars exit the knot, new cars enter the knot to replace those that left.

Astronomers note that the spiral arms are regions of increased gas density.[56] Because of the increased gas density, new, massive, and therefore very bright stars form there. As a star approaches a spiral arm, it will speed up due to the gravity of the stars and gas in the arm. As a star leaves a spiral arm, it slows down, again because of the gravitational influence of the arm's stars and gas. Thus, stellar dynamics stabilize the spiral arm pattern so that it remains not just for hundreds of millions of years but for billions of years.

It must be emphasized that the stars within spiral arms are not fixed components of the arms. As long as the galaxy is accreting enough gas to sustain the increased gas density of the density waves and, thus, to stimulate star formation, the spiral arm pattern will be sustained. Gas accretion normally occurs through a spiral galaxy's absorption of the gas-rich dwarf galaxies in its vicinity.

Computer simulations based on density wave theory show that spiral arms can be sustained for several tens of rotations, that is, for well over ten billion years.[57] In the nearby galaxy M81, astronomers successfully traced the spiral density waves, extracted both the amplitude and the phase of the density wave, and determined that M81's spiral structure must be long-lived (stable for at least the past several billion years).[58] Different teams of astronomers demonstrated density wave theory's success in explaining the abundance gradients of heavy elements in spiral galaxies[59] and in describing stellar streaming motions along the Sagittarius spiral arm of the MWG.[60]

Density wave theory also predicts that astronomers should observe both a specified star color and a specified star age azimuthal (referring to an angular measure) gradient across the arms of isolated spiral galaxies.[61] In a detailed study

of thirteen spiral galaxies, astronomers found that ten matched the theoretical predictions.[62]

A score as high as ten out of thirteen was judged a great success for the theory. Spiral galaxies are much more complex than just an isolated system of gas, stars, and density waves. Some exhibit not only horizontal density waves but also vertical density waves.[63] They all are surrounded by ordinary dark matter (matter made up of particles that strongly interact with photons) and halos of exotic dark matter (matter made up of particles that weakly interact with photons).[64] They are being gravitationally perturbed by other galaxies in their vicinity. They sometimes experience a starburst event (explosive star formation). The central bulge can be transformed into a bar-like structure, and the spiral arms can bifurcate into multiple arms. These circumstances cause the symmetrical spiral structure predicted by first-order density wave theory to be warped, frayed, feathered, and distorted. Indeed, warped, frayed, feathered, and distorted arms are the norm for spiral galaxies.

The extensive spiral arm erosion astronomers observe is a clear sign of galaxy aging. These eroded galaxies must be billions of years old. Furthermore, astrophysicists have generalized the Lin-Shu density wave model to take into account nonlinearities and asymmetries. These new models now successfully predict the detailed spiral structure that astronomers observe.[65] They also have demonstrated success in predicting the inner spiral structure of M51A (NGC 5194),[66] a highly disturbed galaxy undergoing a merger with another galaxy, M51B (NGC 5195). (See figure 17.) No scientific basis remains for doubting the great ages of galaxies.



Figure 17: The Whirlpool Galaxy, M51
The first galaxy to be recognized as a spiral, M51 lies at a distance of 23 million light-years. The spiral arms of the larger galaxy, M51A, are being markedly disturbed by the gravity of the smaller galaxy, M51B. So an advanced, multiple-parameter density wave theory is needed to describe the dynamics and age of M51A's spiral structure. Credit: NASA/ESA/Hubble (STScI/AURA)

Exhibit I: **Trails of human footprints beside or crossing over dinosaur prints prove that dinosaurs were contemporaneous with humans, not millions of years old.**

Some young-earth creationist leaders have widely publicized the supposed discovery of human footprints alongside prints clearly made by dinosaurs.[67] If dinosaurs thrived as recently as a few thousand years ago, the geological strata in which the prints were found could not have been deposited tens of millions of years ago, as geologists claim. They would have been laid down just a few thousand years ago. Thus, neither dinosaurs nor Earth's strata can be used as arguments for an ancient Earth.

Reply: The dinosaur prints at the discovery sites have been identified as belonging to tridactyls, three-toed carnivorous dinosaurs. Due to the mud's viscosity and composition, the dinosaurs' weight and gait, and the lack of erosion, most of the tridactyl prints are well preserved and relatively easy to identify. But not all. Given some areas of deep, soft, low-viscosity mud, some prints would be much smaller than the animal's foot and the print poorly defined. Such variations in mud are common. Thus, the dinosaur prints in question could easily be small enough and unclear enough to resemble human footprints.

Many other markers have led paleontologists—Christians among them—to conclude that these "human" footprints were made by dinosaurs:

- The footprints are too far apart to be made by humans. They fit well, however, with the length of the dinosaurs' stride.
- Most of the "human" prints are too large and undefined to have been made by humans.
- Some of the "human" prints show dinosaur features, for example, claw marks, anterior V-shaped splaying, fissure patterns, and drag or swish marks from a tail or snout.
- The line of supposed "human" prints often blends into a line of near-perfect tridactyl prints.
- Almost all of the "human" prints have indentation patterns and colorations uniquely indicative of tridactyl dinosaurs.
- Many prints that were claimed to be "human" turned out to be mere erosion patterns.

For these reasons and more, both secular and Christian scholars see insufficient basis for claiming that any of the footprints in question are human and abundant evidence to say they are not.[68] To their credit, many young-earth creationist leaders have ceased from making the claim and have removed books and films about it from circulation.[69]

Exhibit J: **Since a comet's average life span is only a few thousand years and the supply of new comets is limited, the existence of comets today proves the solar system cannot be more than several thousand years old.**

Comets (such as Halley's) orbiting the solar system reportedly disintegrate in an average of about 2,000 years. Every time a comet swings close by the Sun, the Sun's heat and light boil away a significant portion of the comet's mass. After a few dozen revolutions, nothing of the comet remains. Since comets are still orbiting the Sun, and since no obvious source for replenishing these comets exists, the solar system must be only a few thousand years old.[70]

Reply: Estimates of comets' average disintegration time date back to the 1970s. At that time, no space-based studies of comets were available. Calculations were based on easy-to-see comets, and the easiest comets to see are those that pass closest to the Sun, thus suffering the most rapid disintegration. So estimates of average comet longevity made prior to 1980 leaned heavily to the

low side.

In 1986, five spacecraft visited Halley's comet and made the first accurate measurements of both its mass and disintegration rate. Data showed the comet massive enough to survive at least another 500 revolutions around the Sun.[71] Measurements of the mass of Halley's meteor stream and of Halley's change in absolute luminosity with each close passage of the Sun indicate that the comet has had 2,300 previous close passages of the Sun.[72] Observations going back to 240 BC establish that Halley orbits the Sun every 76 years. Thus, Halley's life span must cover at least 212,000 years.

Halley's comet has a relatively short orbital period. Comets such as Kohoutek, which orbits the Sun every 75,000 years;[73] Pons-Brooke and Griggs-Mellish, which orbit every 3 million years;[74] Comet West and C/1999 F1, which orbit every 6 million years;[75] and C/1980 E1, which orbits every 7.1 million years[76] are much more typical. Best estimates of these comets' life spans come in at roughly 160 million, 6 billion, 12 billion, and 14 billion years, respectively.[77]

These age determinations presume that comets remain consistently active throughout their lifetime, but they do not. In the case of several short-period comets, their active phases are interspersed among dormant phases during which they remain completely, or almost completely, inactive.[78] Such periods of inactivity greatly extend the comets' longevity.

Astronomers can now measure the ages of short-period comets via ablation (the wearing away of a comet's outer layers). Short-period comets of greater ages show less dust in their spectra than do comets of lesser ages because of ablation. Measurements of the dust-to-gas ratio in the spectra of such comets reveal that many of them have resided in short-period orbits for over a million years.[79]

Similarly, the proportion of crystalline dust in a comet indicates its age. Measurements of such dust show that many of the solar system's comets have existed for at least several million years.[80]

Comets not only last much longer but they are also vastly more abundant than young-earth proponents presume. Until recently, astronomers were unable to see comets any more distant than Jupiter and Saturn. The frequency with which they observed comets and the orbital paths of short- and long-period comets, nonetheless, enabled them to deduce that these comets must have originated from two separate and vast clouds of comets, one just beyond Neptune's orbit (4–6 billion miles away) and the other situated at even greater distances (0.2–5 trillion miles). Astronomers named the former the Kuiper Belt

and the latter, the Oort Cloud in honor of the astronomers who first determined the comet clouds' existence.

Today, the existence of Kuiper Belt and Oort Cloud comets is no longer based solely on theoretical calculations. Technological advance, such as replacing photographic plates with charged coupled devices and using supercomputers for image processing, not to mention the availability of a new generation of very large telescopes, has equipped astronomers to detect, so far, more than 1,200 Kuiper Belt objects,[81] five inner Oort Cloud members (Sedna, 2010 WG9,[82] 2000 CR_{105}, 2006 SQ_{372}, and 2008 KV_{42}), and 400 long-period comets at distances that exceed a hundred times Earth's distance from the Sun (greater than 9 billion miles away).[83]

In addition to finding the two distant comet clouds, astronomers have found a third distant comet repository, "the scattered disc." Scattered disc comets have very high orbital eccentricities (up to 0.8) and inclinations (up to 40°). Their orbits lie between 35–1,000 times Earth's distance from the Sun. So far, astronomers have discovered 277 scattered disc comets.[84]

Astronomers have deduced that the extreme orbits of vastly distant objects result from gravitational "scattering" induced by Jupiter, Saturn, Uranus, and especially by Neptune. This relatively large number of scattered disc objects manifesting the orbital properties astronomers observe implies that the gravitational scattering has been operating for orders of magnitude longer than what any young-earth creationist model would tolerate.

Yet another population of comets exists between the orbits of Jupiter and Neptune. These comets are the Centaurs. So far, 105 Centaurs have been detected.[85]

Dynamical models and detailed numerical simulations performed by astronomers demonstrate that encounters between the Sun and nearby stars and also between the Sun and the MWG's disc gravitationally perturb the Oort Cloud while the gas giant planets gravitationally perturb the Kuiper Belt. These perturbations feed comets from the Oort Cloud and Kuiper Belt into the scattered disc. Next, gravitational interactions by the gas giant planets on scattered disc objects feed comets from the disc into the population of Centaurs. Gravitational interactions between the Centaurs and the gas giant planets appear to be the primary source of the periodic comets that penetrate the inner solar system, while secondary sources are gravitational perturbations that directly transform Oort Cloud, Kuiper Belt, and scattered disc objects into inner solar system periodic comets.[86] These dynamical mechanisms, deduced from the observed populations of Oort Cloud, Kuiper Belt, scattered disc, and Centaur objects,

easily explain in the context of a 4.6-billion-year-old solar system all the short- and long-period comets astronomers have seen.

Some young-earth creationist scientists now acknowledge that their former claims of "absolutely no evidence it [the Oort Cloud] even exists"[87] and that "the discovery of objects beyond Neptune does not in any way confirm a Kuiper Belt"[88] can no longer be sustained. Rather, they attempt to salvage their young-earth position by claiming that the discovered objects are "too few" and "too large."[89]

This claim overlooks three important observational factors. First, current technology prevents astronomers from detecting anything other than the largest —Oort Cloud, Kuiper Belt, scattered disc, and Centaur objects. Smaller objects are simply too faint to be seen. Second, the large objects astronomers do see possess the same chemical composition as the nuclei of comets that penetrate the inner solar system. Thus, no basis exists for concluding that the smaller objects would be substantively distinct.

Third, astronomers note that the objects they observe roughly obey both a mass- and a luminosity-power-law distribution. The numbers of Oort Cloud, Kuiper Belt, scattered disc, and Centaur objects astronomers are able to detect are inversely proportional to both the luminosity and mass of the objects. Astronomers see the same power-law features in the comets that penetrate the inner solar system. They also see evidence that the population of small Kuiper Belt objects (objects with radii less than 0.1 kilometer) has been significantly enhanced by collisions breaking up larger Kuiper Belt objects and that this collisional production of small objects must have been occurring for several billion years.[90] Therefore, astronomers are fully justified in concluding that small Oort Cloud, Kuiper Belt, scattered disc, and Centaur objects must exist and in far greater numbers than the large objects.

The Sun is not alone in hosting comet populations akin to the Oort Cloud, Kuiper Belt, and scattered disc. Astronomers are discovering such clouds, belts, and discs orbiting nearby stars.[91] In many cases the observed clouds, belts, and discs are orders of magnitude denser than those orbiting the Sun.[92] Even white dwarf stars (old burnt-out stars) have been observed to possess such comet populations.[93] Given that every star we can study closely enough to detect its comet populations indeed possesses such populations, astronomers conclude that virtually all stars must possess clouds, belts, and discs of comets as dense as or denser than the Sun's.

Because virtually all stars possess comet populations, the Sun throughout its history would have picked up additional comets via close encounters with other

stars. In these encounters the more massive star will gain more comets than it loses. The Sun is more massive than 89 percent of all other stars in the MWG.[94] Thus, in stellar encounters, the Sun more frequently gains than loses comets.

Earth and the solar system's meteorites contain high levels of the heaviest elements and radioisotopes. Such high abundances imply that the solar system was formed in a star cluster containing at least several thousand stars.[95]

This conclusion favorably alters the former model for the formation of Oort Cloud comets. In this old model, Oort Cloud comets form in the Sun's protoplanetary disc and are ejected to large heliocentric orbits by gravitational interactions exerted by Jupiter, Saturn, Uranus, and Neptune.[96] However, astronomers observe and deduce far more comets in the Oort Cloud than what this limited model predicts. Detailed numerical simulations demonstrate, though, that the Sun captured enormous numbers of comets from other stars while it was still in its birth cluster. These simulations show that more than 90 percent of the Oort Cloud comets may have been captured from the protoplanetary discs of other stars in the Sun's birth cluster.[97]

In addition to all the comets the Sun accumulated from other stars in its cluster of origin, it gained still more from passing stars after its ejection from the original cluster. Several research teams calculated that at least 5 percent of Oort Cloud comets came from encounters with passing stars over the past 4 billion years.[98] What's more, these encounters pumped up the orbital eccentricity of existing Oort Cloud comets by such a degree as to largely explain all the long-period comets we see penetrating the inner solar system.[99]

There is no supply problem, as it turns out, for all the long- and short-period comets that astronomers observe in the context of a 4.57-billion-year-old solar system.

Comets and other Kuiper Belt objects observed by astronomers show multiple signs of age, at least a few billion years' worth. These signs run the gamut from loss of the most volatile ices due to radioactive heating, to dust production from collision events, to crater statistics of the solar system's planets, moons, and asteroids, to dynamical studies of the solar system's past planetary migrations and stellar encounters.[100]

In particular, galactic cosmic rays continuously sputter the surfaces of comets and break chemical bonds so as to reorder the surface ice matrix.[101] The most observable impact of such radiation is a darkening of the comet's surface.[102] Since Kuiper Belt comets are close enough to the Sun to be shielded by the heliosphere, they are significantly less darkened by galactic cosmic rays.

