

Lancaster Theological Seminary

**I Wonder...**  
**Scientific Exploration and Experimentation as a Practice of Christian Faith**

A Major Project Submitted to the Faculty  
in Candidacy for the Degree of  
Doctor of Ministry

by

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I Wonder...Scientific Exploration and Experimentation as a Practice of Christian Faith  
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## Introduction

*From religion comes a man's purpose; from science, his power to achieve it.*

*Sometimes people ask if religion and science are not opposed to one another.*

*They are: in the sense that the thumb and fingers of my hands are opposed to one another. It is an opposition by means of which anything can be grasped.*

—Sir William Bragg, 1915 Nobel Laureate in Physics

Since I matriculated as a candidate for the Doctor of Ministry degree at Lancaster Theological Seminary, I have had to answer the question, “What is your project?” countless times. It would get old but for the double-take most people give in response to my answer. The next logical questions people ask, in about equal proportions, are “Do you have an undergraduate degree in science?” and “Why is this important to you?”

The answer to the first is no, but I have always loved science thanks to parents who believed wholeheartedly in Public Television as an educational medium (for every hour of *The Lawrence Welk Show* and *The Boston Pops* we watched, we watched an hour of *NOVA* and *National Geographic*). They also believed that children should read anything that interested them without censorship, which led me to read every book in the Egyptology section of our local library the summer between fourth and fifth grades. Science? Yes, please, especially when it comes combined with history and political intrigue both ancient and modern. I could have explained in great detail how to make a mummy and then told you the details of the first attempts at monotheism in the ancient world, followed by a brief on the Napoleonic Wars and the state of the Middle East after the fall of the Ottoman Empire and what those had to do with advances in the science of archaeology. Science in relationship to everything, including religion? Of course!

The answer to the second question is both simple and complex.

On the simple end, I want to nurture curiosity about God's cosmos in as many ways as I can in the local church and hands-on science is another avenue of exploration to travel. People who have not "done" science in a long time often do not remember the basic methods: realistically, very few of us have participated in a true science experience since college, if not high school—and when science class was a burden, the joy of learning got lost in the lab reports and exams. It has been my experience that even adults jaded by lab reports and exams in days long gone by can rekindle their native curiosity about creation through play and exploration.

The more complex, and ultimately more important reason, is that I want to counter the prevailing though wrong impression in the cultural *zeitgeist* that Christianity is anti-science. Since I spent seminary and my early years in science and technology heavy Massachusetts, I did not encounter this strain of American society until I arrived in southwest Pennsylvania, the northern end of Appalachia and a very conservative part of the country. My youth group raised it in conversation in early 2007; several of them were in science classes with friends who argued with the teachers about the truth of the Bible and the falsehoods taught by science. How, they wondered, could their peers think like that? Were we wrong not to think that? A few months later, I preached my first "faith and science" sermon. It went over well, particularly with one of our college students at the time, who thanked me for giving her a way to talk to both her anti-science Christian friends and her friends and colleagues in the science department who couldn't understand how she could be both a Christian and a geology major. Conversations with my own more conservative colleagues over the next two or three years convinced me that they would like nothing more than to see the introduction of Intelligent Design into the science curricula of our school districts. Despite the outcome of *Kitzmiller v. Dover Area School District*, which

proponents of Intelligent Design lost ignominiously, such attempts continue around the country. If I can help my congregation be a strong pro-science voice, I have hopes that we can avert any attempts to dilute our science curricula with religious-based concepts that, if they have any place in public schools at all, belong in philosophy classes, not science classes.

We who are people of the Christian faith need to have an informed and respected voice in the ethical and moral debates about the use of science and technology to solve global problems in the twenty-first century. As I write, ethicists around the world have given preliminary approval for gene editing in human embryos using the CRISPR technique and for “three-parent” embryos in which a donor egg is used to provide mitochondrial DNA for the nuclear genetic DNA of a biological mother and father. The hope for each of these is that devastating congenital diseases can be edited out of a child’s genome either in utero or prior to implantation of a fertilized egg; we are capable now of “playing God” in ways that prior generations only dreamed of, but what does that mean morally and ethically (Achenbach)? What does our faith tell us about this?

People of faith who are not afraid of *doing* science will hopefully be unafraid of *talking about* science and its implications. This includes both the epistemological differences between faith and science and the ontological questions that arise because of those epistemological differences.

Christianity is a belief system, which by definition means that at least some portions of it must be taken on faith because there are no testable predictions to be made from empirical evidence. In broad strokes, faith epistemologically rests on what I learned as “the Wesleyan Quadrilateral”: Scripture, Reason, Tradition, and Experience. Various Christian denominations may favor one or two of these sides over the others, but at heart, Christianity has these four elements formed around the Trinity.

Tradition is documentable and somewhat verifiable; we can trace the history of religious movements and how various doctrines evolve over time. We can do the same with Scripture, but different groups of Christians hold Scripture in varying ways from seeing it as the literal, inerrant Word of God to understanding it as a compilation of stories about people working out their relationships with God over time and place. How we interpret Scripture in our faith community is part of its particular Tradition as well as part of the broad scope of Christian Tradition.

Experience can be so specific to each individual that all we can do is hear each other's stories. We have no way to prove the veracity of our own personal encounters with the sacred (one of the major criticisms leveled by scientists); because of this, Christianity—perhaps all faiths, truly—is a grand hypothesis that can never be proven sufficiently to become a theory, though testing can continue for a lifetime. Community discernment practices can and often do mitigate the individualistic nature of Experience and provide some movement toward standards by determining at the very least which experiences do not align with the expectations of Scripture and Tradition. Nancey Murphy explicated in great detail an understanding of Christian discernment practices as analogous to a program of study and experimentation in science as one example. Other communal practices, and perhaps many individual practices, could also be likened to a scientific program of study and experimentation (156-168). Because Christianity is indeed at heart a systematic organization of ideas, it is in essence a paradigm anchored in belief rather than factual observations of natural phenomena like the sciences. Because Reason is a part of this paradigm, is the hope for starting conversation about science within religion.

The faculty of Reason is how we make sense of the world around us. Science has its own particular method of employing Reason—its own epistemological structure: as Phil Plait, the “Bad Astronomer” at *Slate Magazine*, says, science is not a belief system. It is a system of

observing and analyzing evidence and then making predictions based on those analyses. Tested predictions succeed or fail (falsification of predictions, generally speaking) based on new evidence, evidence is analyzed, new experiments are designed, and so on. Good science is based on the understanding that nothing is ever certain: what seems to be true and valid one day might be disproved, or at least thrown into doubt, the next day in an experiment or as someone interprets data from old experiments using new knowledge. Christianity could learn much from this reliance on uncertainty; our certainty about particular beliefs has become strangulating dogma that divides us and soul-sucking doctrine that separates us from the joy our salvation.

Where Christian faith often fails with Reason is at the intersection of religious dogma and doctrine and scientific theory. Theories falsify what are believed to be religious certainties, causing ontological crises. One specific example of this clash of certainty with contrary evidence is the undeniable conflict between the creation stories of Genesis 1 and 2 and Charles Darwin's theory of evolution. Genesis says that God created human beings last and gave us stewardship/dominion over all creation. Evolution teaches that all of life on earth came from the earliest single-celled bacteria billions of years ago. If God did not make human beings specially, what makes us different from the rest of creation?

Another example of the clash comes from the growing evidence that we live in a "Goldilocks" universe where every value is "just right" for our existence. Scientists are forced to wonder why we are even here to ask the question. Religious fundamentalists deny the science to avoid the ontological crisis and the questions it raises about Scripture and thus about the nature of God; materialists who make science the end-all, be-all of knowledge deny that there is any ontological crisis at all because they deny the existence God entirely and (generally speaking) see no purpose to the existence of life as a phenomenon, let alone sentient life capable of



questioning the meaning of its own existence (Barbour *Religion* 5–12, *When* 10-12, 23-24).

There is a wide field between these two extremes, but helping people see the field, and then be prepared to take the field to play the conversational game, is the goal of my work. My primary audience is people of Christian faith, though if my work also reaches scientists who are not particularly religious but are exploring spiritually, I will be delighted.

Sadly, many Christians have to start before the beginning to even begin to see the field: they do not understand the importance of science or its methodologies. My curriculum is a “training camp” to teach the basics of science in a faith context, using the common language of “wonder” to show that both science and faith are rooted in a desire to learn and to understand the world around us; the first chapter establishes this premise.

I have used the creation story in Genesis 1 and Proverbs 8:22-31 as the Scriptural basis for this project. Lady Wisdom (Sophia) speaks in Proverbs 8:22-31 of being present with God from before the moment of creation right through until she could delight in (or play with) human beings. The personification of wisdom is, of course, a metaphor; at my project consultation, I was asked what the metaphor describes. The question stumped me for several days, but then I came to the realization that the operative assumption I have made throughout my work is that Lady Wisdom personifies all that it is possible to know and to understand. Sophia, then, is the personification of God’s omniscience, a word I dearly love because it has the word “science” right in it as the original meaning of the word: knowledge.

There is a distinction between “all knowledge” and “all that it is possible to know” at the heart of two very different understandings of God. “All knowledge” is applicable to the kind of cause-and-effect laws of physics that Isaac Newton described. God in a cosmos with Newtonian physics as its fabric could know all past, present, and future things because if one knows the

cause, one can predict the effects and if one observes the effects, one can describe the causes with certainty. In this cosmos, nothing, not even God, has free will; all was set in place from the moment God said, “Let there be light” and will unfold exactly as God planned until the end of time. Because Newtonian laws adequately describe most of what we humans encounter on a day-to-day basis, the theology of God that accompanies it still holds sway in a vast swath of Christian culture. This theology supports rule-bound practice and literalism as well as predestination.

“All that it is possible to know” applies to a quantum cosmos which operates on probabilities rather than certainties. The outcome of any given binary choice may have a statistically weighted probability in one direction, but in quantum physics, the other outcome is always possible, even if highly improbable. God in a cosmos with quantum fabric “plays dice” with the future, as Einstein so eloquently and disgustedly said. The theory of evolution and all its corollaries work much more logically within a quantum universe than a Newtonian universe. Diverse solutions to similar complex problems encountered by multiple species is about probabilities: *For species Q, R, S, T, U, V, situation A + crisis B = solutions C, D, E, F, G, H...* A cause-and-effect universe would require the same solution for the problem regardless of species: *For species Q, R, S, T, U, V, situation A + crisis B = solution C.*

Although we live in a quantum universe, we do not generally experience the world at the quantum level, which means that theologies springing from a quantum cosmos are not as intuitive or tangible as those from a Newtonian cosmos. Process theology, like quantum mechanics and evolution, focuses on the holistic nature of creation. Everything is interconnected in the ongoing creative process in describable yet unpredictable ways, including humans who respond to God’s persuasive, creative love and are participants in creation (Barbour *When* 114-117, 143-144, 174-180). Unpredictability makes rule-bound faith, literalism, certainty, and

predestination (possibly aside from universal salvation) impossible. In a divine twist, quantum physics supports the notion of miracles more than Newtonian physics because in a universe that operates on quantum laws, *nothing is impossible, but some things are highly improbable* (see Appendix B, “Improbable But Not Impossible”).

Epistemology and ontology are addressed in an examination of the polar extremes of anti-science Christianity (essentially, those forms most bound to Newtonian cause-and-effect physics) and anti-religion science (championed by the “New Atheists”) in chapter two. I propose a thesis-antithesis-synthesis model for moving past the artificial division to establish a both/and system as opposed to the either/or systems so many insist are necessary today.

Church education wings are not conducive to quantum-level experiments, of course; ping pong balls and blow dryers are appropriate, as are cake batter, glow-in-the dark slime, simulated earthquakes, comparisons of different kinds of life, and scale modeling of the solar system. By demonstrating to children and youth that our faith is not opposed to science and its methods, perhaps the next Rosalind Franklin or Stephen Hawking will be inspired to pursue answers to questions about the universe, the laws God put in place that organize it, and the incalculable diversity that those laws allow. Two chapters are devoted to this specific mission. Chapter three is a new, scientifically accurate (as of the date it was last edited) creation myth that uses the structure of Genesis 1 to demonstrate what we know from scientific exploration and experimentation about the laws by which God created the cosmos. Chapter four is the curriculum itself, which in its current form is a five-day Vacation Bible School experience. The original version of this was taught at The United Church of Schellsburg, United Church of Christ, in June 2010, with an intergenerational participation of approximately 35 people. The current version was taught in July 2015 with participation by 18 people of varying ages in an assortment of roles.

The final chapter includes reflections shared by participants in a series of science-inclusive Vacation Bible School experiences at The United Church of Schellsburg from 2010 to 2015, including one based on archaeology in which we learned the science of how we know what we know about the Bible and one that taught the science behind important Bible stories (David's slingshot is an excellent way to teach physics, for example). This chapter also includes my reflections on the experience of designing and leading these encounters so far and my hopes for the future of this project. I will note here that every time I have asked our children and youth what they want to do in Vacation Bible School this coming summer, the answer is always, "Science!" I have so many ideas...

## Chapter One: Why Wonder is Not Mere Child's Play

I remember vividly the first time I ever experienced God in a way that left me speechless. One night while waiting for my father to come out of a meeting at our church, I went into the sanctuary, which was lit only by the lights of the narthex shining through the frosted glass at the back. I climbed to the top of the steps in the chancel and I started to sing because to me, that was a favorite way to play. “Joyful, Joyful, We Adore Thee” echoed around the empty space and came back to me, wrapping me in chords and creating harmonies from my single melodic line. I did not know at that age that the acoustics accounted for the harmonies; as I experienced it, the angels sang with me in praise of God, who clapped loudly at the end as a thunderstorm rolled through. I knew that if I ran outside, the trees and the rain and even the pastor’s big, fierce dog in the parsonage yard would be praising God with me. It was awesome.

Even now, over 40 years later, whenever I get lost in the busyness of life and lose my sense of purpose as a beloved child of God, I can ground myself by going into a sanctuary (with or without a congregation) and letting my voice fly with whatever song is in my heart, which is still play to me. As Abraham Joshua Heschel notes, “When we sing, we are carried away by our wonder; and acts of wonder are signs or symbols of what all things stand for” (41). I am only now beginning to understand how vital is the sense of wonder this play evokes for my spiritual and intellectual well-being. To wonder—to be in awe of what surrounds us—is to begin to answer questions of meaning and purpose. Wonder begins in childhood, but if we are to continue to mature as human beings, it cannot stop at adolescence or adulthood but must instead be a lifelong pursuit (Melchert *Playing* 7f).

A working definition of “wonder” as an emotion is necessary first. Fuller quotes the definition from the *Oxford English Dictionary*: “the emotion excited by the perception of something novel and unexpected” and “astonishment mingled with perplexity or bewildered curiosity” (8). Heschel says that wonder is “radical amazement” and “the state of maladjustment to words and notions” by which we try to “adapt our minds to the world;” he also says that the response is innate, that is, beyond our willful control (11, 27). A definition of wonder from the perspective of a naturalist might be that which causes us to say, “I don’t know” and then to investigate the mystery (Raymo 29-30). Wonder causes us to say, “Oh my, God!” in response to experiences and encounters with the Mystery by which we are surrounded (Cannato 10). The common elements of these definitions are surprise and an inability to articulate a description of what has been revealed.

Furthermore, human beings have the ability to ask, “Why are we here?” and, “For what purpose do we live?” Children are born curious and stand ready to explore the world with open wonder if they know that they are safe and loved, finding meaning and purpose in everything and often helping the adults in their lives to remember why wonder is important (Melchert *Playing* 9-10). According to Abraham Maslow, these questions can only be asked when people do not live in fear for their survival but are capable of expending energy not for the utility of a relationship but for the sake of the person as a person; such relationships lead to the recognition of others as holy and evoke a sense of awe and wonder about the entire world (Fuller 98-99). Wonder is also a necessary part of the evolutionary path of *homo sapiens*, without which society and culture could not assimilate and adapt to changes and thus assure the long-term survival of the species (54-55).

It is not a surprise, then to find that wonder as an emotion has deep roots in world religions and philosophies. As early as the third century BCE, Indian philosophers noted that wonder was the response to an experience of the divine consciousness of all things. Descartes describes wonder as the pull to investigate that which causes surprise; wonder is also our reaction to events and experiences that cause us to see new connections between and among elements of our environment (Fuller 9-11). Because wonder prompts thoughtful examination of the connections between parts and the whole, and because such examination leads one to be more receptive to new ideas, it is a primary expression of human capacity for intelligence and growth (38). Wonder, then, can be defined as *an emotional response that prompts us to reexamine our cognitive categories because of a surprising experience which currently we have no way to describe.*

So what is it that evokes such an emotional response in us? Here again, a working definition is helpful. My own experience as a child, and similar experiences throughout my life, lead me to understand that as a child of God I am both an infinitesimal part of the universe and intimately known by God, who is transcendent in the universe and immanent in relationship (Heschel 244). Heschel says that “the ineffable” occupies the whole of our world, from largest events to smallest things and, “How shall we remain deaf to the throb of the cosmic that is subtly echoed in our own souls? The most intimate is the most mysterious. Wonder alone is the compass that may direct us to the pole of meaning” (5, 16). He goes on to say that wonder is such a necessary part of the human life that without the will to stand in awe of the “throb of the cosmic” one cannot be happy and might as well die (37).

Cannato and Raymo both speak of a unifying force underlying all that we know. For Cannato, this is a God big enough for evolution and cosmic expansion as the processes of a

universe still being created (14-15). Her experience is similar to that of John Muir, who experienced God as inextricably intertwined with all of creation, finding God in forests, raindrops, evolutionary theory and geologic time (Fuller 48-52). Raymo says that “X” is enough of a unifier, the Mystery that is holy, both hidden by Heraclitus’ veil and as easy to see as the nearest flower or ladybug in nature (15, 103, 116). While he does not cite Rachel Carson, Raymo’s reverence for life echoes her presentation of creation as sacred and thus worthy of awe and wonder (Fuller 106).

Research by Richard and Bernice Lazarus leads them to speculate that wonder is a combination of other emotions evoked in moments of awareness of the greatness of creation that provokes trust and feelings of closeness and belonging (Fuller 32-33). William James experienced, under the influence of nitrous oxide, with a medium whose knowledge he could not empirically explain, and while thoroughly exhausted, something that he said was beyond the visible world. As a result of his experience, he proposed that empiricism had to expand to allow for what could not be explained scientifically (69-79). The common element in these experiences and thoughts is the notion that what evokes wonder in us is *that we are part of that which is bigger than and beyond our ability to understand using our known categories of language and science.*

We have not ever allowed that inability to understand stop us from trying to describe and thus know, however. All that is written, painted, sculpted, set to music, or defined by science is the human attempt to categorize what is most significant about existence and began as an attempt to describe and know what was previously indescribable and unknown. Even as we answer one set of questions, we are first left with new mysteries that leave us unable to formulate new questions, and then struggle to formulate new questions that lead to answers and mysteries in a



cycle of exploration and revelation that never truly ends (Heschel 30-31). Asking questions is how we learn, but in order for questions to be valuable, they must be the correct question to elicit the information we want to learn. The problem with asking questions of reality is that we cannot know the right questions to ask; what we think we seek to learn comes out in questions that will give us the wrong information. What do we mean by the “ultimate origin” of the universe, its scientific beginnings (how?) or that which caused it to begin (why?)? (43).

One mystery that currently has neither a how nor a why answer is the recurrence of Phi, the Golden Ratio of approximately 1.618, in nature and in the works of art considered most beautiful across time and cultures. What is the attraction of this pattern in nature, say in the spiral of a mollusk shell or the petals of a sunflower? Is it the recurrence of the pattern in nature that makes its presence in music such as Beethoven’s Fifth Symphony and in art such as DaVinci’s *Mona Lisa*, and in architecture such as the Parthenon and the Taj Mahal, so prominent? H.E. Huntly posits that the recurrence of Phi in surprising places in nature is the mark of an intelligence greater than ours (Fuller 122-124). Could our use of Phi in art, consciously or unconsciously, be an attempt to categorize that which we cannot explain in other ways? I wonder now if the harmonics that elicited such wonder and awe in me at the age of five were rooted in this perfect ratio, and though I will never know for sure, it would take nothing away from the experience if I did. Rather, such knowledge would, I think, further affirm my connection with and desire to worship that which is bigger than I; while the music humans create may consciously copy the patterns of nature, humans only noticed those patterns, we did not create them. That belongs solely to the ineffable.

So what is it about that which is bigger than us and capable of creating patterns that we can recognize and copy that evokes in us a desire to worship it, whether by no name or by a

name with so much historical and emotional baggage as “God” (Raymo 19)? According to William James, one’s religious tendencies are in proportion to one’s perception “of an unseen order of life.” The function of wonder is to make us able to perceive that unseen order (Fuller 150). Heschel says that our need to worship is rooted in our awareness of this omnipresent mystery and our comprehension of it as outside ourselves rather than something we create for ourselves. Only then can we grasp that our very existence means that God thinks of us (63-64). Because God thinks of us, we know that God is more than and beyond even the ineffable and surpasses being itself. This is how we discern God’s presence, but it is not yet a window into God’s essence. Awareness of the ineffable leads us to a place where our souls are laid bare and we realize that faith is the only way we will ever be able to answer the inevitable question of who made us so that we are able to wonder, to be in awe of that which is beyond and above us (67-68).

Another definition is in order here. What do we mean by the term “faith”? Heschel says that faith is the result of asking what we do with wonder, mystery, awe, and fear. To him, wonder is tension between awe and our inadequate ability to describe and define our experiences of the ineffable because wonder is itself a question we are asked by the ineffable. We can choose to answer or not, but answering becomes more urgent as we pay closer attention to what is happening around us (68-69). Faith is the product of one’s yearning for meaning, recognition of being, and awareness of the unbelievable within the concrete and evident. Faith is all-consuming and resides in the recognition of what is marvelous all around, in people and in nature. Faith finds holiness in all things. True faith comes when power, beauty, grief, and fears have been abandoned for love, goodness, gratitude, and strength (89-90). Cannato’s idea of faith involves taking life itself up on its invitation to experience and be in relationship with divine creation,

which is interconnected in ways that mystics and scientists both recognize (11). The invitation, when answered affirmatively, leads to living in awe and falling into wonder (141-142). Faith begins when we want relationship with God more than anything else. Faith motivates us to serve, obey, worship, and adore (175-176).

Raymo identifies faith as the ability to recognize invisible grace in the visible signs of nature, a merger of the best of his upbringing in the sacraments of Roman Catholicism and his adult life as a scientist (22). While Fuller does not himself define faith, he cites Scheiermacher's definition of religion as an emotional response to the intuitive consciousness of God and a relationship therewith and Otto's proposition that a subjective encounter with the transcendent "wholly other" raises feelings of exaltation, submission, rapture, and dependence as viable understandings of faith (3-4). Faith, then, can be broadly defined *as our positive response to the invitation from the ineffable to be in intentional relationship with the whole of creation* and more narrowly defined in the Judeo-Christian tradition *as our positive response to God's invitation to be in intentional relationship with the God of all creation and thus with all creation*.

The distinction between religion and faith appears to be the difference between the rules, dogma, and doctrine of religion and the relationships inherent in faith. Heschel notes that a rationally proved God only requires the kind of order construed by rules, limiting God to that which humans are capable of conceiving. Such a God is one that does not, and cannot, inspire awe, wonder, or reverence (54-55). Proofs for God's existence based on logic fall flat to those who have experienced wonder and awe; such proofs reduce God to laws that hold no sense of the ineffable and provide no light by which to glimpse God. Logic also leads to the search for God as a solution to humankind's problems rather than to the realization that humanity is God's problem (82-83). Human beings have a bad habit of worshipping the doctrines and dogmas we

create to illuminate God rather than God. The certainty of living by strict doctrines is more appealing to most of us than serving God who may ask anything of us (169). Fuller reminds us that some forms of religion which are based on emotions other than wonder, such as fear or guilt or both, repress experiences of wonder precisely because openness to that which exists beyond defined doctrine and dogma breaks the defined line between sacred and profane (156-157).

If indeed God is the creator of the universe and thus nothing can be outside of God's purview, then there can be no true line between sacred and profane because there is no difference between sacred and secular. Everything is sacred (Heschel 267). Children are born knowing that everything is sacred, which they express in all manner of ways from stomping through mud puddles to picking up ugly yet remarkable crabapples (Melchert *Playing* 6f) to tracing the rainbows in autumn trees. Could it be that the key to deepening connection with God throughout our lives, that is, maturing faith, is that we need to approach the world with a child's wonder and play in the mud puddles of life?

When we read in Proverbs 8 that Wisdom herself played in creation, as either a little child or a master worker or both (for what is a child's vocation but to play masterfully?), we are taken aback by the notion. In the same chapter, playful, merry Wisdom invites us to learn and practice her ways (Melchert *Playing* 2-4). Jesus' teaching methods model the practices of play and merriment; he uses humorous and twisting parables to invite contemplation of his meanings and he spends an inordinate amount of time feasting with people whose partying ways raise the eyebrows of those who see and keep a bright line between sacred and profane (4). When asked by his disciples who would be greatest in heaven, Jesus answers by placing a child in the middle of the group. He says to them, "Truly I tell you, unless you change and become like children, you will never enter the kingdom of heaven. 'Whoever becomes humble like this child is the greatest

in the kingdom of heaven. <sup>5</sup>Whoever welcomes one such child in my name welcomes me” (12, MT 18:3-5 NRSV and parallels at MK 9:35-37 and LK 9:47-48). As I read this with Wisdom playing in my head, to approach heaven with humility is to put God in proper place for reverence and awe and to have the wisdom and the freedom to play in creation. In short, to wonder is to be close to heaven.

So how do we who are adults practice play? How do we regain contact with our inner children who picked up ugly crabapples adults would overlook and saw rainbows in autumn trees that adults could not understand? Can we find those children who built snow forts while grownups groaned about shoveling? One way is to spend time with children and take seriously their observations of the world because they see the world differently than we do (Melchert *Playing* 6-7). Another way is to seek out new experiences of the world, like swimming with stingrays off Grand Cayman Island or hiking Diamond Head, both experiences that left me exhilarated and in awe.

Yet another way is to seek out the holy and mysterious in what agnostic science has discovered about the universe and all that is within it. Raymo’s emphasis is on life on earth; he finds mystery without divinity and resists the notion of God because God too often is made in the image of humans. Cannato focuses on the origins of the universe and finds God, Christ, and Spirit (albeit mostly God and Christ, with the Spirit linked primarily to creativity) at work in phenomena such as the Big Bang and supernovae. Both encourage wonder and questioning, mature but fulfilling forms of play that can lead to deepening relationships with the divine.

Chet Raymo approaches spirituality from within nature and admits to having left conventional religious beliefs behind as he became immersed in the study of science; as a scientist, he learned to pay attention to the world around him and sees much revealed. Heraclitus

wrote, “Nature loves to hide.” Ever since, we have been seeking Nature, seeking Kepler’s *facultas formatrix* that provides form and order to the universe. For physicists, the *facultas formatrix* is laws that organize and structure the created order. For believers of many faiths, the *facultas formatrix* is God, a *Deus absconditus* (God in hiding) or even “cloud of unknowing.” Mystics and scientists hold this hiddenness in common. Science has not revealed the hidden, but it has revealed more of what is possible to know and promises to reveal more. Yet the more we know, the more is hidden, or veiled away (15-17). My first thought as I read this is that we are constantly playing “Hide and Seek” with creation!

Teilhard de Chardin wrote of the fire at the beginning of time, linking science to spirituality by way of mystery. Only later did the discovery of background microwave radiation prove the calculations that posited the Big Bang Theory and show that the universe has not always been as we thought it was. But Chardin’s work showed a man trying to hold on to both science and faith in what Raymo sees as an untenable way, through poetry and prose that was rooted in mysticism (22-24). I see Chardin playing in wonder in his poetry.

Breaking free of the past in order to think in new ways has been part of human experience for thousands of years, whether it be old philosophies (Aristotle) or religious beliefs (Catholicism). Today’s divide is not geographic but knowledge-based: those who would cling to old belief systems to the exclusion of all new exploration and evidence-based consensus and learning touted by those who find value and meaning in such knowledge (Raymo 42-44). (I would note that Cannato represents a third group, those whose search for value and meaning spans old systems and new knowledge alike.) Following Occam’s Razor, scientific theories should be reduced to as simple a form as possible, but reducing them too much leads to unwarranted certainty and the potential of self-righteousness in thinking that we know Truth

instead of truth (59-61). Any viable religion of the future will not claim to be Truth. It will be oriented toward the preservation of the environment and based on empirical cosmology that reveals the wonder in all creation (113-114). Progressive elements in Christianity have been working on ecological awareness for many years without excising God; the United Church of Christ recently ran a program for creation care called “Mission 4/1” that includes education, worship, and mission elements to reveal creation’s wonder to God’s people.

The holy is transformative and it rests in the love of individuals to love and suffer so that others might be better off. All of us are born with the capacity to make choices for good or bad; this is independent of religious tradition and practice (Raymo 116-124). Religious naturalism seeks to do away with anthropomorphic gods for a sense of the holy that is compatible with empiricism (124-126). Our ignorance increases with everything we learn (140). Hubris would allow us to think we know Truth, but humility recognizes truth that is ever expanding and that can never be fully known. Sacraments as visible signs of invisible grace point to what is hidden in nature, which is the deep interconnections of all creation (140-142). While I find much of value in Raymo’s reflections, I do not see the need to do away with God; rather, as I read his work, I found myself growing closer to God as Raymo laid out the wonders that science now knows about creation. God’s imagination never ceases to amaze me!

How Judy Cannato reveals God’s imagination is just as amazing, and theologically more uplifting because of the way that she sees God and Christ in the wonders of the universe. Cosmology includes the story of how we came to be in the context of our purpose in the universe. It is connected to theology because both are about meaning; it is connected to science because both are about explanations of reality. The artificial division of faith from science since the seventeenth century never was helpful and is increasingly difficult now as the real universe

becomes more known to us (19-20). Quoting Bede Griffiths, Cannato reminds us that all matter formed at moment of the Big Bang; the universe is not “out there” but inside each of us and in a sense, each of us was present at the Big Bang (43).

Light is the common factor of science and faith. Radiating light shows us the origins of the universe and confirms the Big Bang Theory. We see the Creator in the Light and the Light is woven through our scriptures, yet more of the Light is invisible than visible, like light that comes in waves and particles. The difference is that we can learn to see more Light, whereas we need mechanical or technical help to see more light (Cannato 52-54). This particular observation of Cannato’s brings to mind the wonderful quote from John Robinson “that the Lord hath more truth and light yet to break forth from His holy word.” If we limit our understand of God’s holy word to the Bible, then we miss so much of what God is revealing to us now that we are capable of seeing the light in the universe; the Big Bang is just as much God’s word as Genesis, Proverbs, and Revelation.

So is evolution God’s word. Everything that has gone into the Theory of Evolution in the last 150 years links humans to all of creation genetically, no matter how badly we might want to make it all about us. Extending Paul in 1 Corinthians 12 to include oceans and rivers and forests makes the pregnancy of creation about possibility for the whole; it is part of the transition from wise to universal (Cannato 59-63). Evolution tells us how, but the Mystery that surrounds us only reveals to us why as it guides us to meaning and purpose. Because we embody the whole of evolution from single cell organism to sentience in our lifetime, we reflect that meaning and purpose into the universe (64-66).

Photosynthesis was an enormous evolutionary breakthrough, converting light energy from the sun into nutrients and oxygen (light energy + water + carbon dioxide yields an



adenosine triphosphate [complex sugar] and oxygen). All life on earth, oxygen dependent, is possible because of this evolutionary novelty that takes the light energy from the sun and makes it useable. The Incarnation, in which Light was transformed into a human life in Jesus of Nazareth, came about as a result of the creativity of the Divine (69-71).

The progression of hominids to sentience and then language allowed for communication in symbols, which led to awareness of the “Other” and the worship thereof. The Hebrew people wrestled with how to live with this Holy One, who became human in Jesus of Nazareth. The love and care of the Holy One for all of creation was taught in new ways by Jesus. But like evolution, our understanding of the Divine continues to move forward, toward *Homo universalis*, the universally aware and oriented next species (71-76). I am personally skeptical about the next evolutionary step taking us all the way to *universalis*, but I do remain hopeful that we are continuing to evolve in wisdom and understanding of the universe, our place in it, and God’s nurture and continuing presence in it.

Cannato asks us to ponder the connection between Jesus as the Light of the World and his call to us to be the light of the world. We are connected to the Incarnation and an extension of God’s presence in Creation. We are called to create the realm of God on earth rather than awaiting it in the fullness of time, she says, though she seems to give short shrift to the eternal realm of God that is our model for our work on earth. It is our job to work with God and to trust that when God promises that we can do more than we believe possible, God means it. Because when we think of God, it is most often in superlatives such as omnipresent, omniscient, and omnipotent, we fail to recognize ourselves in God. But God Incarnate, through Jesus’ earthly ministry, reminds us that God is compassionate, welcoming, forgiving, healing, just, and merciful. God is also a servant. We fail to claim the power God promises that we also are called

to be compassionate and welcoming servants who are forgiving, healing, just, and merciful. Our (Cannato says “truly scandalous”) reluctance to emulate the ministry of Jesus limits what we can do to bring about the realm of God on earth even as we await its coming in the fullness of time. The ultimate question here is how do we change our behavior so that we act more as Jesus acted in his ministry (81-84)?

The good news is that if we change our behavior now, there is a good chance that people several generations removed from us will exhibit the same better behavior. Morphogenic fields are forces that help self-organizing entities maintain boundaries and form both in the universe (the biosphere, the solar system) and among humans (families, communities, civilizations). In human fields, morphogenic fields are often organizational memories that shape the field and the individual members within it and such shaping has been shown to work across generations as learned behavior is taught or exhibited (84-88). The history of humanity shows this, though Martin Luther King’s observation that justice comes on a long arc is more true than it should be.

In my opinion, two of Cannato’s analogies stretch thin at this point, though there is no denying objectively that we are all parts of a whole (holons) both cosmologically and theologically (95-102). The comparison of the gravitational pull of black holes with Jungian shadow-side negative behavior falls flat to me (107-114). I admire her attempts but am not particularly inspired by them.

On the other hand, her two most revelatory analogies for me come at the end of her book. Supernovae fascinate me; she says of them that they create life in the death of a star and that we are alive today and contain within us elements that came out of the exploding heart of dying stars. Yet as humans, we fear death: the “final” death as well as all the little deaths represented by letting go and by change. Jesus’ death and resurrection are evidence that we are not to fear

death because from death arises new life (117-119). Jesus does not run from death. Instead, through a series of little deaths (relationships, life's work, betrayal, abandonment) he shows us how to live. Jesus is aware of the power and significance of the death of self and the attendant freeing of Spirit that cannot be defeated by physical death, only amplified in the power of resurrection. When we embrace the power of resurrection in our own lives, we become the light of the world and reflect the Light into the World. Death and resurrection are inevitable, but we do not need to live in fear of death (120-124).

Cannato ends her reflections with dark energy and dark matter, which to my thinking is the ideal way to leave us wondering and ready to play some more. Dark energy is the causal force of universal expansion; it is anti-gravitational and has never been seen (hence “dark”) but its presence and effects have been measured and found to be as theorized by Einstein's Special Relativity. It accounts for about 70% of the universe as we know it. In addition to dark energy, there is also dark matter. Dark matter is theorized to be that which keeps galaxies from spinning apart as they revolve far faster than existing rules of physics say they should. In this instance, “dark” means that this matter does not interact with light energy because it has no charge. Dark matter might be another 25% of the universe (127-129).

This mystery of the 95% of the universe that is either dark energy or dark matter is analogous to the Mystery that frightens us away from exploring the dark and the unknown. We use rules, laws, and dogmas to hide from everything that causes fear, including the call from God to live with faith and trust in that which we cannot know for certain. We cannot see God, but we see the effects of God's presence everywhere if we are not too fearful to open our eyes. With eyes open to perceive that we need not be in fear—if we enter the darkness and Mystery from a place of silence and contemplation—we can be drawn to the heart of the Mystery. When we have

been transformed by the life-giving gifts of the Holy One who is at the heart of Mystery, then we are prepared to radiate light into the world so that others will overcome their fears of the darkness and the unknown. To do this, we must be risk takers rather than resisters (129-132). Children are particularly good at taking risks, in part because they are not yet conditioned to fear the unknown. Maybe part of what Jesus meant about becoming like children is that we must take the risk to do what scares us and to visit places of which we are afraid.

Perhaps the thing that scares us most is the knowledge that it is not necessary that we exist. It is not necessary for *anything* to exist, crabapples or mud puddles or trees and their autumn leaves or supernovae. Scientifically, if the laws of physics had been just one variable off in one equation (what if  $E$  did not equal  $mc^2$ ?), the universe as we know it would not exist, yet science admits that  $E=mc^2$  itself is contingent and could at some later date be replaced with another equation that better explains observed phenomena (Bockman, 51-52). Theologically, existence is “contingent on God’s desire to play and to create,” according to Hugo Rahner (quoted in Melchert *Playing* 8). Biblically speaking, this is portrayed in the creation stories of Genesis 1-3 as well as many other parts of the Old Testament including Job 38-41; Psalms 8, 33, and 104; Proverbs 8; and several chapters of the Book of Amos. When we stop to contemplate what our existence means about God, we realize that we exist because God who is big enough to have imagined any possible universe into existence imagined this one, wrote the laws of physics to be *just so*, in such a way that we evolved to become aware of God (Proffitt *Cultivating* 14-15).

Our awareness of contingency could leave us unable to function were it not for another feature of our existence: dependability. Scientists use models to establish parameters for what is understood; these are dependable yet flexible enough to be adapted when new information is available (Bockman 72-73). In each of the Biblical stories which addresses creation, once our

contingency has been established, the story explains the motive behind God's creative action, which is that God loves us dependably. Anabel Proffitt notes the dialectic in Psalm 8, where the question "[W]hat are human beings that you are mindful of them, mortals that you care for them?" is answered by a short meditation on our place in the created order, "Yet you have made them a little lower than God, and crowned them with glory and honor. You have given them dominion over the works of your hands" (*Cultivating* 6; Psalm 8:4-6a NRSV). Similarly in Job 38-41, God explains to Job just how contingent Job is, but the mere fact that God answers Job's complaints is evidence of God's love, for an unloving God would not have cared enough about what Job had to say to listen, let alone respond. Dependability without connection to contingency, however, leads to the kinds of doctrine and dogmatic thinking against which Fuller, Raymo, and Cannato warn so vehemently; only the two together inspire us to wonder, take risks, and play in the Mystery that surrounds us (Proffitt *Importance* 9-11).

Children learn about the world and the Mystery of it by playing in it. The primary difference between children and adults is the size of our playing field. As we grow up, the world around us gets bigger. If, indeed, we do not fear what we do not know and do not understand, but instead embrace it as a playmate given by God to bring us closer to God, then the whole of creation becomes ours to explore and encounter with wonder. And in our play with mystery, we discover purpose and meaning as each mystery is resolved and new mysteries are revealed. Wonder is indeed not just for children anymore.

## **Chapter Two: The Search for Truth**

Humankind is, as far as we know, the only species on Earth that intentionally seeks an understanding both of the world beyond that which can easily be observed and the purpose and meaning of existence. Science is the means by which we seek understanding of the world; this is, broadly speaking, the path that leads us to know “How” we came to be. Theology seeks purpose and meaning, the path that helps us understand why we are even capable of asking “How?” and “Why?”. Chaos and frustration ensue regularly when those who ask “How?” dare to say that their answers explain “Why?” and when those who ask “Why?” state that they have also answered “How?”. Put another way, we are caught in a conflict between physics, which is the basis of all chemistry and biology in the universe, and metaphysics (literally, “after physics”), which attempts to explain why the universe works the way it does, according to physics, through cosmology, teleology, ontology, and ethics (Davies 31).

The conflict between the two schools of truth-seeking is relatively new in the course of human history, tracing its beginnings to the earliest stirrings of the Scientific Revolution in the sixteenth century. Christianity in particular has been at odds with the findings of science and, it seems, with those whose lives have been dedicated to the scientific exploration of the universe. While the conflict has taken many forms over the centuries, the current dispute is rooted in the theory of evolution first published by Charles Darwin. Substantial subsets of Christian believers perceive evolution as a threat to their understanding of the Biblical creation stories and thus to their entire theological framework. An equally vocal, if not substantial, subset of scientists has proclaimed that the theory of evolution, along with our increasing knowledge of the origins of the universe itself, are the harbingers of the end of faith in a supreme being as though the only

purpose for a supreme being is creation. Members of those threatened subsets want their particular magisterium to have it all.

Between these extremes are faithful Christians and open-minded scientists. Some theologians and scientists resist any overlap at all between science and faith, subscribing to some version of Stephen Jay Gould's "Non-Overlapping Magisteria" idea which places a clear wall of separation between inquiry about "the age of rocks" and the "rock of ages" (Dawkins 79). However, people of faith across a wide swath of professions engaged in inquiry of scientific, ethical, and moral natures seek common ground for dialogue and support of both Christian practice and scientific exploration. They find that the two magisteria may not exactly overlap but do have contiguous and permeable boundaries. This synthesis of the two seemingly incompatible ideas is an important step for the future of humankind because it is a recognition of the fullness of human existence: we are curious beings who need to know both "why" and "how" without either being diminished in importance.

#### "Why?" at the Theological Extreme: Thesis

For millennia before the foundations of true modern scientific inquiry were developed, human beings generally understood that they and everything else in the created order came from some form of divine machination. The exact details varied based on beliefs about the nature of the gods or God at the heart of the society, but extant creation stories involve supernatural beings who could, broadly speaking, control matter to create the sun, the moon, the stars, the planets, land, and sea as well as all life, plant and animal. The Judeo-Christian creation myth preserved in Genesis 1 and echoed in several psalms and proverbs is the best known of these stories and the

one with which this work is most concerned because of its dominant narrative in the western world, where the clash of faith and science is currently the strongest.

We must first acknowledge that the myths of creation were told as ways to help our ancestors understand the world around them. We are, as it were, hard wired to explain the world around us; how we think is at least in part a reflection of the physical world in which human beings evolved. It makes sense that we can analyze and theorize about the experiences we have of the world around us; the open question is what makes us so good at making guesses about and exploring things we cannot see (Davies 24). In the pre-scientific world, explanations that satisfied could not be couched in evolutionary language or explained in the mathematics of physics and chemistry because humans had no way of deriving such things. Instead, observations of the natural world were woven into the divine narratives to produce stories that grounded experience and observation within the unique language and divine presence of each society, which is what theology does at its heart (Polkinghorne 93-97). Such thought patterns encapsulated the “how” into the “why” in stories and myths.

Pre-Enlightenment Christian interpretations of Genesis 1 echoed St. Augustine’s fourth century CE interpretation. Augustine saw God as unbounded by and outside of time, which led him to interpret the seven days of creation metaphorically. He saw that there were many possible interpretations of the story and that, at least in his time, no one interpretation led to more clarity than any other (Collins 151-152). The key point shared by Augustine and his theological descendants is belief that God ordered everything we see and experience into existence from nothing. *Creatio ex nihilo* is embedded in Christian doctrine from before Augustine’s birth in the Nicene Creed: “I believe in one God, the Father Almighty, maker of heaven and earth, of all things seen and unseen.” According to this belief, God wrote the very laws by which the universe



exists. The universe and everything in it are separate and distinct from the creator (Davies 44-45). Though we human beings are created in the image of God according to Genesis 1:26, we are not God. However, the doctrine of the *imago Dei* neatly explains why humans sit at the apex of the created order; earth and all that is in and on it were created *for* us. Our special status as bearers of the image of God separates us from even the most powerful and smartest of animals and gives us stewardship—or in most translations, dominion—over all creation.

It was not just the human place in creation that the story in Genesis cemented. From this story came the doctrine that the sun, indeed, the whole universe, revolved around the earth. This was, of course, backed up by the perception of the sun, moon, and stars rising and setting. Thus when astronomers like Nikolaus Copernicus and Galileo Galilei presented their observations on the heliocentric nature of the solar system, that was a direct challenge to the assumptions of the Genesis creation story and all that came from it. In response, Irish Bishop James Ussher compiled Biblical events to declare the creation of the world occurred on October 23, 4004 BCE, and unfolded literally in six days, after which God rested (Collins 152-153).

If all of Christianity had done as the Roman Catholic Church and most major Protestant denominations have done since Darwin, Ussher's theology would by now be mere historical artifact. It is, however, the lynchpin of a strong thread of Christian belief in the United States and Europe: Young Earth Creationism (YEC). YEC requires its adherents to be literalists about Genesis 1-2 using Ussher's timeline. Adam and Eve actually existed and are the parents of all humans on earth; all species are created specially and individually. YEC adherents use the story of Noah and the flood to explain the fossil record. They reject the overarching theory of evolution on the macro scale but acknowledge the possibility of microevolution within a species.

YEC subscribers tend to dismiss any evidence contrary to their beliefs as evidence of God's plan to use things that work as often as possible (Collins 172-174).

Ken Hamm, the most visible proponent of YEC, founded "Answers in Genesis" and a Creation Museum to promote Biblical foundations and what scientific data his experts have deemed appropriate to confirm YEC (10 Best). The basis of his brand of YEC is stated in this paragraph from the "Worldview" section of the Answers in Genesis website:

"God's people need to stand on the truth of God's Word beginning in Genesis 1:1 and not compromise with the secular religion of the day—evolution and millions of years. The more this compromise runs rampant in the church, the more we will see people doubt God's Word in Genesis and be put on a slippery slope to unbelief" (AiG).

Hamm's work is an extension and expansion of the Institute for Creation Research (IRC), founded in 1970 by Henry Morris to promote YEC from a scientific research base. This statement from the IRC website encapsulates YEC thought:

"All things in the universe were created and made by God in the six literal days of the Creation Week described in Genesis 1:1-2:3, and confirmed in Exodus 20:8-11. The creation record is factual, historical, and perspicuous; thus all theories of origins or development that involve evolution in any form are false" (IRC).

How strong is YEC thought in American theology and politics? Gallup polling data since 1982 shows that 40% (in 2011) to 47% (in 1999) of Americans hold to some version of YEC as opposed to strict evolution (low of 9% in 1982, high of 19% in 2014) or evolution guided by God (low 31% in 2014, high 40% in 1999). The specific option which elicits the plurality

response of belief in creationism is “God created human beings pretty much in their present form at one time within the last 10,000 years or so” (Newport).

Alongside Ussher’s literal creation stands the “argument from design.” Its foremost, but neither first nor last proponent, was William Paley, whose 1803 *Natural Theology* expanded on Bernard le Bovier de Fontenelle’s analogy of a “Watchmaker” to describe the Creator.

According to Paley, if one finds a watch on the road, one automatically envisions a (human) watchmaker because the object is too complex to have been assembled in nature. Likewise, all the various systems in life on earth, from human eyes to echolocation in bats to the propulsion systems of single-celled organisms, had to have been designed as is by a divine Watchmaker because there is no other explanation for their existence (Miller 134-139).

“Punctuated equilibrium” was a critique of evolution that took the absence of gradual change from an ancestor species to one or more descendant species in any fossil record into account as it attempted to hone the theory of evolution. The proposers, paleobiologists Steven Jay Gould and Niles Eldridge, sought to explain this absence in evolutionary but not Darwinian terms by rebutting the Darwinian notion of gradual change—the slow but steady transition of a species into a new species. Their reading of the fossil record showed that ancestor species lived for long periods of stasis (“equilibrium”) then abruptly changed to the descendant species (the abrupt change is like an exclamation mark that ends the stasis, so to speak). Neither Eldridge nor Gould ever argued that punctuated equilibrium destroyed evolution as a theory, but their critique became the fodder needed by a new generation of anti-evolutionists in need of a rational basis for their attacks (Miller 82-87).

“Intelligent design” as a broad idea encompassing any involvement of God in the unfolding of the universe has been roundly confused with “Intelligent Design”(ID), which is a

specific set of beliefs that in essence restates the argument from design. The major focus of ID is the gaps in evolutionary theory that thus far have not explained complexities of life on Earth.

Phillip Johnson, a lawyer, laid out the first ID arguments using punctuated equilibrium to expose what he considered flaws in Darwinian evolution. The absence of evidence for evolution in the fossil record, Johnson said, invalidates the entire theory (Miller 89-92).

ID has since been expanded as a hypothesis by biologist Michael Behe and mathematician William Dembski. With their work, ID takes more of modern science into account than YEC, accepting the standard theories that underlie geology, chemistry, and physics to admit the age of the earth as over four billion years old (Miller 93). It has three basic pillars, one of which is that evolution is an atheistic worldview that cannot be allowed to stand by those who believe in God (Collins 182-183).

The second posits that the major fundamental flaw in evolutionary theory is its failure to explain the intricacies and complexities of creation. Behe, channeling Paley, says that evolution as proposed by Darwin has some value but cannot account, at its core, for the molecular origins of life. That, he says, is the fatal flaw at the heart of the theory of evolution and it will remain wrong unless and until it can account for what he calls the “irreducible complexity” of biological systems. He takes human eyes as his primary evidence for an Intelligent Designer by stating categorically that evolution cannot explain how such a structure came to exist. He also uses flagella on bacteria to prove the flaws in evolution because nothing so elegant as a flagellum could possibly be a fluke of a genetic change, let alone the thirty specific genetic changes that evolution says had to have happened at different times, because one without the other twenty-nine is pointless and has no advantage. Dembski, working from information theory, has

demonstrated that the chances of all thirty genetic changes happening simultaneously are infinitesimal (Miller 131-134; Collins 184-186).