On the other hand, collisions between Kuiper Belt comets occur a million times more frequently than they do for Oort Cloud comets.[103] Consequently, Kuiper Belt comets are smaller and much more collisional dust resides in the Kuiper Belt.

The Oort Cloud environment is much more strongly influenced by gravitational perturbations from passing stars and galactic tides than the Kuiper Belt region. Astronomers observe the distinct signature of these perturbations over the past 4 billion years in the dynamics of Oort Cloud comets.[104]

Galactic cosmic rays, collisions, and stellar encounters age distant comets in different ways, and each of them ages Oort Cloud comets in a distinctly different manner from Kuiper Belt comets. These three factors independently establish the existence of a large number of Oort Cloud comets. They also establish that solar system comets have orbited the Sun for about 4 billion years.

Exhibit K: **The lack of greatly expanded supernova remnants proves that such remnants have been expanding for no more than (probably less than) a few tens of thousands of years.**

When a massive star nearly runs out of fuel, it blows off its outer layers. As a consequence of this explosion, remnants of the star's material expand outward. The force of the explosion is powerful enough to sustain the expansion for hundreds of thousands of years. Therefore astronomers' inability to observe widely expanded supernova remnants (SNRs) suggests to young-earth advocates that our galaxy has existed for less than several hundred thousand years.[105]

Reply: The mere existence of SNRs says that our galaxy and other galaxies are old. Supernova explosions occur only when a massive star has burned up nearly all its nuclear fuel, and this burning process takes several million years—even longer for less massive stars.

Observational difficulties, rather than an actual deficiency of SNRs, lie at the core of this cosmic age challenge. Throughout all galaxies, powerful tidal forces rip apart and disperse SNRs. Also, the ripped remains of previous generations of SNRs lay scattered here and there. The older the galaxy, the more difficult it is for astronomers to distinguish one widely expanded supernova remnant from the background remains of earlier supernova events.

Astronomers encounter other observational limitations. Even when SNRs are relatively young, their expanding shells frequently depart markedly from spherical symmetry.[106] When they are expanding into a magnetized interstellar medium, the magnetized medium will stop the shells' expansion, within 500,000 to 2,000,000 years, and subsequently force the shells to contract.[107] Many SNRs

disperse much more rapidly than the norm. For example, the remnant CTA 1, though only 4,600 light-years away now extends more than three Moon diameters across the sky.[108] Measurements show that CTA 1 reached this extent in 13,000 years.[109]

A few years ago, astronomers used the Very Large Array (an array of 27 radio telescopes) to conduct the first high-resolution survey of SNRs in an especially crowded region of the MWG. Their survey "nearly tripled the number of SNRs known in this part of the Galaxy."[110] Thus, the team concluded that "further deep, low-frequency surveys of the inner Galaxy will resolve the discrepancy between the expected number of Galactic SNRs and the significantly smaller number of currently known SNRs."[111]

Another problem astronomers face in attempting to detect widely expanded SNRs comes from older SNRs' resemblance to the image profiles of X-ray binaries and ionized hydrogen clouds. The older the SNR and the denser and older its home galaxy, the more difficult its detection.

The MWG is so littered with the scattered remains of SNRs, X-ray binaries, and ionized hydrogen clouds that it took astronomers years to find a widely expanded SNR they could clearly identify. But that breakthrough finally came in 2002. They discovered an extended supernova remnant right in our own solar system's neighborhood.[112] This remnant, centered on the constellation Antlia Pneumatica, is vastly expanded (subtending an angular diameter of 24°), and astronomers have calculated its age to be at least 1.1 million years.

An even older SNR, identified as GSH 138-01-94, was detected in the far outer edge of our galaxy.[113] Astronomers Jeroen Stil and Judith Irwin measured its age as 4.3 million years. Stil and Irwin further noted that old SNRs can be seen only "in low density, low metallicity environments such as the outer Galaxy, dwarf galaxies, and low surface brightness galaxies."[114] Recently, astronomer Rosa Williams discovered some old (million-year plus) SNRs in the two Magellanic Clouds, dwarf galaxies that orbit our galaxy.[115] More recently, astronomers determined the expansion ages for four specific SNRs in the MWG: 1,000,000 years,[116] 330,000 years,[117] 300,000 years,[118] and 300,000 years,[119] respectively. In M83, a galaxy 14.7 million light-years away, a team of 26 astronomers discovered seven SNRs with expanding shells so large as to indicate that all seven are older than 100,000 years.[120] In M101, a galaxy 20.9 million light-years away, another astronomer team measured M101's largest SNR to be at least 1.23 million years old.[121] Also, in the gravitationally lensed quasar QSO B1422+231 some 11.8 billion light-years away, astronomers found an SNR with

an angular size and expansion velocity to suggest an age of 400,000 years.[122]

These SNR ages are *not* their current ages. Rather, they are the ages at the respective look-back times. So, for example, the current age of the SNR in M101 = 1.23 (or more) million years + 20.9 million years, and the one in QSO B1422+231 = 400,000 years + 11.8 billion years.

Exhibit L: **Backward-rotating planets and backward-revolving moons in the solar system demonstrate that the solar system cannot be very old.**

If all the planets and moons in the solar system condensed out of the same primordial nebula, they should all rotate and revolve in the same direction. But they do not. Uranus rotates on its side, while Mercury, Venus, and several of the moons of the gas giants revolve in a direction opposite to that of all the other planets and moons in the solar system. It would seem, then, that the solar system did not form out of some primordial nebula through a long process of condensation[123] but rather that Earth was created first, then the Sun and the rest of the solar system bodies, perhaps in a matter of hours.

Reply: The standard model for our solar system's formation does *not* predict, as this challenge assumes, that all the solar system bodies will rotate and revolve in the same direction as the Sun. Planets as close to the Sun as Mercury and Venus are impacted dramatically by the Sun's tidal torques over the course of a few billion years. Such forces slow down these planets' rotation periods till they're as slow as or even slower than their revolution rates. Thus, Mercury may appear to be, but actually is not, exhibiting angular momentum opposite to the rest of the planets. Any planet that rotates more slowly than it revolves merely *seems* to rotate backward (unlike planets that rotate more rapidly than they revolve).

Young-earth proponents' assumptions about planets' rotation axes are also incorrect. Among all the solar system's planets, only Earth maintains a stable rotation axis tilt. This stability exists because Earth is unique—a small planet orbited by a single large moon. The rest of the solar system's planets experience some gradual change in their axial tilt. Thus, if the solar system is several billion years old, one would not be surprised to find Uranus' rotation axis tilted 98° relative to the plane of the solar system, Venus' by 177°, and Pluto's by 122°. Any planet that has its rotation axis tilted by more than 90° will appear to rotate backward even though it begins by rotating frontward.

Backward-revolving moons can also be explained in the context of great age. Not all the solar system's moons are indigenous to their planets. Several were captured. The probability of a planet's capturing an interplanetary body (for

example, an asteroid), and thus making it one of its moons, depends on that planet's mass and distance from the Sun. All four of the solar system's gas giants, then, would be expected to capture interplanetary bodies over the course of a few billion years. Since the direction of capture is random, captured bodies will manifest a 50 percent probability of revolving in the direction opposite to that of the planet's rotation and to the revolution of the planet's indigenous moons.

Does Lunar Recession Refute an Old Earth?

Lunar recession refers to the Moon's movement away from Earth due to transfer of angular momentum from Earth to Moon as a consequence of the tidal interaction of the Earth-Moon system. Lunar laser ranging establishes that the Moon is receding from Earth at a rate of 3.82 ± 0.07 centimeters per year.[124] Assuming a simplified model of the Earth-Moon system (no other perturbing bodies, no interference from gas, dust, or debris, no partial or total tidal-locking episodes, no changes in the continents or oceans, and both bodies presumed to be spherical, solid, and of uniform density), physicist Louis Slichter determined in 1963 that the Moon could not have been receding from Earth for more than 1.4–2.3 billion years.[125] Young-earth creationists cite this work and other simple-model calculations to assert that old-earth creationists must be wrong to claim Earth is 4.5662 billion years old and the Moon about a hundred million years younger.

However, Slichter pointed out that the conflict is resolved if the Moon's tidal torque (which slows down Earth's rotation rate) was less forceful in the past than it is now. In 1982, physicist Kirk Hansen showed that the number, sizes, shapes, and geographical placements of the continents and their accompanying continental shelves hugely impact the Moon's tidal torque on Earth.[126] Noting that today's continental features generate anomalously high tidal torques from both the Moon and Sun compared to typical continental features in the past, Hansen showed that the Moon sat a comfortable distance from Earth 4.5 billion years ago.

Plate tectonics models and geophysical measurements confirm what scientists call the supercontinent cycle: a single supercontinent breaks up into many smaller continents, which spread apart and later come back together to form a different single supercontinent. This cycle repeats roughly every half billion years. As Hansen demonstrated, a single supercontinent allows less tidal torquing than Earth's present continental configuration.

Tidally laminated sediments (which measure the tidal torque strength) and coral reef bands (which measure Earth's rotation rate) confirm a weaker torque in the past. This data shows that the assumptions undergirding the simple model for the tidal interaction of the Earth-Moon system are incorrect. The Moon's recession poses no difficulty for an old-earth view. In fact, tidally laminated sediments and coral reef bands add to the overwhelming scientific evidence for Earth's antiquity.

The processes involved in moon capture, in radical tilting of a planet's rotation axis, and in significant slowing of a planet's rotation rate take millions of years to work their effects. They speak of age, not youth.

Similarly, arguments that the Moon is spiraling away from Earth at too rapid a pace (see "Does Lunar Recession Refute an Old Earth?"), that Earth's rotation rate is slowing down too quickly, and that the Sun is consuming interplanetary dust at too rapid a rate for the earth, Moon, and solar system to be as old as a few billion years are all invalid.[127] Once critical omissions, oversimplifications, and miscalculations are explained and corrected, these arguments for a young solar system transform into arguments for an old solar system.

Provocative Problems

John Morris, a geological engineer and current president of the Institute for Creation Research (ICR), once acknowledged in a radio interview that he has never met (or heard of) a scientist who became convinced on the basis of science alone that the universe or Earth is only thousands of years old.[128] Several other prominent young-earth advocates, when asked, have acknowledged the same.[129]

The vigor with which some young-universe creationist leaders proclaim scientific support for their position tempts some secularists to impugn their motives. Australian geologist Ian Plimer published a book entitled *Telling Lies for God*, in which he charges young-earth creation advocates with outright deception.[130] Other secular scientists have made harsh, condemning remarks in print and on broadcast media.

In light of the theological constraints on young-earth creationist leaders, their position seems understandable. Most believe that if they're wrong on the age of the earth, the basis for their Christian faith—the truth of the Bible—is invalidated.[131] Thus, most young-earth creation leaders remain convinced that the overwhelming scientific evidence for an ancient Earth and universe *must be false*. They can give *no* ground. To accept the scientific signs of age might, in their own words, start them "down a slippery slope" toward apostasy. Such great

concern leads some to even doubt that science can detect physical reality—the subject of the next chapter.

Chapter 18

Physical Reality Breaks through the Fog

Many young-earth creationist leaders declare that their view *is* reality and that virtually all of what has been discovered in the hard sciences is *not* what scientists think it is. This apparent antiscience position obscures physical reality in a dense fog. Galaxies, stars, fossils, dinosaurs, Neanderthals, and many other subjects of scientific inquiry remain cloaked in mystery, supposedly lacking satisfactory explanation. This refusal to acknowledge established data causes many people to dismiss belief in creationism as either complete idiocy or downright deception.

According to geology professor Ian Plimer, "Creationism has no intellectual framework. Creationism is an anti-intellectual attack on all of science."[1] He continues by asking rhetorical questions: "Have they any evidence at all? Have they concocted evidence *ex nihilo*? Have the creation 'scientists' deliberately deceived their followers with erroneous science? Are creation 'scientists' guilty of science fraud?"[2] Michael Ruse, professor of history and philosophy of science, wrote, "Creationists are obviously so impervious to the effects of empirical evidence."[3] Physics Nobel Laureate Murray Gell-Mann compared the Louisiana legislature's decision to mandate "creation science" teaching with Stalin's (and his immediate successors') insistence on the teaching of "the pseudo-science doctrine of Lysenko," which had "adverse effects on agriculture as well as on teaching and research."[4]

The age-old power struggle between creationists and scientists began long before Galileo, but in some ways his story resembles the current conflict. Shedding some light on this tug-of-war begins to chase away the haze and bring truth about physical reality into clearer focus.

Galileo and the Church

In the early 1600s, Roman Catholic authorities refused Galileo's invitation to look through his telescope. They were not interested in visual images of a Sun-centered planetary system. Cardinal Bellarmine formally admonished Galileo for

advocating what he called “realist Copernicanism.”[5] (In the preface of his book, *On the Revolution of the Celestial Spheres*, Copernicus encouraged readers to understand his description of the solar system as a convenient mathematical model and not a portrayal of physical reality.) The Roman Catholic authorities’ greatest fear was not the physics or theology of heliocentrism. In fact, before this incident, the Pope himself had endorsed a Sun-centered solar system. But the Roman Catholic prelates were afraid that laypeople might follow Galileo’s example and begin to publicly challenge biblical interpretations once taught only by priests, bishops, and cardinals. Laypeople were strongly discouraged from even reading the Bible. Only highly trained priests were deemed capable of properly interpreting Scripture.

Animosity stirred by the Galileo incident began to resolve as the church recognized the impossibility of keeping the Bible out of its parishioners’ hands. Some church leaders discovered that encouraging laypeople to read and study the Bible for themselves actually strengthened, instead of weakened, the role of the church. They also discovered that astronomy and the acceptance of its implications about the heavens supported, rather than undermined, biblical authority. A century later, the Roman Catholic Church founded the Vatican Observatory, which functions to this day—funding important research and scientific conferences.

A Dismal Outlook

Even though the Roman Catholic Church settled its differences with Copernicus and (eventually) with Galileo, much of the evangelical Christian community still feels a need to deny the antiquity of the universe, Earth, and plant and animal life. The idea of a long history of plant and animal decay and death is difficult for some to face. Integrating such a seemingly harsh reality with that of a loving, omniscient, omnipotent God can present a significant emotional and spiritual challenge. If no such history happened before Adam and Eve sinned, that pain and problem shrink to fit what seems a more understandable and tolerable framework.

Christian orthodoxy must, however, remain alert to this denial of physical history and its implications. Young-earth creationism implies (and sometimes states explicitly) that only those astronomers, geologists, and other scientists who embrace their particular interpretation of “day” in Genesis 1 have the capacity to recognize what’s true and what’s not. Their words paint a picture of nature—the starry hosts and everything in or on Earth’s crust that speak of long ages—as shrouded in a dense, impenetrable fog. The stars, rocks, and fossils studied by scientists remain hopelessly veiled in mystery, they say, and prone to

distorted interpretation by sin-darkened minds.