The third proposition of ID is that the failure of evolution to explain irreducible complexity requires an Intelligent Designer who was continually involved in shaping the creation of the necessary components as life evolved. This designer could, in one stroke, overcome any gap in the available fossil records and gap in our understanding of molecular change to make a new species; this designer is also, of necessity, responsible for the creation of every species known to human science whether living or dead (Miller 92-96). ID does not say this designer is God, Christian or otherwise, but most adherents are Christians, so the connotation is valid (Collins 186).

The two theologically based understandings of science currently most prominent in the United States are YEC and ID. This has significant implications for the advance of any field of study in which science literacy is important; adherents regularly attempt to introduce either YEC or, more often, ID into public school science curricula couched as efforts to “teach the controversy.” Proponents of ID, particularly the Discovery Institute, maintain that the program, particularly its critique of the current status of Darwinian evolution, remains a valid component of science curriculum despite the thorough abnegation of ID as legitimate in the judicial record of *Kitzmiller v. Dover*. The Discovery Institute views the *Kitzmiller* ruling as flawed because of its reliance upon materials prepared by the American Civil Liberties Union and Americans United for the Separation of Church and State (DeWolf 9-14).

### “How?” at the Scientific Extreme: Antithesis

Scientists who proclaim that knowledge of how the universe works obviates the need for any belief in God or gods stand at the extreme of their field. Astrophysicist Lawrence Krauss and neurobiologist Sam Harris advocate for science over any concept of religion as the answers to the problems of humankind. Biologist Richard Dawkins has argued forcefully for decades that evolution answers all the important questions humanity should be asking while dismissing, for the most part, the deepest questions of meaning and purpose as nonsensical.

In his book *A Universe from Nothing: Why There is Something Rather Than Nothing*, Lawrence Krauss lays out the scientific evidence for the creation of the universe *ex nihilo* using the best available theories of quantum physics. The quantum particles that existed before the Big Bang could theoretically all have *not* existed at the same time, resulting in precisely nothing. This is what Thomas Aquinas posited as the original condition before God brought matter into existence in his third proof (Dawkins 101). Nothingness is inherently unstable and will lead to the existence of something; according to the Heisenberg uncertainty principle, at least some part of “something” will be in existence long enough to expand in a way that leads to the explosive inflation we call the Big Bang and thus to all of what we experience as the cosmos, which is inherently stable (Krauss 152-168).

This conclusion leads Krauss to use an example from Steven Pinker as an analogy about the presence or absence of God in the cosmic system. God, Pinker says, must either be able to decree even the most offensive things to be moral or God must appeal to reason. If God must appeal to reason, then why bother with God at all? Similarly, the creation of the universe, according to Krauss, which he has now proved came *ex nihilo* and *sans deo* (172). He reduces the complex questions of philosophy and theology—the whys and hows that have fueled human

conversation and learning for millennia—to pointless exercises in absurdity while admitting that even his system may require a “First Cause” if he takes it back far enough (173f). Krauss dismisses from the conversation any reason to pursue a non-science based understanding of what it means to be human in our complex outer and inner worlds: “Religious belief in this case becomes less and less necessary, and also less and less relevant” (183).

Dawkins has made his anti-faith stance plain, going so far as to title one of his books *The God Delusion*. His materialistic understanding is that God as Creator cannot exist because any entity intelligent enough to design the universe and create it could not have been present before the universe evolved sufficiently for such an intelligence to be possible (52). He is firmly attached to the idea that the nonexistence of God is as inherently a provable proposition given enough time and data as the nonexistence of Bertram Russell’s imaginary teapot in its orbit between Earth and Mars—which is to say that one cannot prove the *non*existence of anything—but one can make a calculation of probability that something does exist. In his estimation, the probability that God does not exist is far greater than 50% (73-77).

Dawkins is so antithetical to questions of meaning and purpose that he dismisses theology out of hand as a pointless exercise in futility, though he does admit to there being some value in the study of Biblical history and literature (79-80). In an interview with James Watson, co-discoverer of the double helix structure of DNA, Dawkins asked if Watson had any inkling of the purpose of life. Watson answered, “Well, I don’t think we’re *for* anything. We’re just products of evolution. You can say, ‘Gee, your life must be pretty bleak if you don’t think there’s a purpose.’ But I’m anticipating having a good lunch” (126, emphasis in original).

At heart, Dawkins’ argument against the existence of God rests in the stunning simplicity of natural selection as the vehicle by which forms of life have become increasingly complex over

eons. Natural selection is not chance, Dawkins rightly admonishes. It is the gradual building from individual small genetic changes in members of a species a form or function that increases the likelihood of survivability of members of that species bearing the change until the genetic change can be passed to subsequent generations. These descendant generations might in turn pass along that change *and* an additional change that increases survivability, and so on, until a new species with a different form or function has emerged. It is true, he writes, that each individual change is slightly less likely than average, and that the cumulative improbabilities can mislead observers to see a designer's work rather than the work of biology. Thus far, nothing has proved to be an example of irreducible complexity such that Darwin's theory of descent by modification has been struck down, though many have tried and failed to provide just such an example (141-151).

Dawkins notes that the "God of the Gaps" in use by those who oppose or misunderstand evolution suffers from continual shrinkage, which worried no less a theological luminary than Dietrich Bonhoeffer. Bonhoeffer's concerns were about what such a vision of God would do for believers; Dawkins' concerns are that whenever a scientist acknowledges that a piece of information is unknown, elements of the religious community trumpet God as the designer rather than allowing the scientist to do the research required to answer the question. It is not acceptable to have an unknown in faith, but scientists revel in unanswered questions; anytime there is a gap in the fossil record between species that are clearly related, for example, scientists can hypothesize the intermediate species. Those who insist on a designer declare that one directly intervened to create the next extant species, thereby leaving the gap (151-153). While evolution has multiple sources of proof, the best way to falsify and thus nullify the entire theory of descent



by modification is if one “*single* fossil turned up in the *wrong* geological stratum” (154, emphasis in original).

That life arose on Earth at all is due to its location in the solar system orbiting a single sun within the “Goldilocks” zone where every aspect of the environment is just right for life, including the temperature range which allows liquid water, the stability of the orbit thanks to the moon, the shape of the orbit as a near-perfect circle, and the distance from the sun that keeps water vapor from either freezing or boiling in the atmosphere. Design enthusiasts claim that these happy instances are God’s handiwork. Dawkins says that it is instead just a collection of instances that all came together improbably to allow for life to arise and to become sentient, thus becoming capable of asking why it should be so that Earth can support life. The design principle and the Anthropic principle are both responses to the question at hand. One uses God to fill in the gap, the other argues from knowledge and theories that have proven to be useful as explanatory tools and neither would be possible if we did not live on a planet in the Goldilocks zone (162-164).

As improbable as the existence of life on Earth is, chemistry only had to become biology once for life to take hold and begin its evolutionary journey toward sentience. Scientists have not yet discovered how the chemical soup on primordial Earth became the biological life form that started it all; the key word is “yet”. Dawkins has no doubt that life will be created in the laboratory imminently. Unless, of course, God really did stick God’s proverbial finger into the soup to make something happen. Even if the odds are one billion to one against life arising on a planet, if there are (as conservatively hypothesized) a trillion planets in the universe, then there are still one billion where the spark that creates life, whatever that may be, has brought life into existence (162, 164-166). Considering that people play the Mega Millions game routinely despite

their chances of ever winning the jackpot being 258,890,850 to one against, one in a billion is not as far-fetched as we might think (Mega Millions).

According to Mark Ridley, there could be two other gaps that the Anthropic principle explains better than natural selection: the development of complex eukaryotic cells containing mitochondria and nuclei and the development of consciousness. It is possible, hypothetically speaking, that the odds of eukaryotic cells developing on any of the billion planets with life is one in a million and that of those thousand planets with eukaryotic cells, one in ten will eventually feature conscious life. That would leave one hundred planets with conscious life and we happen to be living on one of them. Chance, however, does not explain the immense diversity of life on Earth once it arises. Life only had to happen once, though it could have happened more than once in Earth's history, whereas evolution is an ongoing process by which life adapts itself to its particular and unique environment (Dawkins 168-169).

All of this says, to Dawkins, that life, the universe, and everything can be explained without the need for God. The Holy Grail of scientific inquiry is a "Theory of Everything" (TOE) which neatly explains everything we know about how the universe and everything in it came to exist (Davies 136). This includes at least six specific values in physics that theorists have said have to be exactly what they are for life as we know it to exist. The TOE may show that those six values *all* have to be exactly what they are because they are as immutable as the formula  $\Pi r^2$  is the area of a circle. Or such a TOE may show that these numbers have to be what they are because of the relationships among them, or we may yet discover another variable that sets the value (Dawkins 173).

One key component of this TOE is an explanation of the very origin of the universe, which requires an understanding of how something can come from nothing, as Krauss explains.

The multiverse explanation for the existence of our universe posits that we exist because everything in the bubble of cosmic stuff from which we came was valued exactly right for us to be here: the constants, the law of gravity, the law of energy conservation, and so forth. Ours may not be the only universe capable of supporting life either because ours is not the only universe with these values unique to the support of life or because other bubbles with different values for constants and different laws also became universes capable of supporting life. We would likely never be able to determine if either of those is true or, if either proposition is true, if it is true sequentially or simultaneously with our own universe (Dawkins 173-174).

In *The Moral Landscape: How Science Can Determine Human Values*, neuroscientist Sam Harris goes the next step toward eradicating God from the human experience. He posits that science can even accomplish morality in a far better and more productive way than any belief in any version of God ever can. The greatest impediment in the elimination of human suffering is, as he and other “New Atheists” see it, faith: “conviction without sufficient reason, hope mistaken for knowledge, bad ideas protected from good ones, good ideas obscured by bad ones, wishful thinking elevated to a principle of salvation, etc.” (175).

Harris cites Stephen Pinker as influential in his observation that humanity has moved our understanding of human needs and desires beyond the evolutionary drive for men to reproduce. We regularly defy the limits placed on us by our genetic inheritance by using sunscreen to protect our skin and filling prescriptions for eyeglasses so we can see what the shape of our eyes would ordinarily prevent us from seeing. Even so, we still make choices driven by evolution that do not necessarily translate to well-being. Science can help us overcome those poor choices (13-14). Science has also helped us to understand the evolutionary basis of altruism, which allows for cooperation and thus protects individuals and family groups. Morality evolved only after

language and the need/ability to cooperate with people from other clans and tribes and has allowed humanity to survive and thrive ever since by establishing systems that established institutions, rules, and norms for societies (56-59). Samuel Bowles posits that conflict is a necessary precursor to the development of altruism in a society. Harris sees this as an extraordinarily low valley in the moral landscape that led to the scaling of an equally high peak necessary for the development of our ability to overcome evolutionary tendencies through science (101-102).

Moral claims, according to Harris, are more true if they are linked to human well-being than if they are linked to oppression and harm. This link can be proved scientifically now, which makes science the arbiter of moral values (65). Neurologically, we are predisposed to care for ourselves and those closest to us but the better course of action leading to the greatest human well-being may have us choosing actions that are less beneficial or even harmful to our loved ones to benefit more people (68-70). Religion may have had some evolutionary purpose for the creation of tribes in the early days of human history but its value today, Harris states, is at best questionable as an agent for the improvement of humanity (148). Furthermore, because the primary religions of the world generally contradict each other, promote immoral activities such as genocide and slavery, and belie rational explanation in their origins, even the attempts to mitigate the worst parts of religion by holding up such principles as the Golden Rule and denying the mandates to kill non-believers fail to redeem religion as conducive to greater human well-being (78). In all this, Harris finds no evidence of God at all, however, a study released in February 2016 in the journal *Nature* indicates that Harris is, at least for now, wrong because those whose theology includes a god who punishes people for bad behavior are *more* likely than others to be altruistic, at least within their own faith group (Chokshi).

Like Harris, Dawkins finds no evidence of God. His entire argument comes down to the improbability of God's existence because he cannot get back to a point at which God would not have existed. "How do [theists] cope with the argument that any God capable of designing a universe, carefully and foresight fully tuned to lead to our evolution, must be a supremely complex and improbable entity who needs an even bigger explanation than the one he is supposed to provide (176)?" Dawkins and others want an explicable God who obeys the lessons of rationality and logic laid down by the human beings they believe created the concept of God at the first. Communications with individuals is inherently scientific because how our brains work is scientifically explicable (or will be someday) and a god big enough to converse with millions of people must have tremendous energy from somewhere. His ultimate question is, "Who designed the designer?" (183-184, 188).

#### Interlude: Paradigms as a Model for Comparison

Ian Barbour proposes that science and faith operate similarly from paradigms which help to determine the validity of knowledge in each field. In *Religion in an Age of Science*, he posits that paradigms are models that presuppose concepts and methods which lead to appropriate forms of inquiry about a particular topic. The historical and communal contexts of paradigms make them relative to available knowledge at the time and more resistant to change than the theories which arise within them (33-34).

Scientific theories are evaluated across four distinct but interwoven criteria:

- 1) Does the theory match the data? A match is not conclusive, nor does a mismatch automatically falsify a theory, as various assumptions and anomalies could be at work

in either situation. If the data is as predicted by the theory in unique or unanticipated ways, it is generally accepted as support.

- 2) Is the theory coherent with other theories accepted as normative? Does it provide a link between other theories? Is it generally reduced to the simplest possible form with the fewest assumptions and corrections?
- 3) Is it comprehensive and general? Can the theory be supported by substantial and varied data? Does it bring two or more domains into a unified whole? Does the theory hold up under a wide range of values for the variables in it?
- 4) Is it fertile enough to have use in the future as well as it explains data from past experiments? Can it be used to develop new lines of inquiry?

Furthermore, how we understand scientific truth is related to these four criteria:

- 1) If a statement corresponds to actual events, it is true. This is common sense, empirical truth like that expected in the first criterion. However, not every proposition can be tested empirically, nor can every theory be evaluated.
- 2) If a statement is internally coherent, then it is true. This is tied to the second criteria and applies in particular to theories which cannot be tested and evaluated empirically at this time. Unfortunately, reality denies us the ability to declare that one and only one set of propositions can explain something most of the time.
- 3) Similarly, if a statement is comprehensive in nature, then it is true, as proposed in the third criteria above. Reality also allows for data to be a mismatch for an elegantly comprehensive theory.

- 4) If a statement or action works in the real world, then it is true. Such a pragmatic understanding of truth leads to a somewhat utilitarian approach, but it is reflective of the fertility of a theory.

Taken together, the evaluative criteria and the understandings of truth help us to form a picture of reality because we can match our experiences to meaning ( Barbour *Religion* 34-35).

Religious expression and belief cannot be evaluated using the same criteria. Instead, experiences can be broadly categorized for interpretation and comparison:

- 1) Reverence and awe which provoke wonder and mystery in a person, particularly in an experience described by words such as confrontation, seized, or otherness. People who have such a numinous encounter often say that they have become aware of both the enormity of the universe and their own smallness within it, and of their personal dependence on the divine for existence.
- 2) An experience through which a person perceives the unity of all things through interdependence, loss of identity, being self-less, or absolute bliss.
- 3) Transformation of self by redemption or reintegration/healing.
- 4) Facing death or suffering courageously by acceptance, either by letting go of attachments or by letting trust overcome anxiety.
- 5) Taking on obligations due to moral conviction to fix a wrong or to right an injustice.
- 6) Beauty, order, and creativity in the world which lead to an appreciation of and dependence on God.

These occur in the context of community, for the most part, and the community evaluates and determines the truth of these experiences based on its history and its beliefs (Barbour *Religion* 35-38).

As with scientific theories, religious experiences can be evaluated on the criteria of agreement with data, coherence, scope, and fertility, though not in the same ways:

- 1) Does the report of the experience match the accepted narrative within the community regarding previous such numinous experiences?
- 2) Does the experience match the other elements of the community's belief narrative?
- 3) Does the experience help to contextualize other aspects of life? Does it fit with what is currently known scientifically?
- 4) Does the experience enhance life? Is it in some way transformative or instructive for the future?

When the community accepts an experience as valid, it takes its place with the sacred stories (Scripture), rituals (Tradition), and experiences (Experience) of others that provide parts of the paradigmatic interpretive (Reason) framework (Barbour *Religion* 38-39).

It is possible to have a synthesis of faith and science which honors the unique and powerful knowledge that each field brings to enhance the other rather than to tear it down or dismiss it entirely, as those of faith in the "Thesis" proposition and those of materialistic science in the "Antithesis" proposition would require. As Barbour's criteria note, the epistemology of faith is different from that of science. Both, however, lead to the same kinds of ontological questions at the outer edges of knowledge: why? for what purpose? Both begin to ask their separate epistemological questions out of a sense of wonder from experience and ultimately, if done honestly, both lead not to certainty, which closes off the potential of further questioning and new knowledge, but to uncertainty, which is flexible and allows for new questions and new explorations. The incorporation of scientific exploration and experimentation into the practice of



Christian faith is a paradigm that hinges on one's willingness to embrace uncertainty in the name of God and for science.

### “Why?” and “How?” As Complementary Fields of Human Inquiry: Synthesis

The Roman Catholic Church and most mainline Protestant denominations have embraced the need for human beings to ask both “Why are we here?” and “How did we get here?” Unlike Young Earth Creationists, Biblical literalism is no longer an integral part of the DNA of these Christian groups; unlike those who favor Intelligent Design, most Christians in these groups do not feel the need to have theology taught as science in public schools. Unlike those who are antagonistic to the whole idea of God, Roman Catholics and mainline Protestants hold in tension the scientific theories that explain how we became sentient with questions of purpose, meaning, and the existence of God. Most Christians who maintain this tension do so by exercising some form of Stephen Jay Gould's “Non-Overlapping Magisteria,” though there is now a movement toward incorporating science and faith in dialogue because each can inform the other, particularly in matters of ethics and morality.

Two prominent voices in this discussion are John Polkinghorne and Francis Collins. Polkinghorne is an Anglican priest who began his life as a physicist; he understands that faith and science are very much overlapping, though distinct, magisteria and advocates widely for that understanding. Collins is the Director of the National Institutes of Health and identifies as an Evangelical Christian. He, too, is a vocal advocate for the complementary nature of science and faith, saying that the announcement of the mapping of the complete human genome, over which project he presided, was “a stunning scientific achievement and an occasion for worship” for him (3).

In *Belief in God in an Age of Science*, Polkinghorne observes that the mathematics underlying the universe reveal rational beauty in the equations that explain it, in accord with Paul Dirac. There is no specific evolutionary need for us to understand these equations; while such succinct formulae as  $E=mc^2$  describe important phenomena about the universe, such knowledge is not critical to our continued survival as a species. Perhaps, as Einstein's biographer Abram Pais noted about the theory of general relativity, nature speaks to those who seek its deepest mysteries. Einstein observed that gravity affects all the bodies in the same field equally and suddenly questions of physics could be solved by geometry. Nature revealed itself to Newton and to Dirac (2-4).

Could it be that physics is one way that God has revealed Godself? Perhaps those who, like Dirac and Einstein, have had some kind of insight into the beauty of the universe have had an encounter with God, or perhaps "The Mind of God." Though the mathematics of the physical universe are convincing, the realm of metaphysics is such that proof as required in scientific discourse is not available to either side of the conversation, believers or skeptics (4-5).

Darwin's explication of evolution sank the Newtonian idea of a divine watchmaker more completely than any previous philosophical argument had or could. Theologians were left without any way to reconcile the science of creation as explained by evolution with God's purpose. However, by the 1920s, astronomers and physicists were finding that the universe had been around far longer than previously thought, had a more precise structure than anyone could have known before, and that its complexity applied not just to the universe but to earth and all life on it, as well. This complexity explains why earth is the way it is in a way that evolution by itself cannot. For earth to be in the ideal location it is, the laws of physics have to provide for the specific ways of solar and planetary formation we see in the universe. Further, those laws have to

allow for the mechanics of evolution to occur in such a way as to bring about sentient life: if gravity is not exactly right, no stars can form; without stars, there can be no carbon; without carbon, no life as we know it can exist...and the variable governing the creation of carbon must be what it is to at least nine decimal places for life to be. Given that so many variables are exactly right to allow these things to occur, there seems to be a Purpose at work; theologians and philosophers have called this “the Anthropic Principle” (Martin *Evolution*; Polkinghorne 5-6).

Thought experiments provide us with indirect knowledge of other possible universes in which we would not exist, even though we can only directly know our own universe. John Leslie concludes that the continuing discovery of values that are just right for life in our universe, along with our ability to hypothesize universes where those values are different and thus have different structures that do not allow for the evolution of sentient life, provide evidence enough that “*God is real, and/or there are many and varied universes*” (Polkinghorne 7, quoting Leslie *Universes* 198, emphasis in Polkinghorne).

The ideas of multiverses, parallel worlds, and quantum inflationary bubbles all fail, according to Polkinghorne, leading him to focus on Leslie’s conclusion that God is real. A new natural theology does not hang on Aquinas and Anselm’s proofs or on William Paley’s assertions that eyes are too complex to have evolved without a designer at work. Rather, a theology of nature based on quantum knowledge is rooted in the laws of physics that create the fabric of spacetime and thus the entire universe. This allows theology to complement science rather than to compete with it, such that the human-friendly nature of the laws of physics have an explanation other than accidental. Natural theology based on quantum knowledge also removes any hint of anthropomorphism from the act of creation: humans cannot create at the quantum

level and so have no analogy to give for such creation, unlike that of the Divine Watchmaker (7-11).

Quantum physics also has three specific qualities that allow for the existence of God, collectively known as quantum weirdness:

- 1) Superpositioning, light as a wave and a particle simultaneously;
- 2) The Heisenberg Uncertainty Principle, which states that we cannot know both the speed and position of a particle simultaneously because one doesn't exist if the other has been measured. Unlike the rigidity of Newtonian physics, this means that the universe is based on probabilities rather than certainties until a measurement is made. The future is unknowable because it consists entirely of probabilities rather than predictions;
- 3) Quantum entanglement such that two particles in contact remain entangled forever, no matter how far apart. A change to one results in an instantaneous change to the other. Einstein called this "Spooky action at a distance." Such entanglement puts us in relationship with everything—every particle—in the universe, according to Lee Smollen, author of *Three Roads to Quantum Gravity*. Thomas Martin extrapolates from Smollen that this is how the Trinity is in relationship with itself and with all creation, as well (*Quantum*).

All knowledge is linked, be it scientific or theological, because all knowledge is at least an attempt to explain the phenomena presented to us by the universe. Polkinghorne advocates that practitioners of different fields of exploration be in dialogue one with another because it is the nature of the universe to entangle these many fields. Fields are not walled off so that biology never touches chemistry never touches physics never touches metaphysics. Theologians and

physicists alike are intrigued by the nature of time, how God interacts with time, and whether God takes action in the universe and if so, how. Scientists who become theologians bring to theology the ability to build systematic theologies from the experienced and observed to the theoretical, which is the reverse of the way that theologians generally work (83-85).

Theology and science operate in primarily distinct ways. Science explores the world directly and attempts to explain what is observed. Theology, though influenced by some direct experiences of the sacred, is more concerned with the integration of the observed and received knowledge of the world in its entirety with historical doctrine and knowledge. Polkinghorne says that where the two magisteria overlap concerns provisions for the future, in particular how we use the knowledge science brings us to take care of the world so that the generations that succeed us have a planet to call home (91-93).

Theology helps us see the patterns in life; this is one contribution from theology to science that could be helpful in the future as we learn more about the layers and levels of organization that form the universe and everything in it. Systems in disequilibrium offer the possibility for the selection of particular actions that lead to better outcomes than other that are possible; these better actions then affect interconnected systems, bottom-up and top-down. Such order, skewed toward favorable outcomes, could be an integral part of the evolutionary process in biology as well as the physical structure of the universe. The complexity of the cosmos from the subatomic level to the universal level is just barely understood now and the probability is that developing theories about complexity and chaos are essential to our continuing understanding of the cosmos and everything in it. This mirrors the integrative nature of theology (Polkinghorne 93-97).

Collins directly introduces the idea of scientific inquiry as a practice of faith in *The Language of God: A Scientist Presents Evidence for Belief*. His own Christian faith is rooted in the idea of a universal Moral Law written by a God who wants to be in relationship with intelligent life; Collins found *Mere Christianity* by C.S. Lewis to be an essential part of his developing faith in this regard (11-23). The existence of God and the pursuit of science, from the point in time at which Collins experienced his conversion, were never mutually exclusive. Rather, his knowledge and understanding of God provided a framework for all of his subsequent work in biology, particularly in genetics. Even so, finding common ground between faith and science is difficult because scientific knowledge is always changing and growing through trial and error, hypothesis and theory.

The Copernican revolution in science pitted new theory against ancient theology; in the end science won over Biblical story but both the church and scientific exploration suffered before the dust settled. Modern discoveries are esoteric because of the complex and weird nature of the findings. Who outside of particle physicists could possibly understand red, green, and blue quarks in up, down, bottom, top, charmed, and strange varieties? Quantum mechanics belie Occam's Razor except as elegant mathematical equations, and why should it be that math is both elegant and effective at explaining the universe? Perhaps Stephen Hawking was right to ask if a theory of everything would give us access to the mind of God (Collins 56-63).