Such a view may seem to be backed by Bible verses about the truth-distorting effects of sin (effects I freely acknowledge), but these texts must be handled with care. Even Romans 1, which describes the process by which people's minds become darkened, affirms that nature gives *true* testimony to all people about the existence and characteristics of the Creator. Repeated refusal to acknowledge the Creator and bow in worship to Him leads to spiritual and moral darkness. It leads to belief in lies about the person and work of Jesus Christ.

Many young-earth leaders seem to have misidentified where the "slippery slope" of apostasy begins and ends. They suggest that it begins with a willingness to consider creation days as anything other than consecutive calendar days. Because of that misidentification, believers who teach a billions-of-years-old universe and Earth are often barred by young-earth creationists from speaking in evangelical churches and colleges.[6] Old-earth Christians are often treated as if they have nothing valuable to add to the age-of-the-earth debate or, worse yet, as if they are in danger of denying or distorting the gospel and leading people astray. Only young-earth proponents are considered worthy of the pulpit or platform.

A Biblical Response

This closing of ranks, along with the denial of physical history and the physical implications of that history, blatantly contradicts the New Testament message. Paul taught that all believers belong to one body and that all parts of the body are equally important to the whole (Romans 12:3–8; 1 Corinthians 12:14–31). The New Testament clearly repudiates the notion of a spiritual caste system (Galatians 3:26–29; Colossians 3:11). In Galatians and Colossians, Paul condemned the teachings of those who treated the material realm as "unreal" (in some respect imaginary or illusory).

Fallen Perception

Some young-earth creationist leaders insist that they are not the ones denying physical facts. Rather, they claim, sin causes unbelieving scientists and Christian old-earth creationists to misinterpret nature. James Jordan, for example, asserted that "the creation is designed in such a way that it does not yield its character—its secrets so to speak—to unbelief."[7] Thus, he concluded that "only Christians can understand creation rightly."[8] But he did not include all Christians. Jordan acknowledged that many Christian leaders believe that the universe and Earth are billions of years old. He declared sin as the only possible reason for their

conclusion.[9] Likewise, Ken Ham affirmed that "when sin defaced the image of God back in the Garden of Eden, it marred man's ability to think."[10]

For these young-earth creationists, man's confused and sinful mind is not the only problem. They also consider the record of nature to be a feeble, unstable revelation. Jordan called the witness of nature "cloudy," "questionable," and "temporary."[11] He said that "scientists are dealing with only a very few facts"[12] and that astronomers have just begun to scratch "the first inch of the foyer of the outer universe."[13] He declared that science is unable "to speak of past or future things."[14] He asked, "In a hundred years will anyone still believe that you cannot go faster than light"[15] or that "the red-shift in the spectra of stars is caused by the rapid movement away from us in an 'expanding universe'?"[16] His summation: "Why on earth should anyone, especially thinking Christians, commit themselves to the temporary notions of 'scientific' theories?"[17]

According to young-earth creationist leaders, the star formation that astronomers claim to see is not really happening since all stars were made during the fourth creation day.[18] The supernova eruption astronomers see in the Large Magellanic Cloud 163,000 light-years away did not occur 163,000 years ago. Fossils do not represent ancient creatures. Coal, oil, gas, and topsoil are not the remains of thousands of previous generations of life. Nor do most of the stratified layers of Earth's crust testify of rocks subjected to long-term pressure, erosion, and stress. Nor do coral bands and ice layers demark real years past. Nor does the erosion of craters and mountains on Earth, other planets, and moons result from real, ongoing natural processes.

All these things must be illusions, according to a young-universe creationist perspective, and "knowledge" of anything apart from the Bible's words cannot be trusted. As Henry Morris insisted, the "direct [written] testimony from the Creator [is] the only way to know the age of the earth."[19] Consequently, such leaders say, virtually all research, including the vast scientific database, has led humanity astray.

The Way Back to Reality

The fear that incites such a strong denial of physical reality and cosmic history implications must be addressed. This fear runs deeper and wider than the specific case of creation timescales. Underlying the sweeping denigration of old-earth views is the fear that science research may someday uncover some "new fact" about the universe, Earth, or life that clearly contradicts the Bible's message. To the extent that this threat looms as a real possibility, it hampers a

person's ability to experience the freedom and fearlessness God made available by His Spirit. "God has not given us a spirit of fear, but of power and of love and of a sound mind" (2 Timothy 1:7, NKJV).

If we take the Bible seriously and literally, no basis for such a fear exists. Since God created the cosmos, there can be no contradiction between what He has made and what He has spoken through the inspired writers of Scripture. The testimony of both will always agree, and we need never back away from facts that may appear daunting to our faith. We need only study and investigate further, checking for accuracy—the accuracy of scientific interpretations and the accuracy of biblical interpretations.

To question and challenge scientists' interpretations of new findings may seem intimidating, but it can be done respectfully, on the basis of facts. The facts will always be on the side of truth, even if the interpretations placed on them are not. Adamantly trying to defend pseudoscientific assertions, denying demonstrably correct data from nature, or expressing arrogance and disrespect will only result in a failure to communicate powerful evidence—faith-building evidence.

A Clear View of Reality

Perhaps the most tragic aspect of denying nature's scientifically established characteristics is that such a denial forces the rejection of timely, compelling evidences for the God of the Bible and for the accuracy and authority of His Word. Four examples of observations and interpretations on which the community of research astronomers and physicists agree are given as follows. Each carries enormous theological significance, which the majority of scientists also acknowledge.

1. *Science says:* The universe is billions of years old, but only billions, not quadrillions of years old or a near-infinite age.
   Theological significance: Religious and philosophical systems depending on infinite or near-infinite age have no foundation in reality. (These include most New Age and Eastern religions as well as many atheistic, naturalistic philosophies.)
2. *Science says:* The universe can be traced back to a single, ultimate, simultaneous origin of matter, energy, space, and time.[20]
   Theological significance: Reincarnating universe theologies and philosophies have no foundation in reality. The cause of the universe—that is, the Entity (Creator) who brought the universe into existence—existed

and created from outside (independently) of matter and energy and the 10 space-time dimensions associated with matter and energy. Among the deities described by the world's religions, such an Entity or Creator is consistent only with the God of the Bible.

3. *Science says:* The universe, our galaxy, and the solar system exhibit more than 500 different characteristics[21] requiring exquisite fine-tuning for life's possible existence (any kind of physical life, not just life as we know it). The intricacy, complexity, and precision of this fine-tuning vastly exceed the capabilities of any "force" or "being" contained within the cosmos.[22]
   Theological significance: The Entity (Creator) who brought the universe into existence must be personal, intelligent, knowledgeable, powerful, and caring to a degree far beyond any creature's capabilities. Only a superintelligent, superpowerful, superpurposeful (in other words, supernatural) Person could design and manufacture what we see, including life. Only a supercaring Person could explain the enormous investment of creative effort, the attention to intricate detail, and the comprehensive provision for creatures' needs.
4. *Science says:* Life in complex forms with an optimized ecology originated on Earth suddenly, under hostile conditions without the benefit of a prebiotic soup or a prebiotic mineral substrate.[23]
   Theological significance: Only the intervention of a superpowerful, superintelligent, superpurposeful Creator can explain such origins of life.

All these findings and their implications arise from research demonstrating that the earth and the universe are several billion years old. Insistence on a young universe negates this evidence. Ironically, some young-earth creationist leaders express willingness to negate it because it shows *too much* design.[24] For example, they claim that the old-earth model is in trouble because the need to lower the greenhouse efficiency of Earth's atmosphere (in a way that perfectly and continuously compensates for the gradual increase in the Sun's luminosity over the past 3 billion years) requires too much painstaking design and too much care to create the just-right species of life at the just-right population levels at the just-right times.[25]

A Clear View of God

The heavens have always declared the glory of God (Psalm 19:1–2). His words spoken by the heavens (verse 4) in the physical realm can be read and

understood with a degree of clarity and conviction never before possible. The greatest cosmological discoveries of all time are ones that point people to the greatest spiritual discovery of all time—the God who is there and who cares, the God who planned and prepared His cosmic realm for His good purposes, which include us.

The work of secular scientists is a blessing, not a curse, to Christians. Modern astronomy, much of modern physics, and most of the earth sciences provide powerful faith-building tools. They must not be thrown away.

The next chapter reveals additional reasons why physical reality's implications provide some of the strongest evidences for our Creator and Savior.[26] Let's share in the thrill of believers and nonbelievers alike who are seeing God's glory and splendor through the things He has made and the specific time windows in which He made them.

Chapter 19

Narrow Time Windows

One of the complicating factors in weather forecasting is that storm fronts don't always move in and out at a steady pace. High-pressure systems sometimes stall them and keep a deluge in place. Such a stall has delayed the passing of the creation-day storm front. Secularists engaged in origin-of-life research and in the search for extraterrestrial intelligence share a hope that if the universe is billions of years old, life could self-assemble and develop into intelligent beings by natural processes alone. Young-earth creationists fear that someday science may prove this premise true. The pressure of hope and fear keeps resistance to an old-earth view in a holding pattern.

As research progresses, however, the premise of evolution proves more impossible with each passing year.[1] The entire 14-billion-year history of the universe is much too brief to support the origin and development of life by natural processes alone.[2] A universe and a galaxy must reach a particular age before they can support life. Only when a star and a moon are of a particular age is life possible near them. And only when a planet is of a particular age is life possible on it. For intelligent life, the time limitations are dramatically more constrained.

Just-Right Requirements

Indispensable prerequisites mean that, although the universe contains over 100 billion galaxies, only a few qualify as sites suitable for life. Although our galaxy contains over 100 billion stars, only a few of them can sustain a planet on which life can possibly exist. Even though our solar system contains eight planets and thousands of moons and asteroids, life can survive on only one of those bodies—planet Earth. (However, the remains of life inevitably will be found on several other solar system bodies as a result of the export of Earth life through meteoritic bombardment.)

The Moon, Jupiter, and other solar system bodies must maintain just-right size and composition, just-right positioning relative to the Sun and Earth, and just-right orbital characteristics in order for life, especially advanced life, to survive. These and many other just-right factors effectively rule out the

probability that any other body (besides Earth) in the visible universe has the capacity to support advanced life by natural means alone.[3]

Age Window for the Universe

For biochemical processes to operate, the universe can be neither too hot nor too cold. If it is too hot, complex molecules cannot form, and if it is too cold, biochemical reactions will be too sluggish. As the universe expands from the creation event, it cools, like any other system obeying the thermodynamic laws (the greater volume or surface area, the less heat energy there is to go around). With 50 hot coals inside a barbeque, one can cook. But spread those 50 coals over a football field and the field's temperature will not warm up much. Therefore, the expansion rate gives the temperature and density of the cosmic environment, which must be just right for life, defining a relatively narrow time frame.

These conditions must be just right for liquid water to form and remain in significant quantities in just-right locations. As a result, there are only a few billion years in the history of the universe's expansion when a suitable habitat for primitive life is even possible.

An additional factor may shrink this time window for life even more. Nucleosynthesis is the process by which nucleons (protons and neutrons) are fused to form the nuclei of heavier elements. Hydrogen requires no such fusion since its nucleus is a single proton. But oxygen, for example, requires the fusing of eight protons and eight neutrons.

Nuclear fusion in stars will occur only when the temperature reaches 15 million Kelvin.[4] At temperatures any lower than this or any higher than about a billion Kelvin, it will not occur.[5] As the universe expands and cools, it passes through the temperature range suitable for nuclear fusion in a time span of only about 20 seconds, just three and a half minutes after the initial creation event. In this speck of time, approximately 24 percent of all the nucleons in the universe fuse to make helium and trace amounts of deuterium (a heavy isotope of hydrogen), lithium, boron, and beryllium. Thereafter the universe is too cool for any more fusion until stars make it possible again.

The fusion of most life-essential heavy elements must await the gravitational collapse of gas clouds into giant stars. Only in such collapses can the temperatures necessary for nuclear fusion be achieved again. And only in the cores of such giant stars can elements heavier than boron (such as carbon, nitrogen, oxygen, and phosphorus—the building blocks of life) be manufactured. In fact, two generations of such stars must burn up in order to build a density of

heavier elements sufficient to make life chemistry possible. That is, the universe must be old enough to have produced a third generation of stars, but it must not be too old (for reasons explained in the following section). The very fact that life exists supplies a minimum age for the universe of about 10 billion years and a maximum age of about 25 billion years.

Age Window of the Galaxy

Only in galaxies can the density of heavy elements become great enough to support life chemistry. But even in galaxies the appropriate density of life-essential elements is achieved only at one particular time. When the galaxy is too young, not enough heavy elements have been made in its stars for life chemistry to be possible. When the galaxy is too old, star and planet formation have ceased, and no stars and planets young enough for life chemistry will exist. Life is possible only in galaxies older than about 10 billion years and younger than about 20 billion years.

Age Window of the Star

For life on a planet to be possible, the planet must be warmed by a star that burns at a near-constant brightness and color. For intelligent life to be possible, the star's flaring activity and X-ray radiation must be minimal. Such stability is achieved only by a star no more and no less massive than the Sun and no younger and no older than the Sun.

In the first 50 million years after a star as massive as the Sun begins to shine, it burns far too erratically to maintain temperatures suitable for life on an orbiting planet.[6] For the next 500 million years, the X-ray emission is too intense.[7] After that, the flaring activity continues to subside until it reaches a minimum, when that star is 4.6 billion years old. As the star continues to age, it becomes more and more luminous and more and more variable. When it is about 9 billion years old, the star expands so much that it vaporizes the nearby planets. Only when that star is middle-aged, at 4.6 billion years old, can it sustain intelligent life on one of its planets.

If such intelligent life is to launch and sustain global high-technology civilization, the Sun's luminosity must be exceptionally stable. Solar neutrino research establishes that only 50,000 years ago did the Sun attain such extraordinary stability and that such stability will be sustained for only another 50,000 years.[8]

Age Window of the Planet

Life cannot exist on a planet unless the planet is close enough, but not too close, to its star to maintain a temperature range suitable for life chemistry. For advanced life to exist, the planet needs the gravitational pull of a single, large, and relatively nearby moon to stabilize the tilt of its rotation axis (otherwise, it would vary too much for climatic stability) and to assist in the removal of greenhouse gases.[9] The planet's proximity to the star and moon means their gravity works as a set of brakes on the planet's rotation period. (In the case of Earth, these brakes slow the rotation period by a tiny fraction of a second each year.)