The question of miracles is a challenge if one's worldview is anchored in science. If one does not admit the possibility of miracles, then no amount of evidence of one will suffice. However, since quantum physics provides for at least the possibility that a miracle in any given circumstance is infinitesimal but not zero, the evidence of one may lead to the declaration of the miraculous, barring any other possible explanation. Bayes' Theorem of probability governs such

determinations, even informally. In all circumstances, the preference should be for a scientific or natural explanation, lest miracles become the common explanation without basis. The direct involvement of God in the world must be minimal lest the order of the world come undone; truly inexplicable miracles are exceedingly rare and according to John Polkinghorne reveal something about the nature of God that ordinary events would not (Collins 47-54).

The opening line of the Bible at Genesis 1:1 is, “In the beginning, *when* God created...” According to Thomas Martin, the preposition allows us to contemplate that “the heavens and the earth” were part of a sequence of creation, not the opening act of creation (Martin *Evolution*). We do not know what came before the Big Bang. That the universe began with an explosion of tremendous force and energy, dispersing matter into ever-expanding space, is well-attested by the evidence, but how that explosion came to be is a mystery that humans may never solve. Some see the hand of God in the common thread between the Big Bang and the opening of Genesis, “Let there be light.” *Creatio ex nihilo* cries out for God to be involved (Collins 63-67).

Given the exact parameters of our universe, many have speculated that we humans are the purpose of its existence. This Anthropic Principle has three basic responses:

- 1) An infinite number of possible universes exist or existed which we cannot observe and ours is simply the one of the multiverses in which we came to be;
- 2) We got luckier than we can possibly imagine with the creation of this universe;
- 3) An entity or force designed this single universe specifically to lead to human beings (or sentient life).

Even if one prefers options one or two, the fact of our existence asks the theological question of “why;” Hawking and Freeman Dyson acknowledged the possibility. Nobel laureate Arno Penzias, who co-discovered the background microwave radiation that helped to prove the

Big Bang, proclaimed that God must have been involved somehow. Bayesian theory predicts that option two is the least likely scenario. Option three depends, as do miracles, on whether one is willing to admit the possibility of the existence of God, though because option one defies Occam's Razor, it is not the simplest solution available (Collins 71-78).

Scientific determinism implies that the past and the future can be known by the present and that free will is an illusion. Marquis de Laplace posited that the establishment of the universe set its course and there can be no deviation from that course; all has been defined, as the Newtonian universe would state. Quantum mechanics proved that determinism was not possible thanks to the uncertainty so ably proved by Heisenberg. Even Hawking admits that a supernatural being would not be gambling with the universe even if we perceive it that way. In a strangely satisfying way, the probability-based operations described in quantum theory makes possible, if not probable, the existence of a being who stands outside the bounds of the laws of physics as we know them. Such a supernatural being without the limits of natural laws would not be bound by time, either, leading to the possibility that this being existed before time began for us and that this being knew that we would eventually arise (Collins 78-82).

The complexity of life is an argument for the existence of God, but not the one expounded by adherents of Creationism or Intelligent Design. Paley's watchmaker analogy was one in a long line of design arguments dating back to before Christ but it fails a simple test of logic: one shared feature is not enough to assert similar origin. Until we can uncover the mechanisms by which life originated on earth, there are many hypotheses but no concrete theories. RNA appears to be a good candidate for presence in the first life, but no one has yet created RNA in a lab the same way that amino acids have been made; RNA is essential to the conversion of DNA into amino acids. The absence of an explanation is no reason to insert God



into the process, especially since so very often, where God has been inserted in the past, science has found an explanation. The fossil record dates back only 550 million years, so we do not know what life forms might have existed before the record begins; arguing that God intervened to create complex designs because there is no record is another “God of the gaps” argument. Almost all of the arguments in favor of design have been answered by evidence of evolution, including the discovery in the fossil records of transitional species precisely where geographically and when geologically the theory predicts (Collins 85-96).

When the human genome was sequenced, the evidence confirmed our connections to all other life on the planet. Erasmus Darwin had predicted as early as 1794 that plants and animals were connected by what he called a “filament” that all life had in common; that filament is DNA, which uses 64 three-base sequences to produce a total of 20 amino acids. Those 20 amino acids are the basis of all life on earth. Contemplating the diversity of life created by those 20 amino acids, how, Collins asks, could one not be brought to wonder and awe at the creativity of God (Ridley 12-13; Collins 96-107)?

Collins’ case in point about God’s creativity concerns the similarities and disparities among humans and our closest cousins. We share about 96% of our DNA with chimpanzees, but we are much less genetically diverse as a species than chimps or any other animal. Alone of the primates in the great ape family, humans have 23 chromosomes. All others—chimps, bonobos, orangutans, and gorillas—have 24. Genetic examination shows that two chromosomes merged in *Homo sapiens* but remain separate in the other species; the fused gene reveals the exact markers that one would expect to see when the ends of two genes come together. Genes that no longer work due to deletions and mutations in one species (pseudogenes) are located in the same place on the corresponding chromosome in other species and do work: again, why would a designer ex

*nihilo* bother to include non-functional genes like the one that produces huge jaw muscles in apes but does not work in humans? Humans have a variation of the FOXP2 gene that allows for speech physically and intellectually, yet the same gene in other mammal species is nearly identical without the two specific changes that produced, as best scientists can determine presently, human language (137-140).

What DNA has not revealed at this point in time, is the origin of the Moral Law or the very human interest or need for something greater than ourselves. This is perhaps why evolution is counterintuitive: humans are hardwired to look for a hand in the design process because we cannot grasp the significance or immensity of time as it elapses to allow for evolution. The designer we usually postulate is God, especially in monotheistic cultures where God is specifically said to have created human beings from dust and clay in God's image (Collins 140-141, 147-149).

Collins notes that "Truth cannot disprove truth (198)." Theistic evolution (TE) generally posits the following:

- 1) *Ex nihilo*, the universe came into existence roughly 14 billion years ago.
- 2) The universe has exquisite and improbable conditions for life.
- 3) Life evolved through natural selection over time after the first life appeared via an as-yet unknown mechanism.
- 4) Evolution requires no intervention from supernatural forces.
- 5) Humans evolved from a common ancestor of the great apes.
- 6) Some elements of the human experience are not (yet) explicable by science, including our spiritual nature and the existence of a universal Moral Law.

These six conditions are fully congruent with evolution as well as cosmology and theology (197-201).

Because TE splits the differences, in some ways, those who are TE adherents are often reluctant to speak up about their beliefs for fear of criticism from both sides. The term “theistic evolution” is itself problematic because it is hard to explain and puts faith in the descriptive position rather than the objective place, but “evolutionary theism” is just as bad. Hence Collins’ “BioLogos,” literally “life word.” This echoes John 1:1, where life and the Word of God are intertwined with the beginning found in Genesis 1:1. Such a harmonization of seemingly two disparate fields is not as appealing in the media as a cat fight between the two sides, yet another stumbling block to wide dissemination of the idea. Critiques of BioLogos as another “God of the gaps” theology fail because God is only present where science cannot answer questions, namely purpose and meaning (201-204).

Polkinghorne’s understanding of the relationship between science and theology fits with “BioLogos.” Both science and theology have moved away from any notion of “absolute truth” toward an understanding of reality that provides verisimilitude, or an approximation of truth that allows for further research, exploration, and understanding. Polkinghorne understands this movement to lead to several changes in the way that science and theology intersect and interact in the future:

- 1) Professional theologians will engage in more scientific endeavors.
- 2) The conversation will expand outward from the Abrahamic traditions to include many more of the faiths active around the world.
- 3) Theologians will adopt some of the bottom-up world view that is so fruitful in the sciences to help hone and refine doctrines in light of new knowledge.

- 4) Scientists will adopt many of the ideas of interconnectedness and relationships that are so fruitful in theology to help hone and refine theories that explain the cosmos more accurately.
- 5) Conversations about ethics and morality will be more productive and balanced as each side of the conversation understands the other more clearly, the scientists and society as a whole represented by theologians and faith leaders.
- 6) Continuing exploration of the cosmos to build the knowledge base so that our understanding comes ever more closely to resemble the truth (97-99).

Every particle in the universe is connected by superpositioning. Life is interconnected by DNA. We who are intelligent life should not be surprised that science and theology are also interconnected, if not by quarks or the strands of a double helix, then by the fact that both are human endeavors to explain the universe and our interactions with it. Those who would try to separate the two and raise one while destroying the other are denying the importance of both empirical knowledge and exploration of the meaning of our existence in the universe. The pursuit of scientific knowledge about our universe is the way that human beings make sense of our day-to-day life as well as the way that we can undo the damage our previous endeavors have done to the earth, including pollution of the land and seas and the ravaging effects of global climate change. Even if someday, we or a descendant species determines that there is no meaning to the existence of sentient life in the universe, the journey toward that knowledge will have itself been meaningful to those embarked upon it. When science and theology are not in competition but used to complement each other, much good can be accomplished. How much better, then, for people of faith to understand the pursuit of scientific knowledge and understanding as a practice of our faith rather than as something of which to be afraid.

### **Chapter Three: Science as Faith-Sustaining Mythology: A Creation Story for the Twenty-First Century**

Faith intersects all aspects of life, often uncomfortably. This is certainly true of science despite the common ground of wonder between faith and empirical inquiry; a similar and instructive discomfort exists between faith and the study of history. According to Biblical scholar Bart Ehrman of the University of North Carolina, the distinction between historical knowledge and faith comes down to the difference between what we can show that we know because it is recorded and what we believe even though there is no possible way to document it as fact:

“History is what we can show to have happened in the past. One of the things that historians cannot show as having happened in the past is anything that's miraculous because to believe that a miracle's happened, to believe that God has something in our world requires a person to believe in God, it requires a theological belief. But historians can't require theological beliefs to do their work....Historians acting as historians, whether they're believers or non-believers, as historians they simply cannot say Jesus was probably raised by God from the dead (Gross).”

Just as historical evidence cannot and does not prove or disprove matters of faith, neither can science prove or disprove matters of faith. As historical studies are an important companion piece to the practice of faith, so science can be a companion to the practice of faith, in particular because science and faith share the common root of wonder.

The earliest attempts to express wonder about the origins of the world come to us as creation myths from many cultures. Long before any human being had ever described a systematic way of observing and measuring the world, poets and storytellers crafted tales to

make sense of the world for their companions. These speculative stories provided answers to the questions of life, the universe, and everything in it. Scientific inquiry as we understand it today began perhaps 5,000 years ago, but it has only been in the past 500 years that scientific knowledge has come into conflict with the myths that sustained human civilization for so long. Today, a broad conflict exists between those whose scientific understanding and knowledge leads them to deny the need for mythologies of any kind and those whose intense need for their particular mythologies to be the absolute and inerrant truth leads them to exclude nearly all scientific understanding and knowledge.

The heart of this conflict is the continuing conflation of *how* (epistemology) with *why* (ontology). When scientists, who are answering *how* in clearer ways with every passing year, attempt to use their knowledge to answer *why*, those whose *why* mythologies are thus denigrated or denied often take umbrage at the overreach of science. Likewise, when *why* mythologies are used by their adherents as literal explanations for scientific facts, scientists take umbrage at the overreach of religion, particularly when a “god of the gaps” explanation for that which science has not yet answered becomes the default defensive position of anti-science theologians.

Adherents to each side of the conflict insist that there is only one way to settle it: their own. There is, however, an available middle way which allows wonder to serve as the strong root of both branches of inquiry. We need not disavow faith to pursue scientific inquiry nor scientific inquiry to be people of faith. Indeed, far from constraining our support of and participation in scientific exploration, our faith undergirds and encourages wonder and curiosity about all of creation. Nancy Abrams and Joel Primack state that one of the reasons it has been so difficult to get humans focused on the scientifically solvable problems we have today is that we lack an overarching origins story that provides meaning and purpose for human life (the “why”)

compatible with all that we know scientifically (the “how”). Following Joseph Campbell, who argues that, “Myths are clues to the spiritual potentialities of the human life,” they argue that the task necessary for today is to write and teach a creation myth that is both factually accurate for this time in the twenty-first century and amenable to correction and updating as we discover more about the microscopic and macroscopic worlds around us. They further argue that such a creation myth needs to traverse the boundaries of religion, race, and nation in order for it to be effective as a unifying force for the good of all creation (117-118).

Abrams and Primack may well be right about the need for one universal creation story, though how we achieve such a work at this time is beyond my ability to discern. Until the time that a universal story is available, however, a creation story that speaks to people of the Christian faith is within reach. Honoring the continual active presence of God in the universe without discounting the amazing knowledge humanity has acquired since Nicolaus Copernicus and Galileo Galilei advanced the concept of heliocentrism could be an important step forward in our endeavors as people of faith to address many of the pressing issues of our time: climate change and all the threats it brings; habitat destruction in the pursuit of profit; questions of medical ethics and morality such as those raised by genetic manipulation, the artificial extension of human life, and the distribution of medical resources; and even the cost of scientific exploration of space in relation to its benefits are all of concern to people of faith. Understanding our place in the universe as people of God can help us to discern what we can and need to do to change the current destructive course of human activities.

The key elements of such a mythic story must balance that which can be known—the scientific discoveries of the last five centuries, for example—with that which can never be known but must be taken on faith: the participation of the divine in creation from the beginning

to the present moment to the end of time, if there even is such a point. Further, this new mythic story must be adaptable to the point of complete reversal when new scientific discoveries arise. Wonder, as the common element between science and faith, will allow us to remain curious about the vast puzzle that is life, the universe, and everything—God included.

The natural place to begin for Christians is Genesis, which provides us with conflicting accounts of the creation of the world already. Literalists have attempted to harmonize the two accounts repeatedly, but even a cursory examination of the texts of Genesis 1 and 2 shows that this is not possible. What does bind the two stories is God's presence in and foundation for creation. What if, as Process Theology advocates, the universe is contained by God, who is the source of law and of newness and who is always changing in relationship and experience with all that is created (Morvillo 227)? Our creation myth could then be poetic, scientifically accurate as we understand the laws of the universe today, and amendable when—not if, but when—our understanding of the universe changes in the future.

Genesis opens with the phrase, “In the beginning when God created the heavens and the earth...” The use of “when” in this phrase, as Tom Martin notes, tells us already that our ancestors recognized that God came before creation and it helps us put the beginnings of the universe in perspective as a process (*Evolution*). From a scientific standpoint, the heavens came before the earth—by some nine billion years, give or take a hundred million. But before the beginning of time and space as we know them, before the universe even existed, particles danced around each other in a kind of primordial stew. If we could go back that far, we would not even be able to see the space in which these particles danced; it was smaller than any microscope yet invented can see. We do not know exactly what happened to mark the beginning of measurable time and space, but somehow enough particles were attracted by the force of gravity, or so



scientists think now, to create a kind of bubble. That bubble became so compressed by gravity that it eventually could be compressed no smaller, resulting in what has been called “The Big Bang.” A better analogy than an explosion, recent studies have shown, is what happens if one does not allow a pressure cooker to cool and depressurize before taking off the lid: mashed potatoes all over the kitchen, or, in the case of the depressurized cosmic particles, the building blocks of everything we see today all over the newly created universe, which unlike our kitchen is still expanding today. “The heavens and the earth” came into existence along with time as we know it (Cox 1-6, Kaku 61).

The first stars formed about 13.75 billion years ago from the atoms of hydrogen (element 1), helium (element 2), and lithium (element 3) formed in the expansion and cooling of the bubble. Heavier elements from beryllium to iron formed in the hearts of these stars through nuclear fusion, the most important of which were carbon (element 6), nitrogen (element 7), and oxygen (element 8) (Cox 160-163). All matter in the universe, every atom of everything we see and, in fact, everything we are, traces its origins to these early stars and to stars which burned to the point of collapse as novae or supernovae, producing atoms of elements much heavier than iron, including magnesium and uranium (Kean *Spoon* 68). The core of our planet is iron (element 9) and we are carbon-based life forms which require trace amounts of magnesium (element 12) for our electrically-based nervous systems to work properly and who use uranium (element 92) to generate electrical power for our lights, refrigerators, and computers (194). Carl Sagan was factually poetic when he said, “We are made of star stuff” (233) and even the human-made elements that we have yet to find in nature, such as the recently confirmed but as yet unnamed 113, 115, 117, and 118, are made of matter first created in that initial expansion (Wong).

The laws of physics governed the primordial stew and the expansion of the universe, including the development of incrementally heavier elements that play such an important role in the existence of life on earth. Many scientists have observed that even a minuscule difference in one constant like *alpha*, the fine structure constant that controls the strength of the bond between the nucleus of an atom and the electron(s) around it, would have resulted in something very different than what we have today. For instance, if *alpha* were stronger (a larger number), carbon atoms would never have survived to escape the fusion reactors we call stars, but if it were weaker, the fusion process would not have been hot enough to create carbon atoms at all (Kean *Spoon* 194). *Alpha* is not the only constant that is exactly right, according to theorists, to allow for life as we know it to arise in the universe. There are at present six specific values that scientists understand must be exactly as they are for us to exist, including *alpha*, the relationship of the force of gravity to the electromagnetic forces, and the mass of neutrons (Martin *Evolution*). These facts lead theologians like Arthur Peacocke to see God's handiwork in the origins of the laws that structure the universe (Morvillo 207-208).

For about nine billion years of that time before the first day when God created, those laws were at play as stars and planetary systems came and went across the expanding universe. Just more than four and a half billion years ago, one such star in our very own quadrant of the Milky Way galaxy became a supernova, ejecting massive amounts of elemental material into the cosmic dust. As matter is wont to do, it coalesced, forming accretion disks that soon began to spin and create gravity, attracting more matter. Here we have finally come to the dawn of the first day of creation according to Genesis 1: one of these disks grew large enough to ignite and became our sun. Like every planet ever discovered, Earth evolved from that same chaotic star stuff the same way. The accretion disk, called a planetesimal, formed a sphere that orbited the

central star of the system but did not ignite (Tate, NARO). What matters most to us is location, location, location: Earth is optimally located in relationship to our star for the presence of liquid water to allow for the evolution of life. It is neither too hot like Mercury and Venus nor too cold like Mars and the gas giants. It must be noted, however, that our descendants may yet find life, or evidence thereof, beyond Earth wherever there is or was water; initial results from the Kepler space telescope mission have provided an early estimate that one in five stars in the universe are in the same class and general size of our own sun, thought to be the ideal solar body for planets that can sustain water and thus life (Kaku 241-242; Sanders).

On the second day of creation, Genesis tells us that God said, “Let there be a dome in the midst of the waters, and let it separate the waters from the waters.” The third day, God called out, “Let the waters under the sky be gathered together into one place, and let the dry land appear.” And on the fourth day of creation, the words spoken were, “Let there be lights in the dome of the sky to separate the day from the night; and let them be for signs and for seasons and for days and years, and let them be lights in the dome of the sky to give light upon the earth.” These three days of creation, as told in the Biblical narrative, happened in a much different order in the unfolding of our universe, solar system, and planet across a span of billions of years.

The ancients who told the creation story could not have known that many of the stars we see are much older than our own sun. They had no way to know that the moon itself, the “lesser light” of the night, was born from a collision between Earth and a young protoplanet the size of Mars called Theia, which existed in an orbit that intersected Earth’s orbit very shortly after Earth itself formed. Neither could those ancients have known that there could once have been two moons that collided with each other to create the very distinct light and dark sides of our current single moon (Tate, Vergano). They would not have been able to formulate a simpler, more recent

hypothesis to explain the differences: Earth and the new moon were once only half as far again away from each other as the Earth's diameter, causing immense tidal disparities on the two molten bodies and dramatically slowing both the revolution of the moon around Earth and on its own axis so that the moon's day/night cycle and orbit keep the same side of the moon visible to us on earth (Plait).

While we have observed that the “setting” and “rising” of the sun changes with the seasons and have given various names to seasonal moons, we know now that it is neither the sun nor the moon that causes the seasons. Rather, it is the Earth's axial tilt that gives us summer, fall, winter, and spring in each hemisphere, northern and southern. Even within this pattern, we now know that there are variations over long periods in the strength of the seasonal changes which play a role in the beginning and end of ice ages and other long-term climate change cycles. For example, when the Earth's orbit around the sun is more nearly circular, the seasonal changes are less dramatic than when the orbital path is elliptical; the difference between aphelion around July 4 each year (farthest distance from the sun) and perihelion around January 3 (closest distance to the sun) is much greater when the orbit is elliptical. The angle of the axial tilt itself varies by as much as 2.4 degrees, which also exaggerates or collapses the difference between seasons; when the angle of tilt is smaller, seasons are milder with less difference between them, but when it is larger, the seasonal shifts are much more dramatic and extreme. Currently, the tilt is between the extremes. The circular path of the axis itself allows the hemispheres of the Earth to “wobble” in such a way that one hemisphere or the other is closest to the sun at perihelion. When summer and perihelion coincide, as happens currently in the southern hemisphere, summer tends to be more extreme; likewise, the coincidence of aphelion and winter can lead to more extreme winters. Even though the moon is not responsible for the seasons, without our moon, the extremes of the

axial tilt would be much greater and life on earth would be much less likely to have evolved due to temperature fluctuations on the relatively small scale of 100,000 years (NASA).

Infant Earth was a harsh place. The iron core and molten silicon mantle were soon covered by a crust (the “dry land”) broken in places by volcanoes which spewed carbon, nitrogen, hydrogen, and oxygen into the nascent atmosphere. About 500 million years after its formation, Earth had cooled enough to form large seas (the “waters”) and to hold an atmosphere (the “dome”) essential to the formation of organic compounds that gave rise to the first life (Paleobiology).

On the third day, God called, “Let the earth put forth vegetation: plants yielding seed, and fruit trees of every kind on earth that bear fruit with the seed in it,” which is the first life created by God. We now know that life began as single-celled organisms that did not even have nuclei. In another billion and a half years, life had evolved that turned light energy, water, and carbon dioxide into oxygen and carbohydrates in the form of monosaccharides (sugars) by means of photosynthesis, all thanks to RNA and DNA. The oxygen produced by these very early plants changed the atmosphere of Earth drastically, leading to the evolution of larger life in the billions of years to come. Seeds and flowers are a comparatively recent evolutionary product of plant development, though still arising long before the arrival of the earliest recognizable human ancestors (Paleobiology).

When God said, “Let the waters bring forth swarms of living creatures, and let birds fly above the earth across the dome of the sky,” on the fifth day, the story was at least partly right. Multicellular non-plant life evolved in the seas, according to the best evidence we have now, possibly by a process of endosymbiosis (literally, “living together within”) in which a larger single-celled life form consumed a smaller one without killing it. Instead, the larger organism

incorporated the smaller cell into its energy management system. Evolutionary biologists theorize that such endosymbiotic relationships allowed for the development of mitochondrial DNA (mtDNA), a feature found in almost every form of multicellular life and still bearing its bacterial DNA signature (Kean *Violinist* 103-105).

Eventually, life migrated out of the seas onto dry land. “Let the earth bring forth living creatures of every kind: cattle and creeping things and wild animals of the earth of every kind,” God said on the sixth day. Indeed, it is only within the last 540 million years, or about one ninth of Earth’s existence so far, that animal life has become complex enough to evolve such innovations as hard shells, such as those of the swarming crabs of Christmas Island, and strong bones necessary for upright ambulation. Along with evolutionary changes, mass extinctions have always been a part of the evolutionary life cycle on earth, as well. The Permian Extinction about 252 million years ago led to the end of 70 percent of all life on land and 90 percent of all sea-based life. This gave rise to an environment suitable for the evolution of the first dinosaurs, while another at the end of the Cretaceous Era 65.5 million years ago caused the extinction of dinosaurs (except modern birds, which arrived much later in the evolutionary record than in the Biblical story) and allowed for the rise of mammals (Paleobiology).

At the end of the sixth day, God said, “Let us make humankind in our image, according to our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the wild animals of the earth, and over every creeping thing that creeps upon the earth.” This unique moment of human creation serves as one of the key reasons so many Christians are skeptical about evolution; without it, are humans any different from any other creature on the planet? As noted in a 2009 Pew Foundation poll, a disturbing plurality (43%) of all Protestants surveyed believe that humans and animals have been in their current

form since time began. We collectively are somewhat confused about what separates us from the animals: are we different by kind—that is to say, are we human beings uniquely created outside of any evolutionary or creative processes that occurred to cause the rest of life on earth to exist? Or are we different by degree, at base animals but gifted by God somehow, be it by direct intervention or by evolution, with self-awareness and cognitive abilities that outstrip all other animals? And whichever it is, kind or degree, what part of our existence reflects God's image? We can say empirically, though there are some gaps in the fossil record, that human beings, like all other life on earth, evolved to our present form over millions of years. Thus, our difference is in degree rather than in kind (Martin *Evolution*).