In order for a planet to support life, the rotation period must fit within a certain range. If the rotation period is too long, then temperature differences between day and night will be too great. But if the rotation period is too short, then atmospheric jet streams will manifest too little latitudinal variation and wind velocities will reach levels too high for advanced life. These findings indicate that if Earth were any younger than about 4 billion years, it would rotate too rapidly for advanced life to exist. If it were any older than about 6 billion years, it would rotate too slowly.

To keep a planet's surface temperature within a range suitable for advanced life, greenhouse gases must be removed from the planet's atmosphere at a rate carefully orchestrated to coincide with its sun's increasing luminosity. (All stars during their hydrogen fusion burning stage gradually increase in brightness.)[10] But plants, the basis of life's food chain, need certain minimum levels of greenhouse gases to survive; there is a limit as to how much can be removed. Advanced plant life came on the scene at the earliest possible moment (when the planet was about 4 billion years old) but will come to an end, along with all the rest of Earth's advanced life, less than 50 million years from now.

Civilization Time Window

The physical laws and cosmic characteristics demand at least 10 billion years of cosmic development before primitive life becomes possible. (A number of outstanding divine miracles are necessary to bring about primitive life at all—and certainly in as little as 10 billion years.)[11] An additional 4 billion years of life history on a planet (the source of biodeposits) is needed to sustain an intelligent species and its technological civilization. (Innumerable divine miracles are needed to transform Earth's vital poisons [elements] and to build up adequate biodeposits in as little as 4 billion years.)[12]

The narrowest pane in the time window for life is the period during which advanced civilization is possible. British cosmologist Brandon Carter and, later,

astrophysicists John Barrow and Frank Tipler demonstrated that while a large amount of time is needed for human life to become possible in the universe, the maximum survival time for human civilization is about a million times briefer.[13] This "anthropic principle inequality" applies to any conceivable physical intelligent species under any conceivable physical cosmic conditions. In all likelihood, a nearby supernova eruption, a climatic instability, a social or environmental upheaval, or the genetic accumulation of negative mutations could doom humanity in less than 20,000 years.[14]

Benefits of Being Middle-Aged

For advanced life to exist anywhere in the universe, the galaxy, the star, the planet, and the moon all must be middle-aged. In astronomy, only middle-aged systems are sufficiently stable. The conclusion that *all* these bodies (the universe, our galaxy, our star, our planet, and our Moon) must be several billion years old—no more, no less—carries significant ramifications for both evolutionism and young-universe creationism. A naturalistic scenario for life's origin lies beyond the realm of possibility because several billion years is hopelessly too brief (by many orders of magnitude) to explain life's genesis, development, and existence by strictly natural processes.[15] A timescale for the universe and Earth of only a few thousand years also contradicts nature, which shows how and why astronomical bodies must be at least a half billion years old to be ready for life.[16] In the context of human civilization, the age of the universe must be very close to 14 billion years.

In summary, given the laws and constants of physics that God established from the beginning, nature testifies that God created primitive physical life at the earliest possible moment. Following that moment, God continued to create new life-forms of the just-right types, abundances, and diversities, and at the just-right times, to set the stage for the earliest possible entrance of humanity. This crown of His creation is the focus of the next chapter.

Chapter 20

The Significance of Man

Contemplating the vast and ancient cosmos can make anyone feel small and insignificant. Three thousand years ago, Israel's King David—the mighty warrior and slayer of giants—experienced that feeling.

> When I consider your heavens,
> the work of your fingers,
> the moon and the stars,
> which you have set in place,
> what is man that you are mindful of him,
> the son of man that you care for him? (Psalm 8:3–4)

As David studied the heavens, he saw only five other planets and about 7,000 stars (the limits of unaided human vision). He couldn't see the 200 billion galaxies, each of which contains an average of 100 billion stars that we see today with the help of modern telescopes. He didn't know that all the components of this vast heavenly host play an essential role in sustaining life on Earth, human life in particular.[1] He didn't recognize that Earth's location in the Milky Way Galaxy, in the Local Group of galaxies, in the Virgo supercluster of galaxies offers humans a unique vista on God's creation.[2] Nor did David comprehend the fine-tuning required for humanity's existence and opportunity to be able to view God's creative splendor.

Still, David wondered why the God of the cosmos cared so much about him. Who can help but wonder—why did God go to such lengths to prepare a planet and an observation platform for humanity? When and how did God make the first man and woman?

In the answers to these questions, young-earth and day-age creationists, such as myself, find themselves in agreement on several key points.

- Both views emphasize the divinely ordained significance of the human race.

- Both assert that humanity is the only spiritual species on Earth.
- Both proclaim humanity's eternal destiny.
- Both deny the naturalist view of humans as the random result of blind processes.
- Both declare that all humans arise from a single couple (Adam and Eve) whom God specially created just thousands of years ago.

Theistic evolutionists would disagree with the last two points while evolutionary creationists would dispute only the last point.

Biochemist Fazale Rana and I have written an entire book, *Who Was Adam?*,[3] on the subject of the origin of humanity. What follows in this chapter is a summary of some of the evidences and conclusions described in that book.

Divine Design

The Creator culminated the meticulous and miraculous details of His masterpiece with the special creation of human beings. In Genesis 1, God speaks of *ʾādām* (male and female), and only *ʾādām*, as being made in His image. As humanity's story unfolds throughout the rest of the Bible, the reader discovers the quality that makes people unique—the "spirit" breathed into them by God. None of the rest of Earth's creatures, past or present, possess it. The "spirit" supplies awareness of God, awareness of self, and capacity to form a relationship with the Creator. Some of the specific manifestations of the human spirit include:

- awareness of right and wrong, good and evil, and a moral code "written" or impressed with a conscience;
- awareness of mortality and concerns about life after death;
- yearning for purpose, hope, and destiny;
- a thirst to discover and the capacity to recognize truth and absolutes; and
- a propensity to worship and a desire to communicate with a higher Being.

Expressions of worship are the key markers of humanity's spiritual quality. The universality of worship is evidenced in the ubiquity of altars, temples, and other religious relics. Nonritual burial of the dead, crude tool use, or even the inclination to decorate fall short as evidence of the spirit. Nonspiritual creatures such as elephants, chimpanzees, and bower birds (which decorate their nests)

engage in such activities to a limited extent.

Calibrating the Genesis Genealogies

The time spans for the Genesis 5 and Genesis 11 genealogies have been hotly debated. While the absence of Cainan's name (Luke 3:36) from the Genesis 11 genealogy establishes at least one gap, how many others might exist remains subject to speculation.

Using the relatively accurate dates available for both Abram (Abraham) and Peleg to calibrate the genealogies may help guide some of the guesswork. Biblical and other historical records establish that Abraham lived about 4,000 years ago. Genesis 10:25 says that in Peleg's time "the earth was divided." Radiocarbon dating places the breaking of the Bering land bridge (an event that ended human migration from Eurasia to North and South America until the advent of ships) at 11,000 years ago.[4] If the life spans recorded in the Genesis 5 and 11 genealogies are approximately proportional to the actual passage of time, then the dates for Abraham and Peleg would place the flood of Noah's day roughly 30,000 to 50,000 years ago and the creation of Adam and Eve a few tens of thousands of years earlier.

A Biblical Calendar

Although the biblical genealogies provide little or no help in establishing creation dates for the cosmos and Earth, they do provide a *rough* date for the advent of humanity. I say rough because the Hebrew words used for "father" and "son"—*ʾāb* and *bēn*—have broader definitions than the English translations indicate. *ʾĀb* sometimes refers to "grandfather," "great-grandfather," or "great-great-grandfather," and so forth. Similarly, *bēn* can mean "son," "great-grandson," and so on. In the book of Daniel, Belshazzar's mother refers to Nebuchadnezzar as her son's father, though in fact two kings separate them and they are not even biologically related. This flexibility in the usage of *ʾāb* and *bēn* explains why parallel genealogies (for example, 1 Chronicles 3, Matthew 1, and Luke 3) may vary.

Even in the Genesis 5 and 11 genealogies, where the years between the birth dates of the father and the son are given, the chronology is not as tight as it may appear at first glance. Luke 3, for example, inserts at least one generation, namely Cainan, between Shelah and Arphaxad, while Genesis 11 simply records Shelah as the "son" of Arphaxad.

Some scholars argue that the biblical genealogies can be stretched

indefinitely. Such stretching seems unwarranted by relevant biblical and scientific data. The most reliable and conservative Hebrew scholarship I've read places the biblical date for the creation of Adam and Eve sometime between about 10,000 and 60,000 years ago (with the outside limits at about 7,000 and 100,000 years).[5]

Historical Calendar

Anthropologists have found evidence for several cultural "big bang" events, each reflecting the difference spirit expression makes. While the bipedal primate species that preceded *Homo sapiens sapiens* used only primitive tools and each species exhibited little or no advancement in tool technology,[6] the arrival of humans brought a huge and rapid leap in tool technology—axes, awls, needles, hammers, barbed fishhooks, shovels, harpoons, and more.[7] Humanity's arrival also launched the first clothing[8] and jewelry industries.[9] Dates for these cultural big bangs all cluster around 40,000 to 45,000 years ago.

These explosive cultural developments were accompanied by the first appearance of sophisticated art and music, as well as the first worship and religious practices.[10] A large gallery of advanced art is displayed in the Chauvet cave in France that dates back 36,000 years.[11] Sculpted figurines found in German caves date at least 35,000 years in age.[12] The earliest known evidence for complex language and the diversity of languages dates to about 40,000 years ago.[13]

The accumulation of enough artifacts to leave discoverable traces necessitates minimum human population levels. To attain these levels requires time. So these markers suggest an earlier advent of humanity. Thus, the archaeological dates for the beginning of spirit expression and human consciousness appear consistent with the biblical dates.

Biochemical Dates for Eve and Noah

By measuring diverse peoples' differences in mitochondrial DNA (DNA residing in mitochondria outside the cell's nucleus) and the Y-chromosome segment (Y-DNA), geneticists can test whether the human species descended from many or just a few individuals and whether humans arose from many locations or one. The past 20 years' research shows that we all came from the same location and from just a few individuals or less.[14] Or, to put it another way, the data is consistent with all humanity's descent from a single woman and a single man.

During reproduction, two segments of human genetic material do not

recombine (mix up): (1) most of the mitochondrial DNA (mtDNA); and (2) a large segment of the Y-chromosome. Individuals get nearly all of their mtDNA from their mothers only. Only males carry Y-DNA. Typically the only way someone's mtDNA can be different from his or her mother's is if that person experiences an mtDNA mutation. Likewise, typically the only way a man's Y-DNA can be different from his father's is if he experiences a Y-DNA mutation.

By measuring DNA differences across several generations in different families, geneticists can measure the rates at which mtDNA and Y-DNA mutations occur. Such measures yield dates of 42,000 to 60,000 years ago for the most recent common male ancestor[15] (the biblical Noah) and, taking into account that ten to twenty percent of the human population possesses two types of mitochondrial DNA (heteroplasmy) and a little less than one percent possesses three types (triplasmy),[16] about 50,000 to 70,000 years ago for the most recent common female ancestor[17] (the biblical Eve).

Data Convergence

A brief review of the data shows that the fossil and archaeological dates for the origin of humanity roughly coincide with the dates for the most ancient religious artifacts and for the "cultural big bangs"—the sudden appearance of clothing, jewelry, language, advanced tools, and sophisticated art and music expression. The biochemical history of humans proves consistent with these dates. Thus, all the dates and data fit the estimated biblical dates for the origin of Adam and Eve.

What is man that God should be so mindful of him? He is the crowning masterpiece of God's creation. God cared enough about us to fine-tune every detail of the universe to make a suitable home for humanity at the perfect time in cosmic history. Mindful study of Scripture reveals even more of this amazing creation plan.

Chapter 21

A Clear “Day” Interpretation

After a storm a new day dawns. Brisk, clean air and a bright, blue sky evoke fresh enthusiasm. For the creation-day controversy, this daybreak comes from a more mindful approach to the biblical text. Simple interpretations of Scripture based on the correct vantage point and common sense can bring unity within the body of Christ. An Arkansas grandmother raised in the heart of America’s Bible belt and a boy raised in a Canadian cosmopolitan city illustrate this shared understanding.

The Grandma

Alice was born, raised, and educated in Balch—a town of less than a thousand people. Like everyone else in Balch, she went to church at least twice a week. She never felt she had to read or study the Bible since the pastor and Sunday school teachers taught Bible lessons at every church meeting. A high school basketball star, she earned her diploma but never attended college.

Not until her mid-thirties did Alice ever read the Bible for herself. Going through Genesis 1 for the first time, she was stunned by some simple observations: Eve was created on the same day as Adam (the sixth) but not until *after* Adam took care of several large tasks. The seventh day had no evening and morning. And, in Genesis 2:4, the word “day” refers to the entire creation week. In spite of being taught all her life that God created everything in six calendar days, Alice concluded that the Genesis 1 creation days must be longer time periods. For her, a simple reading of the text led directly to her interpretation.

Science did not influence Alice’s conclusion that Genesis 1 taught long creation days. Years later, when she became a grandmother, Alice discovered that the established scientific record was consistent with her simple understanding of the Genesis text.

The Scientist

Raised and educated in Vancouver, Canada, I did not converse with a Christian about spiritual matters until I was 27. Studies in science consumed all my time and eventually convinced me, at age 16, that a transcendent God must exist. At

the time I doubted that a God who created a hundred billion trillion stars would care much about frail humans on an insignificant planet. Challenged by a teacher to find out why millions of people fought and died for religious beliefs, I set out to prove that the world's religions and their "holy books" were humanly crafted frauds.

There were many serious scientific and historical errors in the non-Christian holy books I studied. But then I picked up a Bible and found it profoundly different. The Bible consistently affirmed—and even predicted—scientific advances.

In my first reading of Genesis 1, I saw indications that the creation days were long time periods. Simple textual observations—the timing of Eve's creation, the lack of an evening and morning for the seventh day, and the Genesis 2:4 usage of the word "day" in reference to the entire creation week—convinced me. I was especially intrigued by God's creation hiatus (the seventh day during which God ceases from creating) following the six prolific creation periods. Finally, here was an explanation for the fossil record enigma—an abundance of speciation events prior to the advent of humanity and virtually none since.

With All Your Mind

Although years, miles, and cultures apart, both Alice and I came to the same simple yet thoughtful understanding of the text. Years later we met and discussed our serendipitous discoveries. It seemed clear to both of us that God intended the meaning of His written Word to be accessible to all people, regardless of education. And yet He challenges people to think. The Bible is dynamic, fresh, and wise—the living Word of God. He makes the Bible (and nature) comprehensible to the simplest minds and yet provocative to the most brilliant and learned.

In the Gospels, Jesus reminded His disciples of the greatest commandment in the Law: "Love the Lord your God with all your heart and with all your soul and with all your mind" (Matthew 22:37). To disengage our minds (our capacities for logic, analysis, and reason) when we read the Bible would be disobedient to that commandment. Speaking through the prophet Isaiah, God says, "Come now, let us reason together" (Isaiah 1:18).

Loving God with "all your mind" means looking beyond the most simplistic interpretation of a given text, especially if that interpretation leads to complications and convolutions of other texts. God calls us to "rightly divide" the Word (see 2 Timothy 2:15, KJV) to search for the simplest, most elegant, most complete and consistent interpretation—one that aligns with both His stated character and purpose. As Alice's and my stories illustrate, a reading of

the Genesis creation days as six ages or eras is that kind of interpretation.

Young-earth creationist leaders loudly proclaim, however, that their interpretation of the Bible's creation text is the only plain and simple one. [1]Yet, ironically, a 24-hour creation day interpretation of Genesis 1 (and 2) complicates and convolutes at least three aspects of God's creation story—the sequence of events, the meaning of Adam's work and words, and the speed of biological development.

It Doesn't Make Sense

Because the same Creator formed both the biblical text and "nature's record," the two should be compatible in their revelation and explanation. However, in the young-earth interpretation of Genesis 1, both Earth and life exist before the Sun, Moon, and stars. This leaves a person to wonder where heat, light, gravity, and Earth's rotational and orbital features came from prior to the fourth creation day. It's also hard to imagine how none of these qualities would have been seriously interrupted when the Sun, Moon, and stars suddenly entered the scene. As noted earlier (see "Absence of Sun or Moon" in chapter 7), the only possible explanation would be that God first created a "surrogate" Sun, Moon, and stars and later replaced them with the currently existing Sun, Moon, and stars. The Bible never mentions such phenomena. Nor does the Bible explain how or if God intervened to prevent such huge upheavals from destroying Earth and life.

The 24-hour interpretation requires that the surface of Earth and the entire universe be devoid of sunlight and starlight until after the fourth creation day. We are left to ponder how and why God would create a universe with matter, space, and time but no physical energy and how a dark universe can be reconciled with the psalmist's statement,

> He wraps himself in light as with a garment,
> he stretches out the heavens like a tent. (Psalm 104:2)

The young-earth interpretation of Genesis 1 also dictates a sequence of life's appearance on Earth that contradicts basic principles of ecology (interspecies relationships). The young-earth interpretation asserts that sea mammals predate land mammals, that birds predate land reptiles, including dinosaurs, and that flowering plants come before insects.[2]

How Did Adam Do So Much?

The simplest and most straightforward reading of Genesis 2 implies that Adam

completed a considerable amount of work before God created Eve (all on the sixth day, according to Genesis 1). To limit Adam's working and taking care of the Garden of Eden to just an hour or two would imply that Eden was tiny. Such an implication seems to contradict God's having made a place where all kinds of trees grew and a river divided into four headstreams, two of which are major rivers today.

Similarly, for Adam to have named all of Eden's animals within a few hours would seem to shrink not just the size but also the bounty of Eden. Adam presumably observed and identified the various characteristics of the animals before naming them—a task requiring and deserving both time and care.

Seeing the need to speed up or abbreviate Adam's animal-naming task, some young-earth creationist leaders have claimed that God did not create all Eden's species and genera in the beginning.[3] They propose that God created only one animal type for each family. They appeal to subsequent rapid natural evolution to explain how the one type in each family split up into all genera and species to fill all the niches in Eden's ecosystem. They make the same appeal to hyperfast, hyperefficient biological evolution to explain how herbivores became carnivores immediately after Adam rebelled against God. Nowhere does Scripture (or the record of nature) hint at these rapid and dramatic changes in God's created kinds. Neither does it suggest the alternative notion that Adam's mind and body worked at hyperspeeds to complete his work in a miniscule amount of time.

Looking Up

What naturalists and young-earth creationists see as the futility of attempting to integrate Genesis with the scientific record arises from a subtle error in applying a basic interpretive principle, a rule to which Galileo referred: "Begin by establishing [not assuming] the point of view."[4] Many Bible commentaries and commentators automatically—and understandably—fix the passage's point of view out in the heavens looking down on Earth. (After all, the revelation comes from God, who looks on "from above.") The result: a scientifically implausible order of creation events.

However, the Genesis 1 text itself includes the key to plausibility. It places the point of view for the creation narrative as somewhere over the planet surface but under the heavens: "Darkness was over the surface of the deep, and the Spirit of God was hovering over the waters" (verse 2).

The view from the Spirit's position just over Earth's waters—looking upward and around—makes a crucial difference in how a reader pictures the sequence of creation events (see figure 21). If He had been describing events from a

perspective far out in the heavens, Earth would have been created before light. The creation of the Sun, Moon, and stars would appear to follow that of plant life and establishment of the water cycle. Instead, God gave us a vantage point from the planet's surface looking up, so we could see His miracles as they took place in the atmosphere as well as on Earth's surface.[5]

With the Genesis 1 point of view shifted from the universe (verse 1) to Earth's surface (verse 2), the text says that light was created "in the beginning" when it couldn't be seen from Earth's surface. But later, during creation day one, light visibly broke through to Earth's surface for the first time. This dawning required the miraculous transformation of the atmosphere (plus the interplanetary medium). The heavens went from opaque to translucent, from densely dark to overcast. Job 38:8–9 affirms that Earth's primordial waters were enshrouded by an opaque cloud cover:

> Who shut up the sea behind doors
> when it burst forth from the womb,
> when I made the clouds its garment
> and wrapped it in thick darkness?

On the fourth creation day another dramatic atmospheric transformation occurred. The skies changed from translucent to transparent, from overcast to clear. Through that miraculous transformation, the Sun, Moon, and stars became distinctly visible from Earth's surface. God did not make (or create) these heavenly bodies during the fourth day. Rather, on that day He made them visible and distinguishable for the first time to an observer (the Spirit) near Earth's surface.

Verse 16 says, "God made two great lights.…He also made the stars." This sentence *follows* the fourth creation day's opening statement, "Let there be lights in the expanse of the sky" (verse 14). To interpret it as a parenthetical note indicating the Sun, Moon, and stars were formed sometime in the past fits adequately within the boundaries of reasonable interpretation.

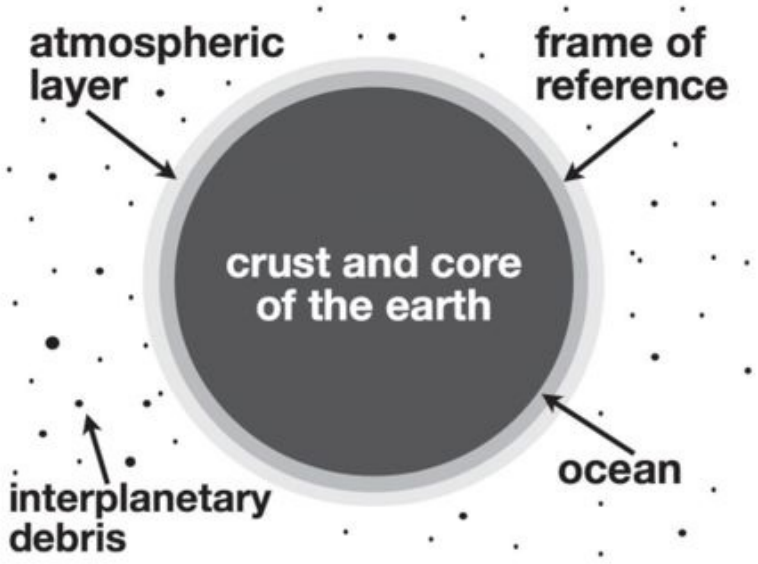


Figure 21: The Point of View for Genesis 1
The point of view from which Genesis 1 describes creation events is the surface of the ocean, underneath the cloud layer, as verse 2 indicates. In the context of verse 2, light in the heavens cannot yet penetrate through the interplanetary debris and atmospheric layer. In verse 3, it can and it does. Credit: Reasons to Believe

This Makes Sense

With the point of view fixed on Earth's surface, the description of Earth's "dark," "formless," and "empty" initial conditions makes sense. Earth's primordial atmosphere and the solar system's primordial interplanetary debris prevented the light of the Sun, Moon, and stars from reaching the planet's surface. Earth was empty of life and unfit for life because life requires sunlight.

This interpretation of the text—its viewpoint (looking up) and initial conditions and perspective on the prior existence of the Sun, Moon, and stars (becoming visible on the fourth creation day though created before the six days)—dates back to the era before modern science, at least back to the late 1600s.[6] Old Testament scholar and Hebrew linguist Gleason Archer offered this perspective in 1955.[7] Robert Newman, John Snow, Herman Eckelmann, William Henry Green, and Daniel Wonderly (all with advanced degrees in science, theology, or both) published a similar interpretation of Genesis 1 in 1977.[8] It is neither new nor novel. And it makes sense.

Fossil Record Consistency

With the point of view and initial conditions correctly identified, the sequence of Genesis creation events harmonizes beautifully with the record of astronomy, paleontology, geology, and biology. A few purported conflicts between the Bible

and the fossil record have arisen, but they seem to stem from difficulty (or oversight) in translating some of the Hebrew nouns for various plant and animal species.

For example, both young-earth creationist leaders and many non-Christian scientists have criticized attempts to harmonize the Genesis creation account with the scientifically accepted history of life on Earth. They point to the incongruity that Genesis 1 insects appear late in the record of life on Earth, *after* the birds and sea mammals and just before humans. They suppose insects are the creatures "that creepeth upon the earth" (Genesis 1:25–26, KJV). The Hebrew noun in question is *remeś*. Its broad definition, however, encompasses rapidly moving vertebrates, such as rodents, hares, and lizards. *Remeś* in verse 24 may have a more restricted usage, since the creatures under discussion are the *nepesh* (verses 20–25)—"soulish" creatures with a capacity to relate to humans. In other words, they are creatures manifesting (to some degree) mind, will, and emotion, such as birds and mammals. The *remeś* of verse 24 cannot be insects. More likely they are short-legged land mammals such as rodents and hares.

Another point of contention is the mention of land mammals (Genesis 1:25) on the sixth creation day, while sea mammals (verse 21) seem to show up earlier, on the fifth day. The fossil record shows that the first sea mammals came on the scene *after* the first land mammals. The solution to this problem lies in identifying the kinds of creatures (the *ḥayyâ*, the *bᵉhēmâ*, and the *remeś*) the text associates with the sixth creation day (verse 25). The words refer to three specific classes of land mammals, *not* necessarily to all land mammals:

- *ḥayyâ*: long-legged quadrupeds typically considered "wild"
- *bᵉhēmâ*: long-legged quadrupeds that are easily tamed
- *remeś*: short-legged quadrupeds

Apparently, God planned for these particular land mammals (all three types) to coexist with human beings. The fossil record confirms that mammals designed to coexist with humans showed up well after the initial appearance of birds and sea mammals.

Events of the third creation day have also been challenged by young-earth leaders and some secular scientists. The Hebrew phrase translated as "seeds, trees, and fruit" (Genesis 1:11–12) has been taken by some as a reference to deciduous vegetation. However, the respective Hebrew nouns—*zeraʿ*, *ʿēṣ*, and *pᵉrî*—belong to the broad category described by the Hebrew word *deshe'*, which

means vegetation or green plant life.[9] It is a word that would apply to any photosynthetic land life. *Zera‘*, *‘eṣ*, and *pᵉrî* are generic terms applicable to plant species as primitive as those that appeared at the beginning of the Cambrian explosion[10] (543 million years ago).

Scientific evidence for ocean life’s predating land life poses no threat either. The Spirit of God “brooded” over the face of the waters (Genesis 1:2). Such brooding makes sense as a reference to God’s creating and incubating primitive life (microorganisms) in the oceans even before the events of the six creation days.

In Order

A careful study of the Hebrew words enhances comparison of the Genesis creation account with nature’s record. A detailed analysis of the words and their contexts yields the list of creation events seen in table 21. The list is sequential. The Genesis 1 creation events overlap only in the sense that God, according to Psalm 104, recreates. For example, while God did not create sea mammals or birds previous to creation day five, He did replace fifth-day sea mammals and birds that went extinct with new species of sea mammals and birds on the sixth day. This study leads not to a scientific impasse but rather to powerful evidence for the scientific soundness of the Bible. Such soundness cannot be considered a mere coincidence.

No author writing more than 3,400 years ago could have accurately described these events and their sequence, plus the initial conditions, without divine inspiration. If God guided the words of Moses to scientific and historical accuracy in this complex report of divine activity, we have reason to believe that we can trust God to communicate with perfection through all the other Bible writers as well.

Of One Mind

These other writers add much detail to Genesis’ brief narrative. As noted in chapter 6, 20 other creation-relevant accounts also address various aspects of God’s creative activity. From all these passages, a consistent and unified position on how God created can be developed:

God created the universe transcendently, that is, from beyond the limits of matter and energy and from outside the space-time dimensions associated with matter and energy. He personally designed and built the universe and our solar system so that life can flourish on Earth. Though the Bible does not identify the specific means by which God produced the lower life-forms, it does state that by

His command He created birds, mammals, and human beings. From the time these animal kinds were created by God through miraculous means, they have been subject to minor changes (such as color adaptation) in accordance with the laws of nature. However, the Bible clearly denies that any of these advanced creatures directly descended (via natural reproduction) from lower life-forms. Human beings were specially created, distinct from all other animals, including the nonhuman bipedal primates that preceded them (see “Why Did God Create Bipedal Primates Prior to Adam and Eve?”), and humans alone possess body, soul, *and* spirit.

Table 21: Order of Genesis 1 Events

1.	God created, by fiat miracle, the entire physical universe (10 space-time dimensions, matter, energy, galaxies, stars, planets, etc.). *Note*: Earth is empty of and unfit for life. Earth’s atmosphere and interplanetary debris prevent the light of the Sun, Moon, and stars from reaching the surface of Earth’s ocean. The ocean covers the Earth’s whole surface.
2.	God cleared away most interplanetary debris and partially transformed Earth’s atmosphere (making it translucent) so that light from the heavenly bodies could penetrate to the surface of Earth’s ocean.
3.	God formed the troposphere with just-right conditions to establish an adequately abundant and stable water cycle.
4.	God formed ocean basins and continental landmasses.
5.	God produced plants on the continental landmasses.
6.	God transformed the atmosphere from translucent to (occasionally) transparent.
7.	God produced swarms of small sea animals.
8.	God created, by fiat miracle, birds and sea mammals.
9.	God created, by fiat miracle, land mammals capable of interacting with the (future) human race. Evidence for the role of the nonhuman bipedal primates comes from the late Pleistocene extinction rates for large-bodied mammals. The arrival of human beings in Australia, which has no history of prehuman bipedal primates, brought about the extinction of 94 percent of all mammal genera (with adults weighing more than 40 kilograms or 88 pounds).[11] For sub-Sahara Africa, which had at least eight distinct species of pre-human bipedal primates, the extinction rate for mammals was less than 5 percent.[12]
10.	God created, by fiat miracle, the human species (specifically Adam and Eve).