The very earliest direct ancestors of humans had evolved into a separate order, the primates, by 33.9 million years ago. We do not know exactly where on Earth the first primate population arose, but we do know that these first primates are the ancestors of modern gorillas, chimpanzees, bonobos, and human beings. Our divergence from chimpanzees and bonobos likely happened when a small population of our last common ancestor was stranded away from the main group. Until very recently, this split was thought to have occurred about six million years ago; recent studies of chimpanzee DNA mutations pushes the date back to about thirteen million years ago (Choi). We know, because there is much more diversity among chimpanzees and bonobos, that humans came out of the smaller group, and that this smaller group found itself in the savannah lands of Africa rather than the forest. We also can say that the inbreeding of this small group led to the fusing of the two chimpanzee chromosomes, which prevented successful reproduction between the two groups when they encountered each other again (Ridley 30-31).

For reasons not yet known, those in the direct ancestral line of human beings developed the ability to walk upright for long periods of time; natural selection favored those who could

walk the farthest and for the longest time, which led to the more upright stance of our ancestors and thus to our standing, bipedal walk. The sunshine on heads exposed on the plains of the Rift Valley in Africa rather than shaded in the forest led to selection for veins in the scalp to wick heat away. Our brains, already among the largest in the animal world before the split, continued to grow with each passing era. Females became more equal in size to males and couples began to mate for life, or at least long-term, which allowed for a variable diet of both meat and fruits, grains, and nuts as males hunted and females foraged. This long-term survival strategy gave the evolving primates a high protein diet, which contributed further to the growth of the brain and the intelligence contained therein. Now, evolved from our last common ancestor, we have mostly bare skin, language, technology, a complex economic system based on division of labor, and the ability to figure out whence we came. Our cousins remain in the forest, hairy yet eerily human if we dare to look beyond prehensile toes and indecipherable screeching (Ridley 31-36).

For all their eerie humanness, not even chimpanzees and bonobos have a sense of wonder as developed as human beings. We have records of the observations of the world made by humans going back at least 5,000 years preserved in the artifacts of many ancient civilizations, particularly astronomical data. Even before the observations begin, we have records of the mythological stories that humans created to explain the ways of the world. The storytellers used words as their tools. The first scientists had only the unaided senses to make their observations, but human ingenuity led to the development of tools to assist in the observation of the world, with everything from lenses to magnify the microscopic in a drop of water and the macroscopic in the solar system to sonic devices that allow us to hear and see the development of a human fetus and to record the songs of whales giving us new information about the universe in which



we live. The evolution of human understanding of creation is nowhere as evident as in the changes in the way we speak of the physics that underlie the universe.

Aristotelian physics, which held sway over Christian understanding of the ways of the world for more than 1500 years, rested on the notion that there are four elements and four causes which govern the known world. Every observable phenomenon could be explained within this earth-centric system because everything had its purpose and its place. Early and medieval Christian understanding of creation came out of a world shaped by Aristotle's science, though his work is not science as we understand it today; earth was the center of the entire observable universe, placed there by God as the centerpiece of creation.

The sixteenth and seventeenth centuries brought a new understanding of creation. Nicolaus Copernicus, among the first scientists to have access to a telescope, observed the motion of the planets and stars in a way no other human being had been able to previously. His observations led to proof that the earth orbits the sun rather than the other way around, upending Aristotle and theologians alike. Galileo Galilei's work, building on that of Copernicus, proved the orbital mechanics of our heliocentric solar system. Both men raised the ire of Christians, Copernicus the newly minted Protestants during his lifetime and both the Roman Catholic Church when Galileo's work was first published during the Counter-Reformation (Hagen).

Isaac Newton launched his investigation of motion and gravity, picking up where Galileo left off, as a way of better understanding God. Newton's three laws of motion did an excellent job of describing the world as people could observe it 350 years ago. We experience our lives according to those laws. We rely on the knowledge that objects tend to remain in the state in which we find them unless something acts to change that (objects in motion/objects at rest) every time we park our cars. Every child knows that the more force one applies to a ball resting on the

floor, the faster that ball will roll across the floor and that it takes more force to push a heavy toy car than a light toy car (force equals mass times acceleration). To walk, we rely unconsciously on the third of his laws, that for every action (a foot pushing down on a surface), there is an equal and opposite reaction (that surface pushing back against the foot).

Newton's laws and the corollaries that helped to define gravity did an admirable job of explaining observable phenomena, but even at the time he lived, other scientists saw flaws in his thinking. Richard Bently described a paradox in Newton's gravitational schema: in a finite universe, if gravity always attracts, then we should live in a universe in which stars and planets are constantly pulled into orbits and destroyed as it collapses on itself. If the universe is infinite, then the force of gravity pulling on an object would also be infinite and thus would pull stars and planets apart. Newton's response was that a uniform infinite universe would exert the same pull on every object from every direction, thereby holding everything stable. The trouble starts when a single object wobbles, upsetting the balance; Newton's solution was occasional divine intervention (Kaku 25-26).

The reality, we understand now, is not divine intervention but quantum mechanics, that is, the interaction of subatomic particles according to rules that defy Newton's laws of motion. We cannot, generally speaking, observe quantum mechanics directly in our daily lives, but everything around exists because of these laws. The most famous law of quantum mechanics is Albert Einstein's theory of special relativity,  $E=mc^2$ , where E is energy, m is mass, and c is the speed of light (186,282 miles per second in a vacuum). Energy and mass are interchangeable, demonstrable by burning a cheese curl: the weight of the curl is greater before it is burned than the weight of the resulting ashes; the missing mass has been converted to light and heat energy.

Everything that exists operates according to this law of physics and the principles we have derived from it (Cox 143-147, 198-205).

One of those principles is superpositioning. Light behaves as an individual particle and as a wave simultaneously, which is both counterintuitive and weird, until it is observed. When it is observed, it “chooses” a behavior. Erwin Schrödinger’s Cat thought experiment postulated that a cat in a box with a vial of poison gas that would be broken when a Geiger counter detects the decay of an atom of uranium is both alive and dead until one opens the box and looks, explaining the principle of superpositioning as well as the unpredictable nature of atoms (Martin *Quantum*; Kaku 158-160).

Werner Heisenberg took this a step further in developing the uncertainty principle, which states that it is possible to know the speed of an atom or a particle but not the exact position of said object and vice versa. Once one knows the speed, its position is the function of a probability equation that provides a range of possible positions; likewise, if one knows the position of a particle, its speed is the function of a probability equation that yields a range of possible speeds. Contrary to the rigidly predictable universe required by Newtonian physics, the universe allowed by Heisenberg exists on probabilities that sometimes allow for the most improbable action to occur (Martin *Quantum*).

A third principle of great importance is the Einstein-Podolsky-Rosen (EPR) Paradox. Physicists have long known that particles are paired, or entangled, with each other. The EPR Paradox shows that knowing the direction of spin axis in one electron in a pair, even light-years separated, automatically means that the direction of the other member of the pair is known to be opposite. If one electron is up, the other will be down. Measuring over a distance of light years violates the uncertainty principle in what Einstein called “spooky action at a distance” across

nonlocal space, which he thought implausible. John Bell showed that quantum theory and mechanics, strange though they be, are right and Einstein was wrong. Because every atom in the universe ultimately formed in the same big bang explosion, as demonstrated by  $E=mc^2$  where energy and mass are interchangeable, every atom in each of us is paired with another atom somewhere in the universe about which we can know its spin, even if we don't know its location. This quantum entanglement means that there is at least some connection between pairs no matter how far apart they may be in the universe, and what happens to one atom causes a reaction in the other instantly (Kaku 174-178).

We have mostly moved on from Aristotelian-based theology. Most Christian theology today, however, is still very much reflective of the Newtonian God who knows everything about every discrete entity because those entities follow set laws of action and interaction. God in this worldview is all-knowing of the past, present, and future because knowing the present state of an object allows one to know both the past and the future state of that object. When applied to people, the question of whether we truly have free will under God as constrained by Newtonian physics becomes knotty and leads to theological rifts over predestination, as well (Martin *Quantum*). Albert Einstein once said that despite all of his research findings otherwise, “God does not play dice with the universe.” If even the father of quantum physics could not wrap his head around God as something other than a divine watchmaker in complete control, then what hope have we to shift our theology in light of what we now know?

Niels Bohr, in response to Einstein, said, “Stop telling God what to do!” Thomas Aquinas, writing in the thirteenth century, declared that everything comes from God, who cannot contradict Godself, and thus faith and science cannot contradict each other. We have no choice but to change our theology to match what we now know about quantum physics because our

understanding of God no longer matches our understanding of creation. Unconstrained by Newtonian laws, God knows not the exact outcome of anything in the future because the future is categorically unknowable according to the laws of quantum physics. There are only greater and lesser probabilities. We might perceive that the “Goldilocks” universe in which we live is impossible without a divine watchmaker, but the reality points us to the fact that our God wrote the laws of physics which allow for the creation of our highly improbable universe. How, we ask from our Newtonian mindset, could we possibly have evolved with such complex organs as eyes and brains, when it makes so much more sense for God to have stepped in directly to change something? Quantum physics and all that comes from it allow for the improbable to happen with astonishing regularity, even such improbable complexities as flagella in bacteria and opposable thumbs in lemurs and primates. Technically, quantum physics also allows for every particle in my body to transport itself to Waikiki Beach and back while I type this sentence, though that is even more improbable than anything we have observed to date and to the best of my knowledge, it did not happen (Martin *Quantum*).

As far as we are able to understand, the ability of *Homo sapiens sapiens* to formulate the statement, “I wonder...” is unique among the species of earth. Other species—chimpanzees and bonobos, certainly, as well as both African and Asian elephants, dolphins, and New Caledonian crows, to name just a sample—display self-awareness and the ability to solve problems creatively, but we do not have evidence at this time that they are sentient in the same way that humans are (Jabr; Garber; Taylor). Perhaps this is the divine image we bear, the ability to formulate questions based on our experiences of the world and then to explore and experiment to discover the answers not just to solve problems but for the sheer excitement of knowing. It is highly probable that someday, a new theology will emerge as new scientific understanding

displaces quantum physics as the bedrock of our understanding of creation, all because we can and do state, “I wonder...”

## **Chapter Four: I Wonder...**

### **Gaining Wisdom and Growing Faith Through Scientific Exploration**

Five-day Vacation Bible School Experience

Note that this chapter is formatted for use as a curriculum:  
Teaching sections are indented and substantial portions are single spaced.

## Purpose

Deepening faith in God and growing scientific understanding of the world around us both begin with the statement, “I wonder...” Using this phrase as the common foundation, learners who participate in this program will develop an appreciation for the role of science in our modern world and how being scientifically curious and literate can deepen the practice of one’s Christian faith, particularly as we are called to be caretakers of creation. Wisdom in the person of Sophia will guide learners through Bible study and experiments as they gain knowledge as people of faith and of science.

## Objectives

—Using Psalm 8, Proverbs 8:22-31, and Genesis 1:1-2:4a as the Biblical foundation, learners will compare and contrast what the authors of the Biblical texts knew and understood about the universe in the first millennium BCE with what is known and understood in the second millennium CE. (The *Common English Bible* will be used in this curriculum unless otherwise noted.)

—Learners will experience the Bible as a collection of stories about people’s encounters with God and with creation that teach us about God but does not speak as God’s voice to us.

—Learners will hypothesize, observe, record, analyze, and theorize during hands-on experiments designed to reveal basic rules and laws of the universe as God created it.

—Learners will write a proverb of their own in the style of Proverbs 8:22-31, using Sophia’s voice to reflect what they have learned about God’s universe.

## Instructional Conceit

In Proverbs 8, Lady Wisdom proclaims, “<sup>22</sup>The Lord created me at the beginning of his way, before his deeds long in the past. <sup>23</sup>I was formed in ancient times, at the beginning, before the earth was.” She then describes what she saw as God created the world, saying that she “was having fun” watching God create and “frolicking” with animals and humans. This beautiful portrayal of the creation of earth is poetic



rather than scientific, but what if the author of this proverb had a vision, like those of the prophets, but could only describe what he or she understood? If we were to have the same vision today, what might our written version be since we know and understand so much more about creation?

## Overview

### *Day 1: Physics*

Physics is the field of science that governs everything else. Physics teaches us about time, gravity, and forms of energy such as heat, light, and motion. The laws of physics are essential to everything we perceive and without those laws, the building blocks of everything could not exist. We can observe many of the laws of physics in our daily life, just like we can practice many parts of our faith in our daily lives. But much in physics is beyond our ability to see directly, so we have to make careful and thoughtful guesses, called hypotheses. When we test these hypotheses, sometimes we find that our guesses are wrong, so we begin again with new guesses. Other times, we find that our guesses are right, or at least right for now, and we begin to develop theories. It is even possible that later on, we discover that our theories are wrong, so we begin again with new guesses based on what we learned. We do the same thing with our understanding of God as we experience God in the world and grow in our understanding of God.

### *Day 2: Chemistry*

Chemistry is the field of science that helps us to understand what everything we see, feel, taste, and smell is made from. Chemistry is the study of the building blocks of everything, which we call elements like carbon and oxygen, and all the different materials that can be made by combining those elements. We have many building blocks to our faith, including the Bible, testimonies from people who have encountered God in their lives, and encounters we have with God ourselves. What's amazing about chemistry is that when different ingredients are mixed together, the ingredients are completely changed,

sometimes from solid to liquid or liquid to gas, for example, and sometimes to a completely new and different ingredient entirely! The same thing is true about the building blocks of our faith: when we put the ingredients of our faith together in different ways, our faith changes and grows.

### *Day 3: Geology*

Geology is the study of the actual planet we call Earth. Geology teaches us how the building blocks of matter have been put together to make our planet and how those building blocks changed over time. The Christian faith has changed over time, and we can study that to help us understand where many of our ideas about God came from. Earthquakes and volcanoes are evidence that Earth is still changing, just as our Christian faith continues to change today, sometimes with great force as with earthquakes and volcanoes, sometimes gently and persistently, as a coastline is changed by the continuing action of waves moving sand from one place to another.

### *Day 4: Biology*

Biology is the study of life. Life on earth is amazingly diverse, from single-celled bacteria and plankton to enormous animals like elephants and great blue whales. It would be easy to think that all this variety of life—protozoa, plants, bacteria, fungi, and animals—has very little in common one with another. But the truth is that all life is linked by one astonishing “ingredient”: DNA, deoxyribonucleic acid. Our faith is like life because God is the one astonishing ingredient that links us all together by faith, no matter how different one person’s understanding of God may be from anyone else’s.

### *Day 5: Astronomy*

Astronomy is the study of space, especially stars. We are, in the words of Carl Sagan, “star stuff,” and it was in the first stars that the building blocks of everything were created. We have learned much about physics and chemistry by studying the stars and by exploring space; we are also looking for signs of life

on other planets that might help us learn more about life right here on Earth. When we look into space, we're looking into the past, sometimes as much as 13 billion years in the past! Our search for knowledge among the stars teaches us that we can learn about God and about our faith everywhere, not just in church, and that we can learn from the past in ways that help us today and in the future. Anything that makes us say, "I wonder..." can teach us about creation and about God!

### Logistics

*Daily Schedule* (2 hours, 35 minutes plus transition time)

35 minutes: Daily Theme Time

55 minutes: Laboratory Time

20 minutes: Recreation Time (Optional)

20 minutes: Snack Time (Optional)

25 minutes: Laboratory Reports

### **DAILY THEME TIME**

Each session opens with Daily Theme Time, designed for about 35 minutes each day. The format is the same for each day:

5 minutes: Gathering song(s) as appropriate for group

5 minutes: Theme song\* learning time

5 minutes: Introduction of Theme (Day One)/Recap of Previous Learning (Days Two through Five)

10 minutes Science Demonstration and Field Introduction\*\*

5 minutes: Daily Scripture

5 minutes: "I Wonder..."\*\*\*

\*Suggested theme songs:

—“In Chaos and Nothingness,” lyrics and tune by David Lee, (C) 2012. For the main page of the hymn, visit <http://www.servicemusic.org.uk/hymn/creation.htm>, from which a .pdf of the hymn set to the tune and commentary on the hymn are both accessible.

—“Earth and All Stars” verses 1, 2, 5, and 6 by Herbert Brokering, to the tune “Earth and All Stars” by David Johnson; for a list of hymnals including this hymn, visit [http://www.hymnary.org/text/earth\\_and\\_all\\_stars](http://www.hymnary.org/text/earth_and_all_stars).

—“God Who Stretched the Spangled Heavens,” lyrics by Catherine Cameron, tune traditionally “Holy Manna” by William Moore; for a list of hymnals including this hymn, visit [http://www.hymnary.org/text/god\\_who\\_stretched\\_the\\_spangled\\_heavens](http://www.hymnary.org/text/god_who_stretched_the_spangled_heavens),

**\*\*Science Demonstration and Field Introduction:** Each day includes simple demonstrations to help explain the field of study for the day (physics, chemistry, etc.). Instructions for demonstrations are included in each lesson.

**\*\*\*I wonder...** This daily exercise primes the learners to ask questions and make guesses during the Laboratory time; prompts are provided in each lesson.

## *Master Supply List*

### Multiple days:

- 9" or larger round balloons
- Ice
- Salt
- Permanent markers
- Poster board
- Copy paper
- Construction paper of various colors
- Paper clips
- Sticky notes, 2"x2" or larger
- Pencils
- Vanilla extract
- Sugar
- All-purpose flour
- Cocoa
- 9"x13" pans (6-10 minimum; disposable or metal, not glass for safety)
- Several measuring cups or pitchers with spouts
- Quart zip-top freezer bags

### Day One:

- Magnets of various sizes and shapes, marked N/S if possible
- Compass (not cell-phone app)
- Assorted coins, country and date of issue unimportant
- Assorted objects made from cloth
- Assorted objects made from plastic
- Aluminum foil
- Iron filings (optional)
- Two balls of the same size but different weight
- Sturdy ladder
- 2 blow dryers with variable heat and speed settings
- Ping pong balls
- Feathers and/or packing peanuts
- Black/UV light
- 60W or higher white light equivalent bulb in lamp base
- Light bulbs of different colors (best if in separate lamp bases)
- Old CDs
- Hand mirrors
- Box large and wide enough to hold the lamp with the white bulb
- Half and half and assorted mix-ins (chocolate chips, nuts, etc.)
- Gallon zip-top freezer bags
- Tonic water with quinine

### Day Two:

- Iodine
- Chlorine bleach
- Empty 2-liter bottles (at least 10, enough for each learner plus 2-3 extras ideally)
- Vinegar

Baking Soda  
Baking powder  
Milk  
Eggs  
Shortening, margarine, or butter  
Cupcake liners and pans  
Mini cupcake liners and pans  
Frosting (optional)  
Epsom salts  
Clean and dry eggshells (1/2 to 2/3 intact)  
White glue  
Liquid starch  
Borax  
Cornstarch (optional)  
Food coloring  
Zip-top sandwich bags  
8 oz. paper cups  
Coffee stirrers or wooden craft sticks  
Sewing thread  
Cinnamon, powdered sugar

Day Three:

Drinking straw  
Scissors  
Dry spaghetti  
Gumdrops  
Building blocks  
Interlocking blocks, e.g., LEGO or DUPLO  
Lincoln Logs, Tinkertoys, or Erector set pieces (optional)  
Beads of varying sizes  
Sugar cubes  
Samples of geodes (optional)

Day Four:

Assorted fruits in the Rosaceae family, as many as possible with leaves attached  
(peaches, nectarines, plums, apples, pears, cherries, strawberries, raspberries)  
Almonds  
2-3 varieties of roses on stems with leaves

Day Five:

Glass pan (see demonstration preparation for size)  
Cherry tomato  
Map  
Yarn in various colors  
Marble  
Walnut  
Golf ball  
Basketball

Soccer ball  
Softball  
Small grapefruit  
Stones of assorted sizes  
Beach ball, preferably with at least 4 colored panels  
Bright light (LED camera or brighter)  
Modeling clay (purchased or made)

## Background on Proverbs 8:22-31

Proverbs is a book of “wisdom literature.” As such, it shares much with literature in the Bible and from cultures all over the world dating from first millennium BCE through the Renaissance. Key features of wisdom literature include a targeted audience of leaders, especially national leaders such as kings and court advisors, applicability to a much broader audience in general terms, and a great deal of what we today call “common sense” knowledge.

Aesop and Confucius were both wisdom teachers whose words were preserved through the ages. The Biblical book of Proverbs is attributed to King Solomon, who is known as the wise king, though it is unlikely that Solomon wrote any of the work. It is possible, though not probable, that some of the wisdom recorded in the work comes from his time and his reign.

Even into the Age of Enlightenment and beyond, we have forms of wisdom literature; Benjamin Franklin gave us such proverbs as “A penny saved is a penny earned,” and “Early to bed, early to rise, makes a man healthy, wealthy, and wise” in his *Poor Richard’s Almanack*. Perhaps some of the more useful “self-help” books of our era could be considered wisdom literature, in a broad sense.

But what do we mean when we talk about “wisdom”? According to Charles Melchert in *Wise Teaching: Biblical Wisdom and Educational Ministry*, wisdom has several related meanings.

Biblically speaking, Wisdom (capital “W”) is Sophia, God’s personified agent who leads human beings to living the right way. Sophia is present in Proverbs as well as the apocryphal works Ecclesiasticus and Wisdom of Solomon; Sophia is also credited with leading the Israelites through the wilderness and is said to be resident in that most revered of earthly places, the Holy of Holies in the Temple in Jerusalem. Sophia will be our guide through this experience, literally, as Wisdom personified.

In another way, wisdom (lower case “w”) is the ability of an individual to reason and apply knowledge to one’s own life. Specifically in Proverbs, this refers to living life according to the ways of



God, so wisdom requires knowledge of God's laws and the ability to apply them using reason. Proverbs that hinge on this understanding of the word often contrast a wise person with a foolish person.

More generally speaking, wisdom (again, lower case "w") is the practice of practical application of knowledge to one's life, including technology and arts, that leads to a fulfilling experience of life. A Judeo-Christian understanding of this means that as we mature in wisdom, we move from trusting solely an authority, such as the Torah or Jesus Christ, to trusting the teaching of someone whose knowledge is derived from an authority, to trusting that we have the knowledge from authority within ourselves and can trust our own judgment.

What then do we make of Sophia in Proverbs 8:22-31 (Common English Bible translation)?

<sup>22</sup>The Lord created me [Sophia] at the beginning of his way, before his deeds long in the past.

<sup>23</sup>I was formed in ancient times, at the beginning, before the earth was.

<sup>24</sup>When there were no watery depths, I was brought forth, when there were no springs flowing with water.

<sup>25</sup>Before the mountains were settled, before the hills, I was brought forth;

<sup>26</sup>before God made the earth and the fields or the first of the dry land.

<sup>27</sup>I was there when he established the heavens, when he marked out the horizon on the deep sea,

<sup>28</sup>when he thickened the clouds above, when he secured the fountains of the deep,

<sup>29</sup>when he set a limit for the sea, so the water couldn't go beyond his command, when he marked out the earth's foundations.

<sup>30</sup>I was beside him as a master of crafts. I was having fun, smiling before him all the time,

<sup>31</sup>frolicking with his inhabited earth and delighting in the human race.

Melchert points out that Genesis 1:26 is plural: “Let us make human beings in *our* image.” Could it be that Sophia is the feminine image of God that is all too often left out in our theology? Considering that Sophia says she was present at the creation of the universe, it makes sense that she was also present at the creation of human beings (in the Biblical story) and that Sophia is still present today.

Sophia also says that she “played” before God and “played” in the world God created; again, Melchert gives us insight that what is often translated as “rejoicing” in Proverbs 8 is the same Hebrew word that is translated as “playing” in every other context. He also notes that “master craftsman” can also be translated as “little child,” which could elicit all kinds of playful mental images if we allow ourselves the space to imagine God as a little child playing in and with creation (amended below by the author after Melchert’s suggestions):

<sup>30</sup>I was beside God, a little child. I was playing, smiling and laughing before God all the time,

<sup>31</sup>playing with God’s inhabited earth and playing with the human race.

The methods of science are, in some ways, just a way of organizing play to gain knowledge. We often forget that children learn best by playing. At least by one account, God created the entire universe by playing, so perhaps that is one way to understand what God’s image within us might be.

In addition to playing with science, this experience allows learners to play with the idea that Sophia’s vision of the creation of the universe is still being cast to us. If that is so, then we would write something different than the version written down by those who first saw her vision because we know the universe and everything in it very differently than our ancestors did or even could. No doubt, if the vision is cast for all time, our descendants will write the vision differently than we can because they will play with all that is in ways we cannot even imagine today.

Lady Wisdom: Sophia is the speaker in Proverbs 8:22-31. Sophia's words were recorded over 2000 years ago when human beings did not know what we do now about the universe. The invitation throughout this curriculum is for learners to wonder what Sophia might say to us now that people in the time before Jesus could not possibly have understood; if someone is available to be Sophia throughout the learning event, this person could guide the learners through both the daily Scripture and the daily Proverb writing exercise during the Laboratory Reports.