Why Did God Create Bipedal Primates Prior to Adam and Eve?

When God created humanity (Adam and Eve), more than 20,000 species of birds and 8,000 species of mammals existed. Today, Earth carries fewer than

10,000 bird species and only 4,000 mammal species. It seems reasonable that God anticipated the negative impact of (postfall) human activity on birds and mammals. One possible scenario is that in the time period prior to Adam and Eve's creation God made a sequence of bipedal primate species, each more skillful at hunting than the one before. Birds and mammals would then have developed better behavioral defenses against the future onslaught of humanity. God may have had other reasons as well for creating bipedal primates—reasons scientists are as yet incapable of discerning.

This mindful interpretation of Genesis 1 and 2 is consistent with the rest of the Bible, with nature's record, and with the clear observations made by an Arkansas grandma and a Canadian scientist as they read the creation story. No contradictions exist between the established record of nature and a plain reading of the biblical creation texts.

Such a view strengthens and simplifies the proclamation of an inspired, inerrant Bible. People throughout the ages and across all educational backgrounds can comprehend the Bible's creation message—one that reveals God's beauty, power, and care in His creation. This position also moves in the calm direction of reconciliation and peace pursued by a first-century council and its modern-day counterparts—the topic of the next chapter.

Chapter 22

Councils Attempt to Bring Calm

Zap! Lightning splits the sky. Crack! The thunder roars. Doctrinal disputes have threatened to divide Christians and put stumbling blocks between unbelievers and the Christian faith in every generation since the church began. Many people watch the unsettling display and back away from any involvement with any church. A powerful story from the Bible shows how such conflicts can be graciously quelled.

Council at Jerusalem

The first-century church dealt with a problem roughly analogous to the dispute over the length of the Genesis creation days. At a time when Gentiles were rapidly responding to the witness of Jewish believers in Jesus, a conflict threatened to dampen evangelistic efforts. Acts 15:1 says, "Some men came down from Judea to Antioch and were teaching the brothers: 'Unless you are circumcised according to the custom taught by Moses, you cannot be saved.'"

The church responded with wisdom and grace. Paul and Barnabas, leaders of the Gentile Christians, were sent to Jerusalem to appeal to the leaders among the Jewish Christians. The council listened as Paul and Barnabas testified of the miraculous way Gentiles were coming to faith in Jesus Christ. Peter reminded the council that only by grace, not by works, can anyone (including Jews) be saved. Because Peter was the first apostle to lead Gentiles to Christ (Acts 10:9–29), his opinion carried great weight. The council deliberated, and James, leader of the Jerusalem church, made this decisive statement: "We should not make it difficult for the Gentiles who are turning to God" (15:19). He recommended writing a letter exhorting Gentiles to adhere to a few basics for spiritually healthy living. The council concurred.

An Essential Letter

A letter was sent by personal courier to all Gentile congregations, setting them free from the circumcision requirement and encouraging them with these words: "It seemed good to the Holy Spirit and to us not to burden you with anything beyond the following requirements" (Acts 15:28). The short list of essentials

included the safeguards of abstinence from sexual immorality and other practices of pagan worship. A potential rift was avoided. Gentile believers were overjoyed and evangelism flourished.

Contributing to the letter's success was the unanimity behind it, the respect expressed for Paul and Barnabas, and the avoidance of condemnation toward those who promoted circumcision as an essential.

The council's unanimous endorsement of Paul and Barnabas settled questions about their character, testimony, teaching, and ministry raised by slanderous accusations from the circumcision party. The reference to "our beloved Barnabas and Paul" (Acts 15:25, NKJV) spoke volumes of reassurance.

Emphasis on the courage of these "men who have risked their lives for the name of our Lord Jesus Christ" (Acts 15:26) blunted the charge that Paul, Barnabas, and their followers were appeasing Gentiles on the circumcision issue to avoid persecution. The label "coward" could hardly describe men whose outreach brought them repeated imprisonment, beatings, and death threats from both Jews and Gentiles. The Jerusalem Council acknowledged their great dedication and commitment.[1]

The council decided the circumcision proponents were in error. However, as it refuted the necessity for circumcision, council members refrained from humiliating and rejecting those who promoted the error. Gentle correction offered compassionately, along with recognition of the fruit of Paul and Barnabas' ministry, ultimately eased tensions and turned some people around. Harsh condemnation would have deepened the rift and perhaps entrenched the division.

Initially the ferocity of the circumcision faction increased. Many threatened and planned to kill Paul as a result (see Acts 21:27–36; 22:22; 23:12–30; 25:1–12). But time as well as wisdom favored the council's decision. The Gentile segment of the church survived and thrived. In fact, the letter swung the door wide open for Gentiles to enter the Christian community. As more and more Gentiles joined the church, the strength of the circumcision party diminished, and by the end of the first century circumcision as a means of salvation was no longer an issue.

First Creation-Day Council

The first serious attempt to reconcile the creation-day controversy was undertaken by the International Council on Biblical Inerrancy (ICBI). Founded in 1977 by a large group of conservative Christian scholars, the ICBI convened annually (or more often) over the course of 10 years. The council's primary purpose was to define and defend the doctrine of biblical inerrancy as "an

essential element for the authority of Scripture and a necessity for the health of the church."[2] It also existed to "counter the drift from this important doctrinal foundation by significant segments of evangelicalism and the outright denial of it by other church movements."

Initial ICBI sessions focused on clarifying the meaning of inerrancy. The group also tackled some of the specific issues directly challenging scriptural authority. The 1982 ICBI summit discussed at length the age of the universe and Earth.[3]

Summit on Scripture and Natural Science

A position paper and two response papers were presented at the 1982 summit. First, Walter Bradley, then a professor of mechanical engineering at Texas A&M University and a former advocate of the young-earth perspective, presented his case for interpreting the Genesis creation days as long epochs. Next, Henry Morris, founder and then president of the Institute for Creation Research, responded by arguing for six consecutive 24-hour creation days. In his response, Gleason Archer, then professor of Old Testament and Semitic studies at Trinity Evangelical Divinity School presented his analysis of the original language of the Genesis text.

After presentation of these papers, the scholars in attendance, mostly evangelical theologians, deliberated for many hours. Afterward, the group concluded that adherence to six consecutive 24-hour creation days is *not* essential to belief in biblical inerrancy. The summit participants then framed a set of affirmations and denials with respect to Scripture and natural science. All but Morris agreed to sign it.

When it became evident that Morris would not accept any statement short of a flat denial of *any* possibility for a creation timescale longer than a few thousand years, the ICBI agreed to word its affirmations and denials in a way that would not condemn any position on the dates for creation. In the council's opinion, belief in biblical inerrancy required no immutable assertion of cosmic or geologic ages. Belief in a finite date for creation was viewed as sufficient. The final affirmations and denials on Scripture and science published by the ICBI are as follows:[4]

> We *affirm* that any preunderstandings which the interpreter brings to Scripture should be in harmony with scriptural teaching and subject to correction by it.
>
> We *deny* that Scripture should be required to fit alien preunderstandings,

inconsistent with itself, such as naturalism, evolutionism, scientism, secular humanism, and relativism.

We *affirm* that since God is the author of all truth, all truths, biblical and extrabiblical, are consistent and cohere, and that the Bible speaks truth when it touches on matters pertaining to nature, history, or anything else. We further affirm that in some cases extrabiblical data have value for clarifying what Scripture teaches, and for prompting correction of faulty interpretations.

We *deny* that extrabiblical views ever disprove the teaching of Scripture or hold priority over it.

We *affirm* the harmony of special with general revelation and therefore of biblical teaching with the facts of nature.

We *deny* that any genuine scientific facts are inconsistent with the true meaning of any passage of Scripture.

We *affirm* that Genesis 1–11 is factual, as is the rest of the book.

We *deny* that the teachings of Genesis 1–11 are mythical and that scientific hypotheses about earth history or the origin of humanity may be invoked to overthrow what Scripture teaches about creation.

By refraining from dogmatic statements on the creation date, the ICBI hoped to keep the creation timescale from becoming an issue for doctrinal orthodoxy and evangelism. But the ICBI's hopes have not been fulfilled. One reason is that their creation-doctrine conclusions received insufficient attention within the evangelical community. Most Christians today remain unaware of these affirmations and denials, and the summit proceedings published by the ICBI have been out of print for more than 10 years. (The records of the ICBI are archived at Dallas Theological Seminary and both the ICBI's full statements on biblical inerrancy [http://library.dts.edu/Pages/TL/Special/ICBI_1.pdf] and biblical hermeneutics [http://library.dts.edu/Pages/TL/Special/ICBI_2.pdf] are publicly available as PDFs at http://library.dts.edu/Pages/TL/Special/ICBI.shtml.)

Subsequent Creation-Day Councils

Similar to the aftermath of the Jerusalem Council's letter in the first century AD, the response of young-earth creationist leaders toward the ICBI council's conclusions grew even more fierce. Today that ferocity has yet to die down. During the past few years, campaigns have been waged in several evangelical denominations and academic institutions to mandate belief in a young Earth and universe. Young-earth creationist leaders demanded that the denominations' doctrinal statements require such a belief as a condition for admission or

membership, especially for leadership.

The Presbyterian Church in America (PCA) faced such a challenge in the late 1990s. In response, the denomination convened a panel of esteemed scholars to study the Bible's teaching on the duration of the Genesis creation days. This panel was asked to determine the limits of permissible interpretations of the creation days under the assumptions of strict biblical inerrancy, biblical supernaturalism, a denial of naturalistic interpretations of life's history, a belief in creation *ex nihilo* (out of nothing), and a belief in Adam and Eve as actual historical persons from whom all of humanity is descended.

Following two years of deliberations, the PCA panel published a 92-page report. That report outlined four different views of the creation days deemed acceptable within the bounds of Christian orthodoxy:

1. *Calendar-day:* creation days consist of six consecutive 24-hour periods that are historical and chronological.
2. *Day-age:* creation days are six consecutive long ages that are historical, sequential, and chronological.
3. *Framework:* the creation week is a metaphor to narrate God's actions in creation with the days to be understood as topical rather than sequential and the durations as unspecified.
4. *Analogical-days:* creation days are analogous to, but not necessarily identical to, human days; that is, broadly consecutive but of unspecified length.

The panel's report concluded with a fervently expressed desire that the creation-day controversy not divide their denomination. Unlike the case of the ICBI statement, all panel members, including proponents of the young-earth interpretation, signed the PCA report.

One of America's largest and most conservative evangelical seminaries, Westminster Theological Seminary (WTS), faced a challenge similar to that encountered by the PCA. They, too, convened a distinguished panel of scholars to examine the issue. The WTS panel spent over a year in deliberations. They focused primarily on discerning the intent of the Westminster divines in framing the Westminster Confession (1646). In contrast to the goal of the PCA panel, their mission was to publish a brief, yet complete, statement that could be quickly read and understood by all Christians. This published report, five pages long, concurred in all points with the PCA report. Both reports are posted on the

respective websites of the WTS and PCA.[5]

Expert Evaluation of Scientific Evidence

What made the deliberations and publications of the Jerusalem Council, the ICBI, PCA panel, and WTS panel so significant and effective was that leading proponents on both sides of the respective debates presented their arguments before respected Christian leaders and well-trained experts in the subject matter pertinent to the respective debates.

Yet for over two decades, young-earth creation scientists refused to debate the scientific evidence within a specific scientific discipline before a panel of Christian experts in that discipline who would then provide a written evaluation. But all that changed on June 1, 2007, when young-earth astronomer Danny Faulkner agreed to debate me on the age of the universe before a panel of Christian astronomers actively involved in astronomical research. Faulkner asked that we also debate the biblical evidence for the age of the universe, and I agreed.

In December 2009, Faulkner and I recorded our debate on the television program *The John Ankerberg Show*, and a panel of 13 evangelical Christian astronomers was invited to critique and evaluate that debate. These astronomers deliberated and worked together to produce a one-page statement signed by all. In 2011, three of the panel astronomers, Donald York, William Keel, and Pamela Gay, appeared on *The John Ankerberg Show* to discuss their evaluation. In 2012, DVDs of the entire debate and the televised evaluation were released to the public along with the panel's written evaluation. (That evaluation follows.)

An Evaluation of Evidence for the Age of the Universe

The following statement, prepared by the scholars whose names are attached, must be given in its entirety wherever it is reproduced. Copyright (held collectively by the authors), 2010.

> A group of Christians professionally trained in astronomical research has reviewed presentations by Drs. Danny Faulkner and Hugh Ross, covering arguments on the age of the universe. We appreciated the civility and respect of the discourse on a topic often generating more heat than light within the Christian community. Our analysis concentrates on arguments made by the speakers dealing with astronomical data and calculations, rather than about biblical interpretation or biological evolution, because the former are our areas of professional expertise. We do note that, for example, one's view of scriptural interpretation and

theology will affect the range of models one would consider.

Our aim has been to assess the evidence for the age of the universe in the light of the arguments presented, using a standard scientific approach. Science seeks to make progress in understanding the physical world through inductive reasoning, rather than the watertight proofs found in mathematics. This means that scientific understanding advances through an enormous amount of focused, incremental efforts with many consistency checks in the context of a mutually accountable scientific community. Drawing sound conclusions about a general question such as the age of the universe cannot be done on the basis of one argument alone but requires many different independent experiments including tests that could falsify competing claims. Any conclusions, along with an evaluation of their certainty, are then made on the basis of the overall weight of the available evidence. There will often be some data that appear to disagree with the rest of the evidence; this does not automatically provide evidence for alternative hypotheses but often means that our theoretical understanding is not yet entirely complete.

Ross' arguments provide solid evidence that the universe is billions of years old. He presents several independent arguments, based on a wide range of data, indicating that the universe and most objects in it are much older than ten thousand years. The light-travel-time argument is particularly strong in both its basis in physical principles and its simplicity. Faulkner does not present evidence for a universe thousands of years old but rather makes claims for isolated inconsistencies in the case for great age. While it is common scientific practice to look for holes in well-established theories, the new contrary evidence must either be very strong to counter the existing evidence for the theory or else be supported by a new theory that readily explains both the new evidence and the old. We judge that the "inconsistencies" pointed out by Faulkner do not meet either of these criteria. In some instances the observations are completely consistent with our current understanding of these physical systems in the context of an old universe; in others, while universally accepted interpretations don't exist today and our knowledge is often still incomplete, such explanations are likely to be forthcoming as observations and theory progress. It is our professional judgment that the weight of the evidence overwhelmingly supports a universe that is billions of years old.