References:

Melchert, Charles F. *Wise Teaching: Biblical Wisdom and Educational Ministry*. Harrisburg, PA:

Trinity Press International, 1998. Pages 4-5, 188-190.

## Day One: Physics

Science Goal: Learners will be able to hypothesize and design experiments using basic theories of physics including gravity, reflection and refraction, and magnetism (aerodynamics, optional activity).

Faith Goal: Learners will describe how God uses the laws of physics to create everything we see and experience.

### **Daily Theme Time**

#### GATHERING SONGS

#### THEME SONG

#### INTRODUCTION OF OVERALL THEME

Ask: What is WISDOM? Is wisdom important? Who has it? Can you gain it? How?

Say: God knows that Wisdom is very important. Wisdom has a name, Sophia, and in the Bible, Sophia is a woman who speaks to us to guide us and teach us.

Read: Proverbs 1:20 (“Wisdom shouts in the street; in the public square she raises her voice.”)  
Proverbs 3:19 (“The Lord laid the foundations of the earth with wisdom, establishing the heavens with understanding.”)  
Proverbs 8:1-2 (“Doesn’t Wisdom cry out and Understanding shout? <sup>2</sup>Atop the heights along the path, at the crossroads she takes her stand.”).

Say: Sophia even teaches us a little bit about how the entire universe and everything in it was made. We can hear what she says in the book of Proverbs, chapter 8, verses 22 through 31. (Introduce Sophia here if one person is playing the part throughout.)

Read: Proverbs 8:22-31. The text of *The Common English Bible* rendering (below) is the preferred reading (with modifications for inclusive/expansive language if desired) but any modern version is acceptable.

<sup>22</sup>The Lord created me at the beginning of his way, before his deeds long in the past.

<sup>23</sup>I was formed in ancient times, at the beginning, before the earth was.

<sup>24</sup>When there were no watery depths, I was brought forth, when there were no springs flowing with water.

<sup>25</sup>Before the mountains were settled, before the hills, I was brought forth;

<sup>26</sup>before God made the earth and the fields or the first of the dry land.

<sup>27</sup>I was there when he established the heavens, when he marked out the horizon on the deep sea,

<sup>28</sup>when he thickened the clouds above, when he secured the fountains of the deep,

<sup>29</sup>when he set a limit for the sea, so the water couldn't go beyond his command, when he marked out the earth's foundations.

<sup>30</sup>I was beside him as a master of crafts. I was having fun, smiling before him all the time,

<sup>31</sup>frolicking with his inhabited earth and delighting in the human race.

Say: Sophia's words remind us that God existed before anything else in the universe. She does not tell us how God created the universe, but because wisdom is still guiding us today, we have learned a lot about that process. God wrote laws for the universe. Everything Sophia

saw and everything we see and know today is a result of those laws. We call the study of those laws science, which has many branches. This week, we will study branches called physics, chemistry, geology, biology, and astronomy to learn more about God's universe.

## SCIENCE DEMONSTRATION AND INTRODUCTION OF PHYSICS

Prepare ahead:

Gravity: Practice with an assistant so that the two balls drop simultaneously exactly on cue.

Practice with two flat sheets of paper, as well.

Magnets: If necessary, use a compass to mark the north and south ends/sides of two fairly strong magnets (For a tutorial, watch this video: <http://www.youtube.com/watch?v=wt1MiDRS-0g>.) Set up a non-metal tray or plate with a few paperclips.

Light: Create a black-light message: on any dark paper, write Genesis 1:3 from the CEB using glow-in-the-dark/fluorescent paint. Or use high quality black poster board and tonic water with quinine, though results may vary with this method.

Aerodynamics: Optional. Obtain ping pong balls and a multi-speed, multi-temperature electric blow dryer and fold a paper airplane.

Demonstrations:

Gravity: Ask learners if they have ever seen pictures or video of astronauts in space. Ask what they noticed about the astronauts in the pictures or videos. Explain that in orbit, the astronauts have no gravity to keep them held down, so they float, and so does everything

else that isn't tied or bolted down. Gravity is important because without it, we would float off the earth, earth wouldn't orbit the sun, and, in fact, the universe wouldn't even exist!

Ask for a couple of volunteers to come up and examine the two balls. What do they notice? How are the balls the same? How are they different? Ask the group what they think will happen if both balls are dropped at the same time from the same height: hit the ground at the same time or will one fall faster than the other? Why do they think that?

Ask the assistant to hold out his/her arms at shoulder height and drop the two balls on the word drop. Let everyone count down from three (3-2-1-DROP!). What happened? Repeat from the highest safe step of the ladder. Did the results change?

Ask two other volunteers to examine two identical sheets of paper. Then ask the learners what they think will happen when the paper is dropped like the balls were. Will the paper drop faster or slower or at the same rate? Try the drop from the ladder. Ask the learners what they observed and whether they want to change their guesses about the paper verses the balls. Tell them they can test their guesses in the lab later.

Magnets: Ask learners if they've ever heard the phrase *opposites attract*. If they have, ask if they have ideas about what it means (be prepared for relationship answers and for the scientific kind of answer, as well). Say that one of the cornerstones of physics is magnetism, which is a field or area around some kinds of materials and around electricity where other objects are repelled or attracted. Demonstrate the concept of the magnetic

field by holding one magnet over a single paperclip; the distance at which the magnet picks up the paperclip is where the magnetic field is strong enough to overcome gravity.

Tell the learners that every magnet has a north pole and a south pole. If no one knew before, ask if anyone can guess what *opposites attract* means now. Affirm the right answer if it is given. Show learners the north and south poles of two magnets, then bring the opposite ends together to show that indeed, opposites attract. Ask them to guess what will happen when south pole is matched to south pole if that has not yet been guessed, then demonstrate.

Say that magnets can make other things into magnets, too. Ask if anyone knows how; if so, allow the learner to demonstrate and assist as necessary. Otherwise, show that two paperclips are not magnetic at all by trying to pick them up with each other. Then use one magnet to stroke one paperclip in the same direction several times. Try to pick up the other paperclip. When it works, ask the learners to think about what they saw so that when they get to the lab, they can test their guesses about what happened.

Light: Hold up the prepared message page. Ask learners what they see. Tell them that there is a message hidden on the paper. Ask them if they can make some guesses about how to reveal the message. After a few suggestions, say that the message is only visible in a certain kind of light that our eyes do not perceive without extra help. Have the lights turned off and then turn on the black/UV light and bring it close enough to the page to reveal the words. Say that physics has helped to reveal something important about the way that God created the universe, and then read the message.



Aerodynamics: Optional. Plug in the blow dryer and turn it on to low speed and medium heat. Ask learners if they think that you can get a ball to float in the air stream. Test what they say. Ask if they think a different surface on the ball would affect the floating, and about speeds and temperatures. Tell them they will get to test their guesses in the lab.

Throw the paper airplane. Ask learners if they can think of things that would affect how far and how fast a paper airplane would fly. They will have a chance to test their guesses in the lab.

#### DAILY THEME SCRIPTURE

Read      Genesis 1:1-5 (Sophia should read all Scripture)

“When God began to create the heavens and the earth—<sup>2</sup>the earth was without shape or form, it was dark over the deep sea, and God’s wind swept over the waters—<sup>3</sup>God said, “Let there be light.” And so light appeared. <sup>4</sup>God saw how good the light was. God separated the light from the darkness. <sup>5</sup>God named the light Day and the darkness Night. There was evening and there was morning: the first day.”

Say      Just like Sophia told us, this passage tells that God was here before there was even a “here” to be in! Before God *began* to create the heavens, which is the ancient way of talking about the universe, and the earth, God was! God wrote all the rules that brought everything we experience into existence AND God’s rules gave us brains to use to help understand the rules so we can understand more about God. Sophia has been around since almost the beginning and she can help us gain wisdom today just like the people who

wrote the Bible long, long ago gained wisdom by listening to her. Sophia has helped human beings learn more and more about God's rules and about all of creation since the first human being began a sentence with the words, "I wonder..."

## I WONDER...

Say       What would you like to explore in the laboratory today? I have some ideas after our demonstrations. Maybe you have some others.

I wonder...what will happen when I drop a ball and a sheet of paper at the same time. I wonder...if I can change how fast something drops by changing its shape. I wonder...if I can do anything to keep objects from dropping. What do you wonder about gravity?

I wonder...why the paperclip acted like a magnet. I wonder...what other things can be made into magnets. I wonder...what are some things that are not magnetic at all. I wonder...if I can make things move with magnets. What do you wonder about magnets?

I wonder...what color the light I see really is. I wonder...if light bends. I wonder...if I can make light brighter. What do you wonder about light?

I wonder...if physics is important when I make ice cream. What do you wonder about ice cream?

I wonder...what kinds of balls would float best in a stream of air. I wonder if temperature or speed affects that. I wonder...what would make a paper airplane fly faster or farther. What do you wonder about the air around us?

We learn best when we record what we observe. While you're in the laboratory, make sure you write or draw pictures to help you remember what you experience so we can talk about it at the end.

## **Laboratory Time**

Prepare lab stations ahead of time:

Magnets: Set out a collection of magnets along with random objects that may or may not be magnetic. Include paper clips, coins, aluminum foil, and items made of cloth and plastic. If desired, include iron filings in a sealed non-metallic container.

“I Wonder...” statements printed and displayed with objects.

Gravity: Blow up several balloons. Set out ping pong balls, different weights of paper, blow driers, feathers/packing peanuts, and balloons. If necessary, designate someone to bring the ladder and the items from the demonstration to the lab area.

“I Wonder...” statements printed and displayed with objects.

Light: Set up as many different light bulbs as possible in lamp bases. Set out CDs and mirrors. Make sure that the white light lamp will fit inside the box with the light exposed on only one side; block any seams or holes in the box with black construction paper. Pull shades and curtains if necessary.

“I Wonder...” statements printed and displayed with objects.

Ice Cream: *At least one day ahead:* Prepare one quart bag by adding all the ingredients, but do not knead on ice. Label “not kneaded.” Prepare another and knead as directed. Label “kneaded”. Put both bags in a freezer.

*During regular set-up:* Set out measuring supplies, quart bags, and 2-3 permanent markers. Prepare 6-10 outer gallon bags by filling with ice and salt; set in freezer (if prepping more than an hour ahead) or cooler (within an hour).

“I wonder...” statements printed out for display.

Aerodynamics: Optional. Gather an assortment of lightweight plastic balls of different sizes and finishes (e.g., ping pong balls, practice golf balls, whiffle balls, etc.), regular letter-sized paper, and one or more multi-speed, multi-temperature electric blow dryers.

Lab Explorations:

Gravity: Have learners experiment and record their observations using the objects provided, guided by the “I wonder...” statements and whatever new statements they develop as they experiment. Drops can be done from any height. An adult learner can prompt ideas about using the blow dryers at various speeds and temperatures. Be sure that any climbing on the ladder is supervised and that the drop zone is clear of learners to avoid injuries.

Magnets: Have learners experiment and record their observations using the magnets and objects provided, guided by the “I wonder...” statements and whatever new statements they develop as they experiment.

Light: Note: this is best done in a big room that can be darkened almost completely; this is also best done as a guided experience rather than free exploration.

Say, “I wonder what color the light I see really is. What do you think?” When they answer, ask the learners if they are sure. Then say, “Let’s find out.”

Turn off all the room lights. Turn on the regular white incandescent light (or fluorescent/LED if incandescent is not available). Give each learner a CD. Ask them to hold their CDs up to the light and help them find the right angle to produce a rainbow.

Ask the learners what they observe. Explain that what we see as white light is actually the result of several different colors of light coming together. The CD is made with lasers that make the surface into a prism that breaks it up so we can see all the ingredients. Each color of light bends a little differently; the prism in the CD bends the light waves.

Ask them to speculate (make a hypothesis) about what the CD prism will reveal for another color light you have available. Then help them test their hypothesis. Were they right? Ask, “Why did you guess that way?” Were they wrong? Ask, “What have we learned that we can use to make another guess about the next light?” Then repeat the

prism work to either confirm the first results or test the second hypothesis. Repeat until all the lights have been tested or until a hypothesis has been confirmed three times (at which point they may be able to make a theory).

Try the black/UV light with the prism. What happens?

Turn off all the lights and let learners' eyes adjust to the darkness. Place the lamp with the white bulb into the box so that the light is blocked above and on the sides. Turn the light on.

Say, "I wonder if light bends. Could we get the light to shine on the ceiling or on the walls without moving the box? What do you think?" Let the learners answer and propose tests. Pass out the mirrors and give each learner a chance to play with bending the light.

Take the lamp out of the box. "I wonder if we can make this light brighter. What do you think?" Ask them to test their suggestions using the mirrors to bend the light toward the same place (a focal point). Does it work?

Ice Cream: Say, "We're making ice cream! Now why do you think that we're making ice cream in a physics laboratory?" Let learners speculate; then explain that making ice cream is all about energy. We have to take out all the energy that keeps the ingredients from freezing.

Take out the samples and let learners observe differences and similarities. Return to freezer. Explain that one was made using only one method to take energy out of the

ingredients, and that was just by freezing it in a regular freezer. The other one used two methods, kneading the mixture on super cold ice and then freezing it in a regular freezer. Both are ice cream, but one is much better looking, tasting, and feeling on our tongues. Can you guess which one is which? (Be sure to return the samples to the freezer after the demonstration for the next group; the one that was kneaded can be eaten during snack time.)

Assist learners to follow the directions below:

- 1) Write your name on a quart freezer bag in permanent marker
- 2) Measure 1/2 cup of half and half and pour into your bag
- 3) Measure 1/4 cup sugar and pour into your bag
- 4) Measure 1/8 teaspoon vanilla and pour into your bag
- 5) Measure 1/4 teaspoon salt and pour into your bag
- 6) Zip the bag closed carefully, getting as much air as possible out
- 7) Put your zipped bag into a bag of ice and zip the big bag closed with as little air as possible inside
- 8) Wrap the big bag in a thick towel and knead all over for at least five minutes; ten is better
- 9) Take the small bag out of the big bag, rinse it briefly in COLD water, wipe it dry, and put it in the freezer

Aerodynamics: Optional. Have learners experiment with different kinds of balls in different speeds and temperatures of air from the blow dryer and record their findings. Help them fold

paper airplanes (there will probably be an expert or two in the group to provide alternate models) and test their hypotheses.

## **Recreation**

**Play** Games that require movement (energy) such as “Red Light, Green Light,” “Simon Says,” or “Freeze Tag” continue the physics theme and can help learners refocus for the last part of the session.

Games that require observation such as “I Spy” or “Twenty Questions” continue the overall science theme and may appeal to a broader age or ability range among learners.

## **Snack Time**

**Bless** Follow the community’s tradition for blessing food, or ask for a volunteer to lead a prayer or sung grace.

**Serve** Each learner should get his/her ice cream and a choice of toppings. Ice cream can be eaten out of the bags, but it is best to put the bags in a bowl or to empty the bags into bowls. Note that the last group through the ice cream lab may have very soft-serve texture! (Send ice cream home if snack time is not offered.)

## **Laboratory Reports**

**Prepare** A poster board with the words, “How wonderful God’s laws are that...”

**Gather** All learners in a circle



Say        God wrote some pretty amazing rules that set the boundaries of our existence, and everything we see and touch and feel and smell and taste follows those rules. That's physics, like gravity and why the sky is blue and why a siren goes "WOOOOoooooo" as a fire engine goes by. We didn't even get to play with sound, did we? When God said, "Let there be light!" and the universe was born, it was physics in action. Every star in the universe runs on pretty simple physics not much different from God's first experiment.

Let's tell Sophia what wisdom we gained today. Sophia, can you come out? (Record the learners' observations while Sophia leads the discussion; this will be important for subsequent sessions.)

Sophia:    Tell me about gravity. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me about magnets. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me about light. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me about ice cream. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Does anyone who didn't speak have something they want to add?

I'm excited that humans have learned so much about the laws of the universe. The people I taught long ago could not have known what you know, so when they wrote down what I said, they could only tell what they understood. Let's start writing a new proverb now to show the wisdom you have gained. We will add to our proverb every day.

Find a partner to work with (encourage older learners to partner with younger ones who might not be able to write) and sit in the circle with your partner.

Pass out sticky notes and pencils.

Sophia: (Show poster board.) Let's start with, "How wonderful God's laws are that..." Now your job is to finish the sentence with something you've learned today.

Give the group about three minutes or watch for signs that pairs are done.

Sophia: Now let's share the first part of our new proverb. Together, we will read our board, and then each pair can read what you wrote. This will be like a chorus and a duet each time. We will start with (names) and go around. Ready?

Read        “How wonderful God’s laws are that...”

Response   Continue pattern until all partners have shared.

Sophia:    That was wonderful! You are very good writing partners. I will see you at the next session.

Say        Thank you, Sophia. Let’s collect what you wrote so we can have it for tomorrow. Can we sing our theme song one more time?

Sing        Chosen theme song

Say        Share announcements, thank learners for coming.

Pray        Benediction

## Day Two: Chemistry

Science Goal: Learners will be able to describe some ways in which chemicals react to create new substances by conducting and observing a series of experiments.

Faith Goal: Learners will describe how chemistry is part of the way that God created and is at work in the universe.

### **Daily Theme Time**

GATHERING SONGS

THEME SONG

REVIEW AND INTRODUCTION OF DAILY THEME

Prepare ahead:

Type out the responses to the proverb statement from the previous session and make copies for learners or otherwise have it available to read. It is not necessary to start every statement with “How wonderful God’s laws are that...” Also prepare a poster board with “God is an amazing chemist who...” for the laboratory reports time.

Say       Who remembers what Lady Wisdom said about the creation of the universe? (Elicit answers, correct or add as necessary.) We’re writing our own proverb about the science of God’s creation in this course. We started at the last session. Let’s ask Sophia to come and help us read the first part of our proverb.

Sophia   Hello, everyone! I’m glad to see you again. I really like what we’ve written so far. Let’s read it now.

Read Proverb

Sophia That's wonderful! I can tell that you are getting wiser already. I can't wait to help you with another part of our proverb later on. Enjoy your laboratory time!

Say Thank you, Sophia. She's right: you are getting wiser already. At our last session, you made guesses and did experiments to test your guesses, right? Well, that's part of the scientific method! When you make a guess, you are creating a hypothesis. Then you experiment to test your hypothesis, and when you find out whether your hypothesis was right or wrong, you can make new guesses to test. If you test and adjust your hypothesis often enough that you're sure your hypothesis is right, then you've created a theory. A theory is a law that explains scientifically how God works in the world. Understanding how to make a hypothesis, test it, fix it, and eventually get to a theory makes you very wise.

How many of you like math? (Show of hands). That's great. What if I told you that without math, none of us would be here? Would that help you like math more? How about fireworks? Fireworks don't work without math. Really!

Today, we're going to do math, but not the way you think. Everything we did in our physics lab has math behind it and you didn't even know you were doing math, did you? Today, we're going to do math in the form of chemistry. Chemistry is the science of how

the basic building blocks of the universe, which are created because of physics, go together to create everything that makes up the universe. Let's see some math in action.

## SCIENCE DEMONSTRATIONS AND INTRODUCTION OF CHEMISTRY

Prepare ahead:

Clear: In a quart jar, mix 1/4 cup iodine with 1 cup water. In a smaller jar, mix 1/4 cup chlorine bleach with 1 cup water.

Balloon: In an empty 2L bottle, mix 1/2 cup vinegar with 1 cup water. Blow up a balloon and deflate. Using a funnel, put 2 tablespoons baking soda into the balloon.

Demonstration:

Clear: Hold up the two jars and ask learners what they observe. Ask what they think will happen when the contents of the smaller jar (clear) are poured into the larger jar (reddish yellow). Why do they think that?

Pour the contents of the smaller jar into the larger jar and let everyone observe what happens. Did they guess right or wrong?

Explain that what happened was a chemical reaction between iodine, which is 2 atoms of the element iodine, and chlorine bleach, which is made of three atoms, one of sodium, one of chlorine, and one of oxygen. Iodine by itself is the red-yellow chemical, but when iodine is combined with other elements, it doesn't have the same color. When we mixed the iodine and the bleach, the iodine atoms split apart and each found a sodium atom

from the bleach to bond to. That left two chlorine atoms that bonded together and two oxygen atoms that bonded together. So we changed iodine and sodium hypochlorite into sodium iodide—which can be used as a medicine!—and chlorine, which we use in pools to keep them safe, and oxygen, which we breathe. And it's all math!

Optional Along with an exchange of energy, the math works out like this:  $I_2 + 2NaClO = 2NaI + Cl_2 + O_2$  (A molecule of 2 iodine atoms plus two molecules that each contain an atom of sodium, an atom of chlorine, and an atom of oxygen equals 2 molecules that each contain an atom of sodium and an atom of iodine plus a molecule that contains two chlorine atoms plus a molecule that contains two atoms of oxygen.)

Balloon: Put the 2L bottle and the balloon out for learners to observe. Ask them what they think will happen when the balloon is placed over the mouth of the bottle. Why?

Carefully stretch the mouth of the balloon over the mouth of the bottle without letting baking soda fall into the bottle. Were the learners right?

Without removing the balloon from the bottle, lift the balloon so the baking soda falls into the bottle. Hold the balloon to the bottle if necessary to keep the mess to a minimum (baking soda will go everywhere if the balloon escapes and deflates). Were their guesses right or wrong?

Explain that what they saw was a chemical reaction that converted vinegar, which is an acid, and baking soda, which is a base, into carbon dioxide gas, water, and sodium. Acids

and bases are opposites chemically; when mixed, most often a reaction happens that makes neutral chemicals like the carbon dioxide in the balloon and the water and sodium in the bottle. Vinegar has 2 carbon atoms, 4 hydrogen atoms, and 2 oxygen atoms. Baking soda has 1 sodium atom, 1 hydrogen atom, one carbon atom, and 3 oxygen atoms. The carbon dioxide gas inflated the balloon. The water and the sodium are left in the bottle. This is not a good way to get clean drinking water, by the way, since there's sodium floating around in it! You will have a chance to do this experiment in the laboratory a little later. When you do, hold on to the bottle to see what you observe about energy.

Optional    Along with an exchange of energy, the math works out like this:  $\text{C}_4\text{H}_2\text{O} + 16 \text{NaHCO}_3 = 20 \text{CO}_2 + 9 \text{H}_2\text{O} + 16 \text{Na}$  (One molecule that contains four carbon atoms, two hydrogen atoms, and an oxygen atom plus 16 molecules that each contain one sodium atom, one hydrogen atom, one carbon atom, and three oxygen atom equals 20 atoms that each contain one carbon atom and two oxygen atoms plus 9 molecules that each contain two hydrogen atoms and one oxygen atom, plus 16 sodium molecules that have just one sodium atom each.)

Note        Chemical equations provided were balanced using the calculator at <http://www.webqc.org/balance.php>.

#### DAILY THEME SCRIPTURE

Read        Numbers 11:7-9



“The manna was like coriander seed and its color was like resin. <sup>8</sup>The people would roam around and collect it and grind it with millstones or pound it in a mortar. Then they would boil it in pots and make it into cakes. It tasted like cakes baked in olive oil. <sup>9</sup>When the dew fell on the camp during the night, the manna would fall with it.”

Say        When the people of Israel were wandering in the desert, they did not have the means to raise animals to eat or to farm for crops. The Bible tells us that God provided manna to them. We don't know exactly what manna is, though scientists have identified some possible substances including sap from certain kinds of plants and honey-like secretions from insects. Whatever manna was, the story tells us that it sustained the people of Israel for a long time, which means it contained all the chemicals humans need to eat to stay strong and healthy, or at least enough of them that with the quail that the people were able to eat, they could survive.

Boiling gives us a clue that chemistry was involved in making it good to eat. That's because cooking is all about chemistry: what goes together well to taste good and give us what we need to stay strong and healthy, whether you take energy out of it by cooling it like we did the ice cream in the last session or add energy to it by heating it somehow, or sometimes just by mixing different things together. Chemistry does amazing things other than give us food, too. Chemistry gives us soap, toothpaste, paint, plaster, plastics, ceramics, gasoline, leather, and everything else. Including life...but we will talk about that in another session.

“I WONDER...”

Say        What would you like to explore in the laboratory tonight? I have some ideas. Maybe you have some others.

I wonder...what happens when we leave certain ingredients out. I wonder...what happens to turn cake batter into cupcakes. I wonder...if batter tastes different from a baked cake.

I wonder...if chemistry can tell us anything about how some kinds of rocks get made.

I wonder...if a chemical reaction can change the temperature of the ingredients. I wonder...if one part can be warmer and one part can be colder after the reaction than before.

I wonder...if you can lift an ice cube with a piece of thread. I wonder...if adding things will make it harder or easier to do.

I wonder...if regular glue can be changed into something else by adding ingredients. I wonder...if different ingredients and different methods can make glue into different things.

We learn best when we record what we observe. While you're in the laboratory, make sure you write or draw pictures to help you remember what you experience so we can talk about it at the end.

## Laboratory Time

Prepare ahead:

Cupcakes: Make several copies of the recipe (below). Assemble ingredients and tools. Note that the first two batters, made without baking powder and without salt, respectively, is the first activity for all lab groups together.

“I wonder...” statements printed out for display.

Geodes: Be sure that egg shells are clean and dry. If desired, have a station set up for painting the insides during part two of cupcakes; glow-in-the-dark or fluorescent paints work best. Set up a dry place for eggs to sit until the next session; if necessary, use a fan to speed up evaporation.

“I wonder...” statements printed out for display.

NOTE that for time management, the balloon and ice activities can be done at the same laboratory station.

Balloon: As above for the demonstration, mix vinegar solution and fill 6-10 2L bottles for each laboratory group if possible, or be prepared to rinse and refill bottles between groups. Fill 6-10 balloons per laboratory group with baking soda as above.

“I wonder...” statements printed out for display.

Ice Lift: Cut 12” lengths of regular sewing thread. Set out bowls for ice; dishes of salt, cinnamon, powdered sugar, and cocoa; and spoons.

“I wonder...” statements printed out for display.

Polymers: Assemble ingredients for each activity. Young learners will find it easier to measure powders from labeled open containers and to pour liquid starch from a smaller container. Prepare borax solution for bouncing balls if using.

“I wonder...” statements printed out for display.

Laboratory Explorations:

Cupcakes: DO PART ONE FIRST WITH THE ENTIRE GROUP.

#### PART ONE

Say Chemistry is important to food. Salt makes things taste better and baking powder provides lift and lightness to cakes, cookies, and things like pancakes. We’re going to make two batches of cupcakes, one without salt and one without baking powder, to compare them to the cupcakes we will make later for snack time (or to take home). We’ll add food coloring to make these two batches different from each other, and we’re going to make these as mini-cupcakes so everyone can try them.

Explain the recipe and ask for volunteers to help measure the ingredients for the batter, leaving out salt, while others prepare mini-cupcake pans. Finish the batter with other volunteers, adding food coloring before the final beating. Pour into prepared pans. Rinse

beaters and bowl or use another mixer and bowl, then prepare the batter without baking powder, using a different food color. Pour into prepared pans and bake; begin checking for doneness after 12 minutes (this will be while a group is making regular cupcakes; assign someone to track the time).

## PART TWO

Working with smaller groups, prepare cupcakes as directed. If the final group's cupcakes bake during recreation time, they may be too hot to eat during snack time. The recipe makes 12-18 cupcakes, so there should be plenty for the whole group. Allow group to taste unbaked batter from bowl and beaters (use pasteurized eggs if there are health concerns).

2 1/4 cups all-purpose flour

1 1/3 cups sugar

3 teaspoons baking powder

1/2 teaspoon salt

1/2 cup shortening (or softened margarine or softened butter)

1 cup milk

1 teaspoon vanilla

2 large eggs

Preheat oven to 350 degrees. Line cupcake pans with paper liners.

Combine flour, sugar, baking powder, and salt in a large mixing bowl. Add shortening, milk, and vanilla. Beat for 1 minute on medium speed. Scrape side of bowl with a spatula.

Add eggs to the mixture. Beat for 1 minute on medium speed. Scrape bowl again. Beat on high speed for 1 minute 30 seconds until well mixed.

Spoon cupcake batter into paper liners until 1/2 to 2/3 full.

Bake for 20 to 25 minutes or until toothpick inserted in center comes out clean.

Cool 5 minutes in pans then remove and place on wire racks to cool completely.

Once cupcakes are completely cooled, frost with your favorite frosting recipe or decorate as you desire.

### Geodes

At the end of part one of the cupcake lab, show learners the Epsom salt. Pour a little into an eggshell and ask learners what they think would happen if you tipped it over.

Demonstrate to check their answers. Explain that it is possible to make the salt stick to the eggshell in a way that creates bigger crystals, but first the salt has to be dissolved into water. Ask if they know the best way to dissolve salt in water. Pour the salt into a pot and add water. Turn heat on to medium. Explain that heat makes it possible for the salt and the water to mix thoroughly without causing a reaction. The ratio of water to salt is 2:1. This is important for the next step. Reserve a tablespoon of salt for comparison at the next session.

Watch the water-salt mixture; when it boils and the salt is completely dissolved, remove the pan from the heat and allow to cool, refrigerating if necessary to speed the process.

During part two of the cupcake lab, allow learners to paint eggshells, if desired. Label cups in egg cartons with learners' names and use as a container for the painted shells. Place in a dry room or in front of a fan until snack time.

During snack time (or as the final activity before learners leave), assist learners to fill their eggshells to about 3/4 full with saltwater solution; a spouted measuring cup or a pitcher will make this easier. Keep in a dry place to dry, with a fan running to expedite drying if the geology session is the next day.

Balloons: Remind learners what they observed in the demonstration. Ask them what hypotheses they came up with as they watched and remind them that they're to observe what happens to the liquid and to the gas as the reaction occurs.

Ice: Tell learners that their job is to lift an ice cube using a piece of thread. They have time to experiment with the thread and the different powders (tell learners what those powders are). Ask them if they have any hypotheses before they start.

Polymers: Explain that polymers are a kind of chemical molecule that create stretch and bounce. We can take every day things from the grocery store and mix them together to make polymers, but we have to be careful to follow the steps just right or things might not

work. Ask them what they think about the items that are set out and whether they think they will be making things that stretch or things that bounce. Why do they think that?

### *Silly Putty (Elastic)*

2 tablespoons white glue

1 tablespoon liquid starch

food coloring (optional)

Stir glue and any food coloring together in a bowl. Gradually mix the starch into the glue in a small bowl. More starch may be added if the mixture seems too sticky. Cover and refrigerate the putty when not in use. This putty can be pulled, twisted, or cut with scissors.

### *Slime (Elastic Polymer)*

2 ounces white glue

1/4 cup water

1/2 teaspoon borax powder

1/2 cup water

food coloring (optional)

In a cup, mix the glue with 1/4 cup of water. In a bowl, mix the borax powder with 1/2 cup of water and a few drops of food coloring. Slowly stir the glue mixture into the borax mixture. As slime forms, pull it out; there will be a lot of liquid left over after all the slime has formed. Knead the slime until it feels dry; the more you play with it, the drier it will get. Store in a plastic bag in the refrigerator.



### *Bouncing Ball (Polymers)*

1/2 teaspoon borax solution (below)

1 tablespoon cornstarch

1 tablespoon white or gel glue

food coloring (optional)

Measure cornstarch and place on a small plate. Pour glue into a cup. Stir in food coloring if desired. Add borax mixture and then the cornstarch. DO NOT STIR for 15 seconds.

Start stirring. Stop when you can't mix any more into the ball that forms and then dump the mixture into your hands. Knead and mold the ball until it isn't sticky any more. Keep your ball in a plastic bag in the refrigerator when you aren't playing with it.

Borax solution: Mix 1/2 cup water with 2 teaspoons borax powder. This will make about 24 bouncing balls using the recipe above.

## **Recreation**

Play Games that build groups mimic chemical reactions. "Red Rover, Red Rover" and "Snake Tag" expend pent-up energy and refocus learners for the laboratory report time. ("Snake Tag" is played by having those tagged by "It" make a line and follow the leader; only the head and tail of the line can tag other players.)

Games that require observation such as "I Spy" or "Twenty Questions" continue the overall science theme and may appeal to a broader age or ability range among learners.

## **Snack Time**

**Bless** Follow the community's tradition for blessing food, or ask for a volunteer to lead a prayer or sung grace.

**Serve** Each learner should get a mini-cupcake from each batch and a cupcake from the laboratory time. Frosting can be offered, if desired. Ask them to observe the similarities and differences among the regular cupcake and the two different mini-cupcakes. (Send cupcakes home if snack time is not offered.)

## **Laboratory Reports**

**Say** Chemistry shows us how things go together to make other things. We use chemistry every day to help make our water clean and safe to drink, to clean our clothes, to wash our bodies and our hair, and even to bake cookies and cakes!

Let's tell Sophia what wisdom we gained today. Sophia, can you come out? (Record the learners' observations while Sophia leads the discussion; this will be important for subsequent sessions.)

**Sophia** Tell me about chemistry in cooking. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me about chemical reactions and energy. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me about making polymers. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Does anyone who didn't speak have something they want to add?

I'm excited that humans have learned so much about chemistry and how important it is to everything that we have. The people I taught long ago could not have known what you know, so when they wrote down what I said, they could only tell what they understood. Let's add to our new proverb now to show the wisdom you have gained.

Find a partner to work with (encourage older learners to partner with younger ones who might not be able to write) and sit in the circle with your partner. You can choose the same person as the last session or someone new.

Pass out sticky notes and pencils.

Sophia: (Show poster board.) Let's start today with, "God is an amazing chemist who..." Now your job is to finish the sentence with something you've learned today.

Give the group about three minutes or watch for signs that pairs are done.

Sophia: Now let's share the next part of our new proverb. Together, we will read our board, and then each pair can read what you wrote just like we've done before. We will start with (names) and go around. Ready?

Read "God is an amazing chemist who..."

Response Continue pattern until all partners have shared.

Sophia: That was wonderful! You are very good writing partners. I will see you at the next session.

Say Thank you, Sophia. Let's collect what you wrote so we can have it for tomorrow. Can we sing our theme song one more time?

Sing Chosen theme song

Say Share announcements, thank learners for coming.

Pray Benediction

### Day Three: Geology

Science Goal: Learners will demonstrate and explain basic concepts of geology such as plate tectonics, volcanoes, earthquakes, and erosion.

Faith Goal: Learners will describe how God works in the world through the mechanics of geological change.

### **Daily Theme Time**

GATHERING SONGS

THEME SONG

REVIEW AND INTRODUCTION OF DAILY THEME

Prepare ahead:

Type out the responses to the proverb statement from the previous session and make copies for learners or otherwise have it available to read. It is not necessary to start every statement with “God is an amazing chemist who...” Also prepare a poster board with “God created the earth by...” for laboratory reports time.

Say       Who remembers what Lady Wisdom said about the creation of the universe? (Elicit answers, correct or add as necessary.) We’re writing our own proverb about the science of God’s creation in this course. We’ve worked on it for two sessions now. Let’s call Sophia out to help us read what we’ve written so far.

Sophia   Hello, everyone! I’m glad to see you again. I really like what we’ve written so far. Let’s read it now.

Read Proverb

Sophia That's wonderful! I can tell that you are getting wiser already. I can't wait to help you with another part of our proverb later on. Enjoy your laboratory time!

Say Thank you, Sophia. She's right: you are getting wiser every day. We've learned about making hypotheses by making good guesses about what we observe. We've learned to test those hypotheses to see if we're right or wrong, to make more guesses to make changes to our hypotheses or to create new ones entirely, and that once we've tested a hypothesis enough to know that we're getting the same results many times, we have enough to make a theory. Did you know that scientist keep testing theories even when they are almost positive that they're right? That's because every time we learn something new, we have to test what we find out to see if it fits what we knew before or if it makes us rethink what we knew before.

Geology is the study of planets, especially the earth. We'll talk a little more about astrogeology in our astronomy unit, but it's pretty neat that scientists who study the earth can use what they know about our planet to study the planets in our solar system and now planets that orbit other stars. A minute ago, I told you that sometimes scientists learn something new that makes them think about the theories to see if the theories have to be changed. Geology is one field of science in which scientists have had to adapt their theories because of new evidence. Once upon a time, scientists thought that the earth has looked the way it does since it was created. But as we began to get better maps, found more and more fossils—basically, those are remains of animals and plants that have

turned into rocks—and noticed patterns in the location of volcanoes and where earthquakes happened, the theory that earth is like it always was had to change. Let me show you what I mean.

## SCIENCE DEMONSTRATIONS AND INTRODUCTION OF GEOLOGY

Prepare Ahead:

Map Study: Print the two copies of a world map such as the one found at [www.printableworldmap.net](http://www.printableworldmap.net).

Visit the world earthquake record site, <http://earthquake.usgs.gov/earthquakes/dyfi/>, for a list of earthquakes in the past 24 hours and/or earthquakes felt in the past 7 days. Mark several of these events on one copy of the map, particularly those that occur along the coastlines of continents and that are close to your location.

The map at <http://www.scienceclarified.com/landforms/Ocean-Basins-to-Volcanoes/Volcano.html> provides a good picture of where the volcanoes of the world are and the site content is excellent background for this lesson. Mark several of the volcanoes on the other copy of the map. NOTE: If your group is large, consider making additional copies of each map to give learners a better view during the demonstration.

Fill a gallon zip-top bag about 2/3 full with water; color with food coloring if desired. Zip but do not press out air. Obtain a basin and a drinking straw.

Drift: Set up and test audio/visual equipment to show the time-lapse movie “Continental Drift.”

“I wonder...” statements printed out for display.

Demonstration:

Map Study:

- Say        Geologists study many things about the earth. Some specialize in studying earthquakes. Who can tell me what happens in an earthquake? Has anyone ever felt an earthquake? (Allow for answers.) The scientists who study earthquakes are called seismologists; the word seismic comes from a Greek word that means “to shake,” which is what the earth does during an earthquake. Seismologists have discovered some very interesting things about earthquakes in the past one hundred years.
- Show       Take a look at this map of the continents of the earth. I have marked some of the earthquakes that have been measured since we last met (24 hours, 7 days, etc.). What do you notice about them? What guesses can you make about the way the earth is, based on the pattern of earthquakes?
- Say        One of the other specialties within geology is the study of volcanoes. What is a volcano? Has anyone ever been to a volcano? (Allow for answers.) Scientists who study volcanoes are called vulcanologists, a word which comes from the name of the ancient Roman god of fire and metalworking, Vulcan. The English word volcano comes from the same word, actually. That gives us a clue about volcanoes, doesn't it? We know now that the earth has layers. We live on the top layer, called the crust, and underneath that is a layer of melted rock called the mantle. Volcanoes are places where the mantle comes through the crust. Watch this.



Show Show learners the prepared zip-top bag. Explain that the top of the bag is like the crust and the water inside is like the molten rock in the mantle. We can see that there's plenty of room for the mantle to move around. Some places on the earth have less free flow space between the crust and the mantle; let's see what happens when I let some air out of the bag. (Be sure to hold the bag over the basin! Open the bag a little and press some air out; reseal.) Press the bag and ask learners what they observe. Let's press more out. (Repeat.) What do you notice now? Let's try it one more time. (Press as much air as you can out of the bag and reseal, then press the bag.) What do you think would happen if we put this straw into the bag now? (Allow for answers.) Let's try it and see if you're right about your guesses. (Unzip the bag as little as possible; insert straw and zip as tight as possible to the straw.) Are you ready to see if you're right? Let's count down from three. Three-two-one, squeeze! Were the learners right or wrong about their guesses?

Show Let's look at another map of the world. I have marked several volcanoes on this map. What do you notice about this map? If we compare this map to the earthquake map, what do you observe? Can you make some guesses about what you see?

Drift:

Say When seismologists and geologists began to realize that earthquakes and volcanoes often happen in the same place, they began to make guesses about why. Their answers helped to explain observations made by other scientists about fossils, rocks, and other features that are similar along the coastlines of continents that are separated by thousands of miles

of oceans. Together, all these observations became the theory of continental drift, or plate tectonics. Let's watch a video that explains how it works.

Show "Continental Drift" video.

Say What did you observe in the video?

#### DAILY THEME SCRIPTURE

Read Genesis 1:9-10

"God said, "Let the waters under the sky come together into one place so that the dry land can appear." And that's what happened. <sup>10</sup>God named the dry land Earth, and he named the gathered waters Seas. God saw how good it was."

Say We know now what the people who wrote the Bible could not have known: it took a whole lot longer than six days for God to create the earth and everything on it. We also know that the surface of the earth has changed many times in the billions of years since it was created. Places that are dry land now were often under water at some point in history, and we know that many places which are under water now were once dry land. To the best of what we know now, there was never a time that the whole surface of the earth was under water. But good observations and new knowledge might someday tell us we're wrong, and that would be okay, because science is designed to change. God sees how good it is, and wants us to keep working to learn more.

“I WONDER...”

Say        What would you like to explore in the laboratory tonight? I have some ideas. Maybe you have some others.

I wonder...what continental drift can tell us about the earth's past. I wonder...if the continents are moving together or apart today. I wonder...if continental drift can tell us more about features of the earth.

I wonder...what happens when water and land meet. I wonder...how rivers change the features of the earth. I wonder...how much of the earth is covered by the oceans.

I wonder...what happens to buildings of different kinds and designs during earthquakes of different kinds. I wonder...if buildings can be strong enough to survive big earthquakes. (Normal: plates pull apart; thrust: plates push together; strike-slip: plates slide past each other)

I wonder...if chemistry can tell us anything about how some kinds of rocks get made.

We learn best when we record what we observe. While you're in the laboratory, make sure you write or draw pictures to help you remember what you experience so we can talk about it at the end.

## Laboratory Time

Prepare ahead:

Drift: Print copies of the world map for every learner. Set out scissors and, if desired, markers or crayons.

Erosion: Sift a little cocoa into several cups of flour. Fill 9"x13" pans with flour-cocoa mixture to a depth of about 3/4". Pile flour to one short end of each pan, leaving part of the other end as bare as possible. Scatter sugar cubes and assorted beads into flour. Set out measuring cups or pitchers and fill with water; each pan will take a quart or a little more of water.

NOTE: Prepare enough pans for every three learners if possible ahead of time, or be prepared to refill pans between groups. The contents will be messy.

"I wonder..." statements printed out for display.

Earthquake: Set up two tables side by side that are light enough to be moved by one person each. Set out building supplies: dry spaghetti and gumdrops or marshmallows (make a sample building using gumdrops to secure spaghetti at corners), building blocks, interlocking blocks, and construction toys if using.

"I wonder..." statements printed out for display.

Geodes: If learners painted their eggshells before the salt solution was added, have a black/UV light available. Place egg cartons under a light source to facilitate evaporation and to aid glowing (note that learners should not take their geodes home from this session if any liquid remains in their eggs). Have reserved salt available.

#### Laboratory Explorations:

Drift: Invite learners to cut out the continents and to play with the pieces as though they are puzzle pieces. What do they notice? Have them put the continents back in place. What happens if North America and South America move away from Europe and Africa? Can you make some guesses about what happens when continents collide? When they move apart? What land features might be made when collisions or separations happen?

Erosion: Ask learners to pick a partner. Give each pair a pan of flour. Have them observe the pans of flour and make some guesses about what might happen when water is added in various places and at various speeds. What will happen to the beads?

Allow them to conduct experiments to test their hypotheses by pouring water according to their guesses.

Did pair's pan develop a canyon? A river? A lake? What happened to the beads? This is very much like the way that water works on earth. Rivers carve canyons and flow into lakes and oceans. The sugar cubes and beads are like rocks which are carried by moving water. What happened to the sugar cubes? The beads? The sugar cubes are like some kinds of rock that are soft enough for water to wear away, or erode, easily. The beads are like other kinds of rock that are much harder.

Earthquake: Invite learners to look at the different construction materials and choose one kind with which to make a building, working in pairs or trios. The object is to build as tall a building as possible in two minutes and have it as strong as possible to withstand different kinds of earthquakes. Time learners.

When two minutes have passed, help learners move their buildings to the joint of the tables.

Explain that this is going to mimic a “normal” earthquake. Two plates pull away from each other across a fault line, which is where they meet. Ask for two volunteers and position one in the middle of the outside of each table. Ask the other learners to observe what happens to their buildings. Then cue the volunteers to pull the tables away from each other very gently about an inch.

What did the learners observe? Push the tables back together. Give each one a chance to rebuild or repair the building. Ask someone on the left table to push the table as hard as he/she can toward the right table and the other to hold the right table in place. This mimics a thrust fault (note that in a real thrust fault, the two plates push into each other; this is one-sided for safety). What happened to their buildings?

Again, give teams time to repair their buildings. Ask for two volunteer to stand at opposite ends of the tables. One volunteer should to pull the right table and the other the left table toward themselves about one inch each to mimic a strike-slip fault earthquake. Again, observe what happens.

Did any building survive all three earthquakes? What kind of construction did better? What does this tell you about the kinds of buildings that should be built in earthquake zones? How do you think earthquakes might have played a part in the way the world looks today?

Geodes: Ask learners to make initial observations about what they see. Darken the lights and turn on the UV light or allow learners to observe the glow. What do they think happened? How different does the salt look now than it did before it was dissolved in the water? Real geodes form when rocks are hollow and can let water with minerals in. The water leaks back out or evaporates, just as the water in the eggshells evaporated, and the minerals are left behind. (If there is time and interest, the slideshow at <http://scienceline.org/2012/11/where-do-geodes-come-from/> is excellent, or arrange to borrow a geode to show if possible.)

## **Recreation**

**Play** If a hill is available, “Monarch of the Hill” (a.k.a. “King of the Hill”) fits the theme. A cooperative game to build a bridge over a “river” and get everyone in the group over it also fits the theme. Either would help learners expend energy and be ready for the Laboratory Reports time.

Games that require observation such as “I Spy” or “Twenty Questions” continue the overall science theme and may appeal to a broader age or ability range among learners.

## Snack Time

- Bless** Follow the community's tradition for blessing food, or ask for a volunteer to lead a prayer or sung grace.
- Serve** Any layered salad or dessert fits the theme of the session. Suggestions include "Dirt" and gelatin wigglers with gummy critters embedded. (Snack time is optional.)

## Laboratory Reports

- Say** Let's tell Sophia what wisdom we gained today. Sophia, can you come out? (Record the learners' observations while Sophia leads the discussion; this will be important for subsequent sessions.)
- Sophia** Tell me what you learned about the way that continents move on the earth's surface. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?
- Tell me what you learned about erosion and the way that water has shaped the surface of the earth. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?
- Tell me what you learned about earthquakes. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?



Does anyone who didn't speak have something they want to add?

I'm excited that humans have learned so much about geology and how important it is to everything that we have. The people I taught long ago could not have known what you know, so when they wrote down what I said, they could only tell what they understood. Let's add to our new proverb now to show the wisdom you have gained.

Find a partner to work with (encourage older learners to partner with younger ones who might not be able to write) and sit in the circle with your partner. You can choose the same person as the last session or someone new.

Pass out sticky notes and pencils.

Sophia: (Show poster board.) Let's start today with, "God created the earth by..." Now your job is to finish the sentence with something you've learned today.

Give the group about three minutes or watch for signs that pairs are done.

Sophia: Now let's share this part of our new proverb. Together, we will read our board, and then each pair can read what you wrote. This will be like a chorus and a duet each time. We will start with (names) and go around. Ready?

Read "God created the earth by..."

Response Continue pattern until all partners have shared.

Sophia: That was wonderful! You are very good writing partners. I will see you at the next session.

Say Thank you, Sophia. Let's collect what you wrote so we can have it for tomorrow. Can we sing our theme song one more time?

Sing Chosen theme song

Say Share announcements, thank learners for coming.

Pray Benediction

## Day Four: Biology

Science Goal: Learners will be able to articulate a basic understanding of DNA and how DNA pervades life on earth in all its diversity because of evolution.

Faith Goal: Learners will describe how God nurtures and encourages life to thrive by adapting to changes over time.

### **Daily Theme Time**

GATHERING SONGS

THEME SONG

REVIEW AND INTRODUCTION OF DAILY THEME

Prepare ahead:

Type out the responses to the proverb statement from the previous session and make copies for learners or otherwise have it available to read. It is not necessary to start every statement with “God created the earth by...” Also prepare a poster board with “God connected all life on earth by...” for laboratory reports time.

Say       Who remembers what Lady Wisdom said about the creation of the universe? (Elicit answers, correct or add as necessary.) We’re writing our own proverb about the science of God’s creation in this course. We’ve worked on it for three sessions now. Let’s call Sophia out to help us read what we’ve written so far.

Sophia   Hello, everyone! I’m glad to see you again. I really like what we’ve written so far. Let’s read the whole thing now.

Read Proverb

Sophia It's getting pretty long, isn't it? That's because you're getting wiser with every session. I can't wait to help you with another part of our proverb later on. Enjoy your laboratory time!

Say Thank you, Sophia. She's right: you are getting wiser every session. We've learned about making hypotheses by making good guesses about what we observe. We've learned to test those hypotheses to see if we're right or wrong, to make more guesses to make changes to our hypotheses or to create new ones entirely, and that once we've tested a hypothesis enough to know that we're getting the same results many times, we have enough to make a theory. We've learned that scientists learn from each other and that sometimes things which seem like they have no connection at all are parts of the same puzzle. Today, we're going to learn about another gigantic piece of the science puzzle, and that's life, which is the subject of biology. "Bio" means life. There is a lot of life on earth and it's all connected!