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Physics and Astronomy, University of California, Riverside)
Gerald Cleaver, PhD (Associate Professor, Department of Physics, Baylor University)
Kyle Cudworth, PhD (Director, Yerkes Observatory, Professor, Department of Astronomy and Astrophysics, University of Chicago)
Pamela L. Gay, PhD (Executive Director, Astrosphere New Media Association, Edwardsville, Illinois)
Deborah Haarsma, PhD (Chair and Associate Professor, Department of Physics and Astronomy, Calvin College)
Bruce Hrivnak, PhD (Professor, Department of Physics and Astronomy, Valparaiso University)
Stephen Kane, PhD (NASA Exoplanet Science Institute, Caltech)
William Keel, PhD (Professor, Department of Physics and Astronomy, University of Alabama)
Patricia Reiff, PhD (Director, Rice Space Institute, Rice University)
Aaron Romanowsky, PhD (Associate Specialist, University of California Observatories)
Matthew S. Tiscareno, PhD (Research Associate, Department of Astronomy, Cornell University)
Rogier Windhorst, PhD (Regents' and Foundation Professor, School of Earth and Space Exploration, Arizona State University)
Donald York, PhD (Professor, Department of Astronomy and Astrophysics, University of Chicago)

The statements from three different evangelical councils (ICBI, WTS, and PCA) and from the panel of Christian astronomers are available to the Christian community. At the time of this book's writing, however, not one of these statements has yet been distributed widely enough (either inside or outside the church) to make much of a difference in resolving the creation-day controversy. Something more is needed—a way to test the creation models. This topic is the theme of the next chapter.

Chapter 23

Tranquility through Testing

Debates and councils have failed to resolve the creation-day controversy.[1] Limited awareness due to poor publicity has certainly contributed to this lack of success. The church and the world outside it need a way to evaluate different creation-day models—a way that is objective, easy to apply, and easy to understand.

The apostle Paul recommended evaluation in 1 Thessalonians 5:21: "Test everything. Hold on to the good." The most efficient *and* peaceful path for resolving the creation-day controversy is to put both the 24-hour-day (young-earth) and day-age (old-earth) models to the test.

Putting creation-day models to the test seems such an obvious step that one wonders why Christians haven't done it sooner. A hint comes from German Assyriologist Friedrich Delitzsch. Writing over 100 years ago, he described a daunting defeatism: "How absolutely futile all attempts are and will forever remain to harmonize our Biblical story of the creation with the results of natural science."[2]

The consequence of this defeatism has been a reluctance on the part of Christians to produce creation models or to allow their interpretations to be subjected to any kind of meaningful testing.

Creation Models

Models, by definition, are explanatory scenarios constructed from theory and observations and sufficiently detailed for testing. Effective models attempt to explain not only how a particular phenomenon arises and develops but also why. They are capable of predicting future discoveries and anticipating breakthroughs.

Both the 24-hour (young-earth) and day-age (old-earth) creation models are adequately developed and detailed for testing. Each yields straightforward predictions of what scientists and Bible scholars can expect to discover in their research. Such predictions allow researchers and laypeople alike to determine in a fairly brief period of time the relative merits of the two models compared. If, for example, in a given 12-month period, all or most predictions of one model come true, and few or none of the predictions from the other model, then the

creation-day controversy could be settled peacefully in favor of the most predictively powerful model.

Such a contest can never prove *absolutely* which creation model is correct. The work of a transcendent Creator can never be exhaustively investigated by humans because people are limited to the space-time manifold of the universe. Such a contest can effectively rule out a model, however, if none or very few of its predictions prove true. The model with all or nearly all its predictions fulfilled should be preserved for ongoing study and refinement.

The beauty of objective testing is that it reduces the emotional pitch of a conflict. No more name-calling. No more basis for hostility and defensiveness. Differences can be discussed more calmly and rationally. The current pace of scientific research means findings can be evaluated and compared in a fairly brief time span. New discoveries allow creation models to be tested almost on a daily basis.

The Testing Process

Creation-day models touch upon virtually every academic discipline, from the sciences to theology to the arts and humanities. So the range of potential testing is wide. Because the 24-hour and the day-age models typically yield distinctly different (usually opposite) predictions, most testing yields unambiguous results.

The sheer quantity of testable predictions is perhaps the biggest challenge. Space does not permit an exhaustive list. But even a brief list of short-range predictions offers some useful data (see table 23, “Putting Creation Models to the Test”). These particular predictions arise from the disciplines of anthropology, astronomy, and Christian theology. In them the differences between the two models are great and thus readily open to evaluation. These predictions have a high probability of being either fulfilled or falsified during the next several years. Multiple experts in appropriate disciplines—researchers willing to follow wherever the evidence leads—can then judge the predictions’ outcomes.

Table 23: Putting Creation Models to the Test

A sample of contrasting short-range predictions (in three different disciplines) that arise from the young- and old-earth models.

		Young-earth/24-hour days	Old-earth/day-age
Theology	1.	As theologians more thoroughly integrate all the Bible's creation accounts and remaining creation verses, they will discover increasing biblical consistency for the 24-hour view and increasing biblical inconsistency for the day-age view.	As theologians more thoroughly integrate all the Bible's creation accounts and remaining creation verses, they will discover increasing biblical consistency for the day-age view and increasing biblical inconsistency for the 24-hour view.
	2.	Biblical inerrancy will become more defensible with the 24-hour view than with the day-age view.	Biblical inerrancy will become more defensible with the day-age view than with the 24-hour view.
Anthropology	3.	Research will show that no hominid species (large bipedal primates) existed prior to Adam and Eve.	Research will show that several different hominid species existed at different times and places previous to Adam and Eve. These species will prove morphologically and genetically distinct from present-day humans.
	4.	Research will show that Neanderthals and *Homo erectus* were fully human, the offspring of Adam and Eve.	Research will show that both Neanderthals and *H. erectus* are morphologically and genetically distinct from *H. sapiens sapiens* (modern humans). It will also show that only *H. sapiens sapiens* experiences cultural big bangs (religious expression, clothing use, advanced complex language, advanced tools, music, art, and jewelry).
	5.	Fossils of bipedal primates except for humans (humanity would include both Neanderthals and *H. erectus*) will prove to be either fraudulent or grossly misinterpreted.	Fossils of bipedal primates dating before the Neanderthals and *H. erectus* will for the most part prove authentic.
Astronomy	6.	Evidences for the big bang will decrease and become weaker. Astronomers will begin to abandon the big bang model.	Evidences for the big bang will increase and become more compelling. Astronomers will establish the big bang model as the uniquely reasonable explanation for the origin and structure of the universe.
	7.	Astronomers' measurements of the age of the universe will become more discordant or will quickly drop down to values consistent with thousands of years.	Astronomers' measurements of the universe's age will become more consistent, more precise, and more certainly fixed on billions of years.
	8.	Evidences for cosmic history will evaporate. All objects, regardless of look-back time, will measure to be younger than a few tens-of-thousands-of-years old.	Evidences of cosmic history will increase. Objects far away will continue to measure much younger (due to look-back time) than objects in Earth's solar neighborhood.

		Young-earth/24-hour days	Old-earth/day-age
Astronomy (continued)	9.	Currently accepted values for cosmic expansion rates will prove incorrect. New measurements will establish that the universe has been expanding for less than 10,000 years.	Cosmic expansion measures will become increasingly consistent and accurate, providing substantial evidence that the universe has been expanding for billions of years.
	10.	The number of scientists (both Christians and non-Christians) who conclude on the basis of physical evidence alone that the universe and Earth could be only thousands of years old will soon grow from essentially zero to millions.	The number of scientists who conclude based on physical evidence alone that the universe and Earth are only thousands of years old will remain at essentially zero.
	11.	Evidence for star and planet formation and star extinction will prove false.	Evidence for star and planet formation and star extinction will increase.
	12.	Radiometric dating methods will prove thoroughly unreliable.	Radiometric dating methods will prove more accurate and more reliable. Radiometric dates for the age of the universe, Sun, Earth, and first life-forms will become more consistent and precise.
	13.	Evidence that the Sun and stars produce most of their energy through nuclear fusion will be overturned. Stellar nuclear burning models will become utterly unreliable in their capacities to predict stellar characteristics and will produce cosmic age measures increasingly less reliable and increasingly more discordant with other cosmic age measures.	Evidence that the Sun and stars produce most of their energy through nuclear fusion will increase. Stellar nuclear burning models will become increasingly successful in their capacity to predict stellar characteristics and will deliver increasingly accurate and consistent age measurements for the universe. These age measurements will become more consistent with other cosmic age measures.
	14.	Distant galaxies will prove neither close together nor otherwise younger-looking than galaxies in the Milky Way's neighborhood.	Distant galaxies will prove closer together and will be seen at earlier developmental stages than galaxies in the Milky Way's neighborhood.
	15.	Globular cluster dynamics will prove that all such clusters are younger than 50,000 years old.	Studies of the dynamics of additional globular clusters will demonstrate that these star groups are as old as the 100 or so globular clusters already dated at several billion years old.
	16.	Evidence for the distant comet clouds, the Oort Cloud, and Kuiper Belt will be invalidated.	Evidence for the distant comet clouds, the Oort Cloud, and Kuiper Belt will grow stronger and more abundant.
	17.	Evidence for highly dispersed supernova remnants will prove false. Astronomers will fail to discover more evidence for widely dispersed supernova remnants.	Evidence that supernova shells have been expanding for millions of years will become increasingly secure. Astronomers will discover more of the widely dispersed supernova remnants.
	18.	Astronomers will discover a major discontinuity in the laws and constants of physics corresponding to the time (a few thousand years ago) when Adam and Eve first sinned.	Astronomers will continue to accumulate evidence that the laws and constants of physics have remained fixed for the past several billion years.

Pursuing Resolution and Reconciliation

Given that various creation perspectives are readily testable, a pathway exists for peaceful resolution of creation-day controversies. With so much scientific data

and many different biblical creation accounts open for investigation, little basis remains for conflicts or disputes over creation doctrines. By assembling even brief lists of the different creation models' predictions and putting them to the test, otherwise divisive disputes can be resolved or avoided altogether. If a model passes a test, that interpretive approach can be kept for further refinement. If a model fails to pass one test after another, that model or interpretation needs to be set aside.

For the vast majority of young-earth and old-earth creationists, a scan of competing short-range predictions and emerging discoveries offers a quick, relatively easy, and peaceful route to the resolution of the creation-day controversy. Most people are willing to allow evidence and logic to inform and even alter their ideas. But not all people. Sometimes reaching resolution is not quite so simple.

Fears, emotions, and ideology can place a virtual lock on some people's commitment to a model. Getting past such obstacles requires a pursuit of truth wrapped in humility. It also requires a willingness to be wrong. At times when people refuse to let go of ideas for irrational reasons, the grace of early church leaders and of church councils throughout history provides a helpful example. Though some people will never change their minds no matter what the evidence, this resistance does not mean they're not genuine Christians.

What's Next?

The creation-day controversy is a resolvable conflict. But until resolution comes, the mere willingness to test interpretations of the record of nature and the Bible can enhance Christians' efforts in evangelism and discipleship. People who think Christianity demands blind faith and an antiintellectual bias can be brought to faith by Christians who are well prepared to discuss and demonstrate, based on the facts, why they believe what they do. And when differences exist, a spirit of love and compassion can speak of Jesus Christ in a way no other evidence can.

Whether or not the storm ever clears over the days of creation, no doubt other controversies will threaten to divide Christians and stymie both church growth and the character growth of individual believers. But learning how to resolve conflict matures us and prepares us to recognize and deal with problems in ways that the world needs to see, ways that bring honor to God. Controversies compel us to worship Him—heart, soul, mind, and strength. They also challenge us to come to God for the healing of our hearts.

My prayer is that Christians henceforth will respond to conflict, including the current creation-day controversy, in a manner that will build up believers and testify to nonbelievers of God's power to bring unity and harmony out of a

thunderous clash. May the calming of this particular storm encourage and equip Christ's followers to bring future tempests to respectful resolution for the glory of God and the impact of His church.

Appendix A

The Meaning of Faith in the Bible

The *Zondervan NIV Exhaustive Concordance*[1] lists three Hebrew words that are translated into English as "faith."[2] The lexical definitions are[3]

'āman: to confirm, support, uphold (Qal); to be established, be faithful (Niphal); to be certain, i.e., to believe in (Hiphil).
'ēmūn: faithful, trusting.
'ēmûnâ: firmness, fidelity, steadiness.[4]

One main verbal stem in New Testament Greek is translated into English as "faith."[5]

pistis: faith; faith and confidence, fidelity and faithfulness;[6] conviction of the truth of anything, with the predominant idea of trust (or confidence);[7] firm persuasion, a conviction based upon hearing, trustworthiness, a ground for faith, an assurance, in contrast to belief in its purely natural exercise, which consists of an opinion held in good faith without necessary reference to its proof.[8]

Appendix B

Creation-Related Passages and Verses in the Bible

Old Testament

Genesis 1–11	Job 33:4–6	Psalm 136:3–9
Genesis 14:19–22	Job 34:10–22	Psalm 139:1–18
Genesis 15:5	Job 35:5–13	Psalm 146:6
Genesis 22:17	Job 36:5–16	Psalm 147–148
Genesis 32:12	Job 36:24–41:34	Proverbs 1:33
Exodus 7:18	Psalm 8	Proverbs 3:19–20
Exodus 8:13	Psalm 19:1–6	Proverbs 6:6–8
Exodus 10:17	Psalm 24:1–2	Proverbs 8:22–31
Exodus 20:8–11	Psalm 33:6–9	Proverbs 24:30–34
Exodus 31:14–17	Psalm 37:2	Proverbs 30:18–19
Exodus 35:2	Psalm 50:6	Proverbs 30:24–28
Leviticus 23:3	Psalm 51:5	Ecclesiastes 1; 3; 8–12
Leviticus 25:3–4	Psalm 65:5–13	Isaiah 11:4–9
Deuteronomy 5:12–15	Psalm 72:5–7	Isaiah 34:2–5
Deuteronomy 11:21	Psalm 74:12–17	Isaiah 38:7–8
Joshua 10:1–15	Psalm 89:5–12	Isaiah 40:12
Judges 4–5	Psalm 90:2–6	Isaiah 40:21–22
2 Kings 20:8–11	Psalm 93:1–2	Isaiah 40:25–28
1 Chronicles 16:30–34	Psalm 95:4–5	Isaiah 42:5
2 Chronicles 6:10	Psalm 95:11	Isaiah 44:2
Nehemiah 9:6	Psalm 97:6	Isaiah 44:24–25
Job 5:9	Psalm 98:2–3	Isaiah 45:7
Job 8:16–19	Psalm 102:25–27	Isaiah 45:12
Job 9:3–12	Psalm 104	Isaiah 45:18
Job 12:7–10	Psalm 105:29	Isaiah 48:13
Job 14:5	Psalm 119:64	Isaiah 49:5
	Psalm 119:89–91	Isaiah 50:2
	Psalm 121:2	

Job 14:7–12	Psalm 124:8	Isaiah 51:6
Job 22:12	Psalm 125:1	Isaiah 51:13–16
Job 23:8–10	Psalm 134:3	Isaiah 55:10
Job 25:2–3	Psalm 135:6–7	Isaiah 60:18–21
Job 26:7–14	Jeremiah 33:22	Isaiah 64:4
Job 28:1–11	Jeremiah 33:25	Amos 9:5–6
Isaiah 65:17–25	Jeremiah 51:15–16	Micah 6:2
Isaiah 66:22	Ezekiel 28:12–17	Habakkuk 2:14
Jeremiah 4:23–28	Daniel 12:3	Habakkuk 3:3
Jeremiah 5:22	Hosea 3:4–5	Habakkuk 3:6
Jeremiah 10:12–13	Hosea 6:1–3	Habakkuk 3:8–10
Jeremiah 23:23–24	Joel 2:30–31	Haggai 2:21
Jeremiah 27:5	Amos 5:8	Zechariah 12:1
Jeremiah 32:17		
Jeremiah 33:2		

New Testament

Matthew 2:1–16	Romans 8:28–30	Hebrews 4:13
Matthew 5:18	Romans 8:37–39	Hebrews 7:26
Matthew 19:4–6	Romans 14:5–8	Hebrews 9:11–14
Matthew 22:23–32	1 Corinthians 2:9–11	Hebrews 9:22–28
Matthew 24:35	1 Corinthians 3:12–15	Hebrews 10:1–18
Matthew 25:41	1 Corinthians 4:9	Hebrews 11:3
Matthew 25:46	1 Corinthians 6:3	Hebrews 12:22–23
Mark 10:6	1 Corinthians 6:13	Hebrews 12:26–29
Mark 12:25–27	1 Corinthians 8:4–6	1 Peter 1:20
Luke 3:35–37	1 Corinthians 11:8–12	2 Peter 3:3–13
Luke 13:1–4	1 Corinthians 15:20–28	1 John 1:1–2
Luke 20:34–38	1 Corinthians 15:35–58	1 John 2:17
John 1:1–2	2 Corinthians 3:7–11	1 John 3:2–3
John 1:10	2 Corinthians	1 John 3:8
John 2:6–10	1 Corinthians	Revelation 3:12
John 14:2–4	1 Corinthians	Revelation 3:14
John 16:7–11	1 Corinthians	Revelation 4:11
Acts 4:24	1 Corinthians	Revelation 5:13
Acts 14:17	2 Corinthians 3:7–11	Revelation 7:13–17
Acts 17:24–28	2 Corinthians	Revelation 10:6
Romans 1:18–23	2 Corinthians	Revelation 11:17–

Romans 2:12–16 Romans 5:12–17 Romans 8:18–25	4:10–12 2 Corinthians 4:16–18 2 Corinthians 5:1–4 2 Corinthians 5:14 Ephesians 1:4 Colossians 1:15–20 1 Timothy 4:3–4 2 Timothy 1:9 Titus 1:2 Hebrews 1:1–12 Hebrews 4:1–11	18 Revelation 14:7 Revelation 17:8 Revelation 20–22

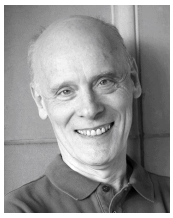
Appendix C

The “Voice” of Nature

Many Bible passages state that God reveals Himself faithfully through the “voice” of nature as well as through the inspired words of Scripture. Here is a partial list of such verses:

Job 10:8–14	Psalm 98:2–3
Job 12:7	Psalm 104
Job 34:14–15	Psalm 139
Job 35:10–12	Proverbs 8:22–31
Job 36:24–25	Ecclesiastes 3:11
Job 37:5–7	Isaiah 40:21–28
Job 38–41	Isaiah 45:18–24
Psalm 8	Habakkuk 3:3
Psalm 19:1–6	Acts 14:17
Psalm 33:4–9	Acts 17:23–31
Psalm 50:1–6	Romans 1:18–25
Psalm 85:11	Romans 2:14–15
Psalm 97:6	Romans 10:16–18

About the Author



Hugh Ross is founder and president of Reasons to Believe, an organization that researches and communicates how God's revelation in the words of the Bible harmonizes with the facts of nature.

With a degree in physics from the University of British Columbia and a grant from the National Research Council of Canada, Dr. Ross earned a PhD in astronomy from the University of Toronto. For several years he continued his research on quasars and galaxies as a postdoctoral fellow at the California Institute of Technology. His writings include journal and magazine articles and numerous books—*Navigating Genesis*, *Hidden Treasures in the Book of Job*, *Why the Universe Is the Way It Is*, and more. He has spoken on hundreds of university campuses as well as at conferences and churches around the world.

He lives in Southern California with his wife, Kathy, and two sons, Joel and David.

About Reasons to Believe

Uniquely positioned within the science-faith discussion since 1986, Reasons to Believe (RTB) communicates that science and faith are, and always will be, allies, not enemies. Distinguished for integrating science and faith respectfully and with integrity, RTB welcomes dialogue with both skeptics and believers. Addressing topics such as the origin of the universe, the origin and history of life, and the origin, history, and destiny of humanity, RTB's website offers a vast array of helpful resources. Through their books, blogs, podcasts, and speaking events, RTB scholars present powerful reasons from science to trust in the reliability of the Bible and the message it conveys about creation and redemption.

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HOW LONG WERE THE CREATION DAYS OF GENESIS—HOURS OR EPOCHS?
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HUGH ROSS (PhD, University of Toronto) is founder and president of Reasons to Believe. He is the author of numerous books, including *Navigating Genesis*, *Hidden Treasures in the Book of Job*, and *Why the Universe Is the Way It Is*. An astronomer and pastor, Ross has addressed students and faculty on over 300 campuses in the United States and abroad on a wide variety of science-faith topics. From science conferences to churches to government labs, Ross presents powerful evidence that science and faith are allies, not enemies.

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Notes

1. Flash Point

1. John Ankerberg, Hugh Ross, and Kent Hovind, *The John Ankerberg Debate: Young-Earth vs. Old-Earth*, aired October 9, 2000 (Covina, CA: Reasons to Believe, 2000), DVD. The unaltered, unabridged debate is available for free at Reasons to Believe's YouTube channel (http://www.youtube.com/user/ReasonsToBelieve1); Stacia McKeever and Ken Ham, "Slippery Slide to Unbelief: A Famous Evangelist Goes from Hope to Hopelessness," *Creation* 22 (June 2000): 8–13; Jonathan Sarfati, "Exposé of *The Genesis Question*," *Journal of Creation* 13 (November 1999): 22–30; John Morris et al., *After Eden*, episode 6, Institute for Creation Research, 2003, CD.
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4. Ibid., 15.
5. Ibid., 22.
6. Ibid., 23.
7. See articles 8, 9, *Ecumenical Creeds*, 87.
8. Ibid., 87.
9. Ibid., 88.
10. Ibid., 91.

11. See article 2, *Ecumenical Creeds*, 79.
12. Ibid., 88.
13. According to the Bible, space and time were created when God created the universe. That is, time, as we experience it, did not exist before the creation of the universe. This cosmic time is unidimensional, unstoppable, and irreversible. Since the Bible attributes cause-and-effect and relational capabilities to God before the existence of the universe, He must have retained some kind of temporality before the cosmic creation event. Therefore, it is entirely appropriate for the Belgic Confession to say that God "created heaven and earth...when it seemed good to him."
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30. Kenneth R. Samples, "The Orthodoxy of Days," *Facts for Faith*, Quarter 4 (2001): 54.

6. Toward Better Interpretations

1. For a thorough overview of the author's and Reasons to Believe's position on God's revelations through the words of the Bible and the record of nature, see *God's Two-Part Harmony: Scripture and Nature* (Covina, CA: Reasons to Believe, 2003), available as an MP3 audio download from shop.reasons.org.
2. Since Christians are quite familiar with the issue of sin and their own ability to deny God's truths, this topic will not be addressed in this book. For more on God's revelations through Scripture and nature, see

Kenneth Samples, “Revelation Times Two?,” *Facts for Faith*, Quarter 2 (2000): 50–54.
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2. Francis Brown with S. R. Driver and Charles A. Briggs, *The Brown-Driver-Briggs Hebrew and English Lexicon* (1906; repr., Peabody, MA: Hendrickson, 1997), 398–401; H. W. F. Gesenius, *Gesenius’ Hebrew-Chaldee Lexicon to the Old Testament*, trans. Samuel Prideaux Tregelles (1847; repr., Grand Rapids, MI: Baker, 1979), 341–42; R. Laird Harris, Gleason L. Archer, and Bruce K. Waltke, *Theological Wordbook of the Old Testament* (Chicago: Moody, 1980), 1:370–71.
3. William Wilson, *Old Testament Word Studies* (Grand Rapids, MI: Kregel, 1978), 109.
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5. Brown, Driver, and Briggs, *Hebrew and English Lexicon*, 787–88; Harris, Archer, and Waltke, *Theological Wordbook*, 2:694; Gesenius, *Hebrew-Chaldee Lexicon*, 652.
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8. Guided by Theology

1. See, for example, Psalm 119:160; Isaiah 45:18–19; John 8:31–32; 10:35b; Titus 1:2; Hebrews 6:18; 1 John 5:6.
2. For example, modern distilleries can alter youthful whiskeys by adding chemical flavorings to make them taste like whiskeys that have been aged for 30 years.
3. See Psalms 8 and 19 for examples.
4. See Job 9:1–35; 35:11; 36:2–42:3; Psalms 19:1–6; 50:6; 65:6–13; 89:5; 97:6; 98:2–3; 104:1–32; 119:64; Habakkuk 3:3–4.
5. See Psalm 119:96; Matthew 19:17; John 14:6; 17:17.
6. For an explanation of dark energy and how it is designed to make life possible and human civilization optimal, see my book *Why the Universe Is the Way It Is* (Grand Rapids: Baker, 2008), 38–40, 53–56.
7. See Genesis 22:17; Jeremiah 33:22; Hebrews 11:12.
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10. Peace through Paradise

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12. See Job 38:22–38.
13. See Psalm 19:5–6.
14. See Ecclesiastes 1:5–6.
15. See Psalm 104:14–17.
16. See Psalm 104:32.
17. See Job 9:7.
18. Genesis 2:1 makes the same claim as Hebrews 4:3—that God's creation work in preparing the cosmos and Earth for humanity's entrance was completed.

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18. Physical Reality Breaks through the Fog

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2. Ibid.
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24. Danny Faulkner, "The Young Faint Sun Paradox and the Age of the Solar System," *Creation Ex Nihilo Technical Journal* 15 (August 2001): 4.
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19. Narrow Time Windows

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20. The Significance of Man

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21. A Clear "Day" Interpretation

1. One of the most dramatic instances of such proclamations occurred throughout *The John Ankerberg Debate: Young Earth vs. Old Earth*, a two-hour television debate between Kent Hovind and me. The unaltered, unabridged debate, which aired October 9, 2000, on *The John Ankerberg Show*, is available for free at Reasons to Believe's YouTube channel (http://www.youtube.com/user/ReasonsToBelieve1).
2. Jonathan Sarfati, *Refuting Compromise: A Biblical and Scientific Refutation of "Progressive Creationism" (Billions of Years) as Popularized by Astronomer Hugh Ross*, 2nd ed. (Atlanta, GA: Creation Book Publishers, 2011), 139–40; Terry Mortenson, "Evolution vs. Creation: The Order of Events Matters!," Answers in Genesis, posted April 4, 2006, http://www.answersingenesis.org/articles/2006/04/04/order-of-events-matters.
3. The late Duane Gish of the Institute for Creation Research repeated this claim in an interview with RTB scholars. Duane Gish, interview by Hugh Ross et al., *Creation Update Primetime #5*, Reasons to Believe, March 13, 2003. A recording of this interview is archived at Reasons to Believe. The recording notes are available at http://www.reasons.org/cu-archives/cu-outline-2003#p5.
4. James Brodrick, *Galileo: The Man, His Work, His Misfortunes* (New York: Harper and Row, 1964), 75–77.
5. For a more complete explanation in the context of the original Hebrew words, see Hugh Ross, *Navigating Genesis: A Scientist's Journey Through Genesis 1–11* (Covina, CA: RTB Press, 2014).
6. Thomas Burnet, *Archeologia Philosophica, or The Ancient Doctrine Concerning the Originals of Things* (London: E. Curll, 1692).
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12. Ibid.

22. Councils Attempt to Bring Calm

1. See also 2 Corinthians 11:23
2. James Montgomery Boice, *Does Inerrancy Matter?* (Oakland, CA: International Council of Biblical Inerrancy, 1979), 2.
3. Ibid.
4. Earl D. Radmacher and Robert D. Preus, eds., *Hermeneutics, Inerrancy, and the Bible: [papers from the ICBI Summit II]* (Grand Rapids, MI: Academie Books, 1984), 901–3.
5. PCA Historical Center, *Report of the Creation Study Committee*, June 2000, http://www.pcahistory.org/creation/report.html; "Westminster Theological Seminary and the Days of Creation," Westminster Theological Seminary, accessed June 6, 2003, http://www.wts.edu/about/beliefs/statements/creation.html. Also see "Report of the Creation Study Committee," Reasons to Believe, posted January 1, 2000, http://www.reasons.org/articles/report-of-the-creation-study-committee.

23. Tranquility through Testing

1. Three creation-date debates—in the form of two books and a television broadcast—have received significant public exposure. The books are David G. Hagopian, ed., *The Genesis Debate: Three Views on the Days of Creation* (Mission Viejo, CA: Crux Press, 2001); and J. P. Moreland and John Mark Reynolds, eds., *Three Views on Creation and Evolution* (Grand Rapids, MI: Zondervan, 1999). The television broadcast was a debate between young-earth creationist Kent Hovind and me on *The John Ankerberg Show* in October 2000. The unaltered, unabridged debate, entitled *The John Ankerberg Debate: Young Earth vs. Old Earth*, is available for free at Reasons to Believe's YouTube channel (http://www.youtube.com/user/ReasonsToBelieve1).
2. Friedrich Delitzsch, *Babel and Bible*, trans. Thomas J. McCormack and W. H. Carruth (Chicago: Open Court, 1903), 45.

Appendix A: The Meaning of Faith in the Bible

1. Edward W. Goodrich, John R. Kohlenberger III, and James A. Swanson, eds., *Zondervan NIV Exhaustive Concordance*, 2nd ed. (Grand Rapids, MI: Zondervan, 1999).
2. Four other words are translated in the sense of "breaking faith" or "keeping faith."
3. R. Laird Harris, Gleason L. Archer Jr., and Bruce K. Waltke, eds., *Theological Wordbook of the Old Testament*, 2 vols. (Chicago: Moody Press, 1980).
4. Ibid., entries 116, 116d, and 116e, respectively.
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6. Kenneth S. Wuest, "Golden Nuggets," in *Wuest's Word Studies from the Greek New Testament: For the English Reader* (Grand Rapids, MI: Eerdmans, 1973), 3:38.
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