## SCIENCE DEMONSTRATIONS AND INTRODUCTION OF BIOLOGY

### Background for DNA and Amino Acids

DNA is found in every life form on earth. The basic construction of DNA is a "double helix" of paired nucleic acids that form a ladder-like structure. DNA has four nucleic acids that can only be paired in two ways, though the order does not matter. The nucleic acid pairs are

Adenine and Thymine: A+T/T+A only (Color coded as blue+yellow or yellow+blue in most models, sometimes as purple+orange/orange+purple)

Guanine and Cytosine G+C/C+G only (Almost always coded as green+red or red+green)

DNA is essential because it provides the building blocks for amino acids, which in turn make proteins. The DNA double helix is first split down the middle, then each side is transcribed into RNA (which is a critical step but it is not necessary to understand the details for this very basic demonstration of the concept; see “Additional Resources” for the “Crash Course” tutorials if desired) and then translated into amino acids by the reading of three-letter groups called codons. Those amino acids then form proteins by bonding together in chains, helices, and other structures. For a relatively easy tutorial, follow this link: <http://www.dnatutorial.com/index.shtml>.

### Recipe Key

A (Blue) = measurements / T (Yellow) = measured components

G (Green) = actions / C (Red) = descriptions and utensils

### Prepare ahead:

DNA: Easy Cupcakes with steps as DNA nucleic acids. Using 4 colors of paper, write/print out directions on one side of page. Fold and number each pair on the back, e.g., “preheat” on green is 1A, “oven to” on red is 1B; “350” on blue is 2A, “degrees” on yellow is 2B, etc. These are the cards for the exercise.

1A. (G) Preheat	1B. (R) oven to	2A. (B) 350	2B. (Y) degrees.
3A. (G) Line	3B. (R) cupcake pans with paper liners.	4A. (R) In a large mixing bowl,	4B. (G) combine
5A. (B) 2 ¼ cups	5B. (Y) all-purpose flour,	6A. (Y) sugar,	6B. (B) 1 ⅓ cups
7A. (B) 3 teaspoons	7B. (Y) baking powder,	8A. (B) ½ teaspoon	8B. (Y) salt
9A. (R) To the same bowl,	9B. (G) add	10A. (B) ½ cup	10B. (Y) shortening,
11A. (Y) milk,	11B. (B) 1 cup	12A. (B) 1 teaspoon	12B. (Y) vanilla.
13A. (R) on medium speed	13B. (G) beat	14A. (B) 1	14B. (Y) minute.
15A. (G) Scrape	15B. (R) side of bowl with a spatula.	16A. (R) To the mixture	16B. (G) add
17A. (B) 2	17B. (Y) eggs	18A. (R) on medium speed	18B. (G) beat for
19A. (B) 1	19B. (Y) minute	20A. (G) Scrape	20B. (R) bowl.
21A. (G) Beat	21B. (R) on high speed until well mixed,	22A. (B) 90	22B. (Y) seconds
23A. (G) Spoon	23B. (R) into paper liners.	24A. (G) Bake	24B. (R) until toothpick inserted in center comes out clean
25A. (B) 20 to 25	25B. (Y) minutes	26A. (G) Cool	26B. (R) in pans
27A. (B) 5	27B. (Y) minutes		

Amino Acids (Optional): Make signs for each of the 18 amino acid groups (codons) in Table 1, using the letters and the amino acid name (e.g., GAG Glutamic Acid); there are duplicates in this section. Also make a sign for each codon in Table 2 below and group by acid. [There are 20 amino acids made using 61 3-letter combinations plus a stop code that can be made using any of 3 3-letter combinations.] Print Table 3 and Table 4 in color or color code them.

TABLE 1 DNA Nucleotides by Color to Amino Acid Codons				
Step	Left A	Nucleic Acid	Right B	Nucleic Acid
1	Green	AGA Arginine	Yellow	TCT Serine
2	Blue		Red	
3	Green		Yellow	
4	Red	CAT Glutamic Acid	Green	GTA Valine
5	Blue		Yellow	
6	Yellow		Blue	
7	Blue	AAC Asparagine	Yellow	TTG Leucine
8	Blue		Yellow	
9	Red		Green	
10	Blue	ATA Isoleucine	Yellow	TAT Tyrosine
11	Yellow		Blue	
12	Blue		Yellow	
13	Red	CAG Glutamine	Green	GTC Valine
14	Blue		Yellow	
15	Green		Red	
16	Red	CAC Histidine	Green	GTG Valine
17	Blue		Yellow	
18	Red		Green	
19	Blue	AGG Arginine	Yellow	TCC Serine
20	Green		Red	
21	Green		Red	
22	Blue	AGG Arginine	Yellow	TCC Serine
23	Green		Red	
24	Green		Red	
25	Blue	AGA Arginine	Yellow	TCT Serine
26	Green		Red	
27	Blue		Yellow	
1	Green	AGA Arginine	Yellow	TCT Serine
2	Blue		Red	
3	Green		Yellow	

Steps 1-3 repeated to show how the DNA sequence would repeat with no stop codon in the strand.

NOTE: When DNA is “unzipped”, Thymine (T) is replaced by Uracil (U), so the amino acid

“recipes” are often written with “U” instead of “T”. You can see this in action in a codon wheel, like the one found at

[https://rbssbiology11ilos.wikispaces.com/file/view/codon\\_wheel.jpg/303524714/codon\\_wheel.jpg](https://rbssbiology11ilos.wikispaces.com/file/view/codon_wheel.jpg/303524714/codon_wheel.jpg). The center grid is the first letter, the middle ring is the second letter, and the outer ring is the third letter in each codon.

TABLE 2 Additional Amino Acid Codons					
Amino Acid	Nucleic Acid Grouping	Amino Acid	Nucleic Acid Grouping	Amino Acid	Nucleic Acid Grouping
Aspartic Acid	GAC	Aspartic Acid	GAT	Glycine	GCG
Aspartic Acid	GAT	Aspartic Acid	GAC	Glycine	GGC
Histidine	CAT	Glutamic Acid	GAG	Glycine	GGT
Isoleucine	ATC	Glutamic Acid	GAA	Glycine	GCA
Isoleucine	ATT	Phenylalanine	TTT	Alanine	GCG
Leucine	CTT	Phenylalanine	TTC	Alanine	GCC
Leucine	CTA	Cysteine	TGT	Alanine	GCT
Leucine	TTA	Cysteine	TGC	Alanine	GCA
Leucine	CTC	Asparagine	AAT	Methionine	ATG
Lysine	AAA	Lysine	AAG	Threonine	ACC
Proline	CCG	Valine	GTT	Threonine	ACT
Proline	CCC	Glutamine	CAA	Threonine	ACG
Proline	CCA	Tryptophan	TGG	Threonine	ACA
Proline	CCT	Tyrosine	TAC		
Serine	TCG	Arginine	CGG		
Serine	TCA	Arginine	CGC	Stop Codon	TAG
Serine	AGC	Arginine	CGA	Stop Codon	TGA
Serine	AGT	Arginine	CGT	Stop Codon	TAA



TABLE 3: Left DNA Strand Replication Errors					
Step	Green G	Red C	Blue A	Yellow T	Amino Acid
1	Preheat				AGA Arginine
2			350		
3	Line				
4		In a large bowl			CAT Glutamine
5			2 1/4		
6				sugar	
7			3 teaspoons		AAC Asparagine
8			1/2 teaspoon		
9		To the same bowl			
10			1/2 cup		ATA Isoleucine
11				milk	
12			1 teaspoon		
13		On medium speed			CAG Glutamine
14			1		
15	Scrape				
16		To the mixture			CAC Histidine
17			2		
18		On medium speed			
19			1		AGG Arginine
20	Scrape				
21	Beat				
22			90		AGC Serine
23	Spoon				
24		Until toothpick...			
25			20 to 25		AAG Lysine
25			20 to 25		
26	Cool				
27			5		See Table 4!

TABLE 4: Amino Acid Changes Resulting from Left Strand Replication Errors					
Step	Green G	Red C	Blue A	Yellow T	Amino Acid
27			5		AGA Arginine
1	Preheat				
2			350		
3	Line				CAT Glutamic Acid
4		In a large bowl			
5			2 1/4		
6				sugar	TAA Stop Codon
7			3 teaspoons		
8			1/2 teaspoon		
This strand of DNA will stop producing amino acids here because of the stop codon. If it had been a codon for another amino acid, then the DNA would continue making amino acids, but note the differences from the original!					
9		To the same bowl			CAT Glutamic Acid
10			1/2 cup		
11				milk	
12			1 teaspoon		CAA Glutamic Acid
13		On medium speed			
14			1		
15	Scrape				GCA Glycine
16		To the mixture			
17			2		
18		On medium speed			CGA Arginine
19			1		
20	Scrape				
21	Beat				GAG Glutamic Acid
22			90		
23	Spoon				
24		Until toothpick...			CAA Glutamic Acid
25			20 to 25		
25			20 to 25		
26	Cool				GAG Glutamic Acid
27			5		
1	Preheat				
2			350		AGT Serine
3	Line				
4		In a large bowl			

## Demonstrations:

### DNA:

Part 1: Hand out cards to as many learners as possible and ask learners to find a partner whose card is a different color. Make a double line of partners and, starting from the front, have each pair read what's inside, left-right, left-right. What do they notice?

Part 2: Ask each learner to find a partner with a complementary color, so that reds and greens are together and blues and yellows are together. Form the double line again and read pairs left-right, left-right. Can they make any guesses yet?

Part 3: If learners have not already seen the numbers and letters on the outside, point them out and ask 1A to find 1B. When all the pairs are matched, ask the pairs to line up again with all the As on the left and all the Bs on the right (if there are not enough learners to use every card, place unclaimed cards on the floor in order). Now read what's inside, left-right, left-right down the line, stopping every three pairs to ask if anyone knows what's happening. As soon as someone recognizes that this is the cupcake recipe, move to the explanation of DNA. If you are doing the Amino Acid demonstration, have them remain standing, otherwise, they can sit down.

Say DNA has only four ingredients. These are chemicals called nucleic acids and they can only pair one way: adenine can only go with thymine and guanine can only go with cytosine. When scientists draw DNA, adenine is blue and thymine is yellow. Guanine is green, which is the easy one to remember because both words start with "g", and cytosine is red. That's why when we put the recipe in order, yellow only went with blue and green

only went with red. The really cool thing about DNA is that the pairs can mix and match in many different ways, so that you might have a bunch of red-green pairs in a row, followed by a blue-yellow pair and then a yellow-blue pair and then a green-red pair, or some other combination. The way these pairs line up is critical to making every living thing, whether it's a mushroom, a flower, a tree, an insect, a snake, or even a person like you or me. Every living thing has DNA. DNA is God's basic recipe for life!

### Amino Acids (Optional)

Say        We used the recipe for cupcakes to get something really good to eat the other night. DNA is the basic recipe for life, but if that's all we had, we would just be spirals of stuff hanging out in space. Pretty weird, right? God did something truly amazing using DNA: from DNA, we get all the ingredients to make life as small as microscopic plankton in the sea and as big as elephants on land. Those ingredients are called amino acids. Let's see how DNA becomes amino acids.

The first thing that happens to make DNA into amino acids is that the pairs get split up, kind of like a zipper unzipping. This makes two separate DNA sequences.

Do        Walk between the A and B sides of the line of pairs and have them move about 3 feet apart.

Say        Then, each side of the zipper—each sequence—gets broken into groups of three (1-2-3, 4-5-6, etc., on each side. Each group of three will be an amino acid or a stop code.) The first group on the left is blue-green-blue, or A-G-A, which makes arginine (give group

- the sign). The next group is red-blue-yellow, or C-A-T, to make glutamic acid. Each of these three letter groups is called a codon.
- Do Finish the left groups, then do the right groups.
- Say The amino acids along each side of our DNA work together to make proteins, which make all the different parts of living things. We stopped with nine codons on each side, but DNA can go on for hundreds or even thousands of codons, building and building and building proteins.
- Do Ask the common amino acids to stand together (serine 4x, valine 3x, arginine 4x). Six others appear only once each: glutamic acid, glutamine, asparagine, leucine, isoleucine, tyrosine, and histidine.
- Say In our DNA, we made 10 amino acids! Let's look for a minute at the letter groups, for those of you that are grouped with others. Do you have the same letters? (Valine has 3 different codons in our DNA; hand this group the additional valine sign from Table 2. Serine and arginine both have 2 different codons in our cupcake; hand the groups the additional 4 codons each from Table 2.)
- Say There are 10 other amino acids, though, and all of them are important.
- Do Show each acid and say how many codons can make that acid.

Say Remember that I said that DNA can go on making proteins for thousands of amino acid groups? That means this left side sequence will just keep repeating and this right side sequence will just keep repeating. If I tell you that there are codons left over (show the stop group pile) which are very, very important, can you make a guess about what those three codons might do? (Ask for some guesses; after a moment or if you get a close or correct guess, go on.) These are stop groups, and these three codons act just like a stop sign to tell the amino acid chains to stop making proteins.

Say Think back to when we first put red and green together and blue and yellow together. We didn't have a very clear recipe, did we? Do you think we could have made our amino acids? Would they be the same or different? How much would it matter? In the amazing way that God works, it matters a great deal!

You see, when cells multiply, the DNA gets copied, too, but sometimes the copy gets messed up. Sometimes, a red-green pair flips over, or a yellow-blue pair gets copied twice. If we copied the instructions to bake the cupcakes for 20-25 minutes so that it said to do that twice, it would really mess up our cupcakes, wouldn't it? They'd be burnt! Let's see what happens to our DNA and our amino acids if there's a mistake in copying our cupcake recipe.

Show Table 3 with the duplication of step 25 and the swap in step 26. Note that now step 27 is just hanging there, so it then becomes part of the next group of three on the repeat.

Show Table 4 where steps 27, 1, and 2 form a new codon.

Say        We can see where the DNA has changed, or mutated. There's now a stop codon here at the fourth group! This means that whatever this strand of DNA was supposed to do can't happen the way it did before. Sometimes, the new combination of amino acids causes real problems; if the protein isn't made, the cell might die or it might not be able to do its job. Sometimes, it doesn't matter. Sometimes, the change gives the life form an advantage to survive in its environment. When an error or change in the DNA gives an individual plant or animal an advantage over others like it, that change is likely to be passed on to its children and grandchildren, who will often have that same advantage. We can trace changes in DNA to see how plants and animals that seem very, very different from each other are really very much alike because they share the same DNA change from a very, very long time ago. That's evolution, and it's how God created life to adapt to changing conditions so no matter what happens, there will always be life in God's universe!

#### DAILY THEME SCRIPTURE

Read        Genesis 1:11-13, 20-26

“<sup>11</sup>God said, “Let the earth grow plant life: plants yielding seeds and fruit trees bearing fruit with seeds inside it, each according to its kind throughout the earth.” And that's what happened. <sup>12</sup>The earth produced plant life: plants yielding seeds, each according to its kind, and trees bearing fruit with seeds inside it, each according to its kind. God saw how good it was. <sup>13</sup>There was evening and there was morning: the third day.

“<sup>20</sup>God said, “Let the waters swarm with living things, and let birds fly above the earth up in the dome of the sky.” <sup>21</sup>God created the great sea animals and all the tiny living things that swarm in the waters, each according to its kind, and all the winged birds, each according to its kind. God

saw how good it was. <sup>22</sup>Then God blessed them: “Be fertile and multiply and fill the waters in the seas, and let the birds multiply on the earth.” <sup>23</sup>There was evening and there was morning: the fifth day. <sup>24</sup>God said, “Let the earth produce every kind of living thing: livestock, crawling things, and wildlife.” And that’s what happened. <sup>25</sup>God made every kind of wildlife, every kind of livestock, and every kind of creature that crawls on the ground. God saw how good it was. <sup>26</sup>Then God said, “Let us make humanity in our image to resemble us so that they may take charge of the fish of the sea, the birds in the sky, the livestock, all the earth, and all the crawling things on earth.”

Say        People a long time ago knew that God is responsible for the creation of all life. They may even have gotten the order right, at least of plants and then animals. Scientists today think that plant life came before animal life, according to all the evidence we have now, but that evidence also tells us that animal life probably began in the sea and then found its way to land and into the air. The people who wrote the Bible had no way of knowing about DNA or amino acids or proteins and they certainly couldn’t have known that plants and animals share DNA. We know now that the world wasn’t made in six days, though we know that God made it happen!

“I WONDER...”

Say        What would you like to explore in the laboratory tonight? I have some ideas. Maybe you have some others.

I wonder...how many different kinds of life humans have discovered. I wonder...how we know if something that is alive is a plant, an animal, or something else.



I wonder...how many different kinds of life live close by. I wonder...how many life forms are animals and how many are plants. I wonder...how many different kinds of insects are around.

I wonder...how plants that are very different might be related. I wonder...how animals that are very different might be related. I wonder...how we can make guesses about life from a long time ago by studying life today.

We learn best when we record what we observe. While you're in the laboratory, make sure you write or draw pictures to help you remember what you experience so we can talk about it at the end.

## **Laboratory Time**

Prepare ahead:

Nature Walk: Gather blank paper and pencils for learners. Determine a safe, accessible place for the group to go to, explore, and return from in about 20 minutes. Note that this is for the entire group to do first before the other laboratory stations.

“I wonder...” statements printed out to read and for reference.

Life's Sorting Hat: Make separate poster boards labeled BACTERIA, PROTOZOA, CHROMISTA, PLANTS, FUNGI, and ANIMALS. Hang in the laboratory space. Download and print

the suggested pictures or search for similar one for the Bacteria, Protozoa, and Chromista pages.

**Optional** If a microscope is available, obtain prepared slides of examples of bacteria, protozoa, and chromista if possible.

“I wonder...” statements printed out for display.

Seeds and Feet: Gather assorted stone fruits (cherries, apricots, peaches, nectarines), berries (strawberries and raspberries), and roses (wild or cultivated), as many with stems and leaves as possible. Also, gather some almonds. Print out suggested or found photos of a clam, a squid, a snail, an ant, a lobster, a chimpanzee, and a chicken foot. Print the photo of the dinosaur footprint.

“I wonder...” statements printed out for display.

Laboratory Explorations:

Nature Walk: Set whatever ground rules are necessary to get the entire group to the destination safely. When the group reaches the destination, explain that each learner is to find as many kinds of life as possible and write down or draw what is observed. Hand out paper and pencils to every learner and allow them to explore for the set time. Point out hard to see types of life such as fungi, algae, and small insects and spiders. Walk back safely. Divide the group into two groups and send one to the Sorting Hat lab station with their

worksheets. Ask a youth or adult member of the other group to collect and hold on to the worksheets until that group goes to the Sorting Hat.

Life's Sorting Hat: Explain that the six boards represent six different kinds of life that all have at least one thing in common: DNA. Record answers on each board as learners share (tape Bacteria, Protozoa, and Chromista printouts in place of a list).

Say All life has to have a way to contain DNA. The most basic container is a cell. Some kinds of life are like a big play room where DNA and other parts of the cell like mitochondria hang out all together. Other kinds of life have a separate smaller room for DNA, called the nucleus, and rooms for other parts including mitochondria. We can separate life into different categories starting with that small difference.

BACTERIA are almost all too small to see without a microscope and have only one single cell, though they often form colonies in places that are good for them to live. Bacteria don't have DNA inside a nucleus. You may have heard of some things that bacteria do. If you like to cook, you have to be careful to wash your hands, your counters, and all your knives and things between cutting raw meat and cutting other things because of bacteria called *Salmonella* and *Escherichia coli*. Has anybody ever had strep throat? That's caused by some kinds of *Streptococcus* bacteria. Not all bacteria are bad, though. If you like yogurt, you can thank bacteria called *Lactobacillus* AND a bacteria called *Streptococcus thermophilus*. That's also one of the bacteria that makes cheese!

PROTOZOA are also too small to see and are also single-celled organisms. Protozoa are usually larger than bacteria and DNA is contained inside a nucleus in a protozoa. Some have little tails that move like whips; this group is called flagellates after the flagella. Some have things that look a bit like hair to help them move; the hair-like things are called cilia, giving this group the name ciliates. Another group makes a foot-like extension called a pseudopod, or false foot. Protozoa also have something like a stomach and they mostly eat bacteria, which is generally good for us. But some protozoa cause diseases in humans. The protozoa infection that kills the most people around the world is malaria; humans can get a protozoa infection called toxoplasmosis from cats.

CHROMISTA take their name from the fact that most of them are brown or yellow in color and the word color in Greek is “chrome.” This huge group of life includes microscopic single-celled organisms and huge strands of kelp or seaweed longer than a football field. You might have chromista growing in your house in damp corners in the form of mildew. And it’s very likely that your toothpaste and your favorite ice cream from the store is made with chemicals made from chromista, too, because these chemicals help make toothpaste pasty and ice cream creamy. Every time you use chalk, thank a chromista! When they die, their skeletons often form layers of calcium carbonate, which is chalk. Do you think you saw anything on your nature walk that might be a chromista? (For the purposes of this exercise, any yellow or brown algae/fungus on sidewalks, walls, or trees can be considered chromista in the absence of conclusive evidence to the contrary; record what they share, if anything.)

PLANTS are all over the place, aren't they? What makes a plant a plant is the kind of chemical it uses to get energy to live: green chlorophyll turns sunlight into a different kind of energy called a carbohydrate by a process called photosynthesis. I'm going to guess that you found all kinds of plants on your nature walk. (Let learners share their observations and record what they share; green algae are considered plants.) Let's see if we can group some of the plants by types, like trees and flowers and grasses.

FUNGI make the world a fun place. Without fungi, we wouldn't have bread, cheese, or mushrooms. Of course, we wouldn't have athlete's foot, either, but all-in-all, fungi are neat. Did you see any blue stuff growing on trees while you were on your walk? That was probably mold, which is a type of fungus. Anybody see mushrooms? Did you see different kinds of mushrooms or just one kind? Here's something even more fun about fungi: the cells that make up fungi have more in common with animal cells than with plant cells, which means that fungi are closer cousins to us than trees. Isn't that strange?

ANIMALS are pretty much everything else. What animals did you see on your walk? (Let learners answer and record what they share.) Let's see if we can make some guesses about things that might be related. (Group insects, spiders, birds, and mammals—subdivide into species like dogs, cats, and squirrels if possible.)

Isn't DNA amazing? God created DNA, and all this life came from that DNA!

Seeds and Feet: What do you observe here on the table? Let's do some sorting. Let's put plants at one end of the table and animals at the other to start.

That's pretty easy to do, isn't it? Now, remember that all of these things are related by DNA because all life is related that way. What if I told you that all of these plants are from the same family because they have a whole lot of DNA in common? Let's make some observations to see if we can find things in common among them. [Learners should be able to see several common elements, particularly the way the edges of leaves look and the way that fruit or flower hangs from the branch.]

Now let's look at a smaller group. What do you know about cherries and peaches and nectarines? (Let learners make suggestions.) We don't eat the pits of cherries or peaches, but we do eat the pit of another fruit in the family. Can you guess which item on the table is the pit that we eat? (Almonds.) If you planted the pits, you'd get new plants because the pits are seeds.

What do strawberries and raspberries have in common? (Let learners make suggestions.) Both of them have lots of seeds, don't they? Cherries and peaches only have one big seed, every almond is the seed of a single fruit, and roses don't make a fruit we can eat but they do make seeds. Even though all these plants make a different number of seeds and some have fruit we can eat and some don't, they're very close cousins among plants. Their leaves are very similar and if we had flowers from a cherry tree or a peach tree or even an apple tree, we would see that those flowers look a lot like roses, at least on the inside. That means something important: a very, very long time ago, all these plants shared a common kind of plant as an ancestor! They are all part of the family Rosaceae.

Evolution is the process that allows life to adapt to changing conditions on earth. We call it evolution by natural selection, which means that at some point in the past—the ancient past!—a rose-like bush might have been able to survive a drought better than its sister rose bush, and so the surviving bush passed along that ability to its children and so on down the line. Maybe that hearty rose bush became a kind of early peach tree that protected its seeds by wrapping each one of them in fleshy fruit. And maybe somewhere else, that same kind of plant got smaller to survive drought and became an early kind of strawberry plant that protected its seeds by packing a lot of them together in one fruit.

Now let's look at the animal pictures and see if we can make some groups based on similarities. What would you put with this clam? (Let learners offer suggestions and provide evidence for their suggestions. When they concur on a correct answer, affirm the suggestion; the sub-group is clam, squid, and snail, all mollusks.) That's a pretty strange group, isn't it? Clams generally live near the shore of an ocean or lake, squid usually live in deeper ocean water, and most snails live on land. But like the plants, a very, very long time ago, there was one kind of animal that was the common ancestor of all the mollusks we have today, no matter where they live on earth.

Changes in the DNA make those kinds of adaptations possible. Many mollusks developed shells over time, so somewhere back in history, there might have been two squid-like creatures living in the same part of the ocean. One might have had thicker skin than the other, so that thick-skinned squid was harder for bigger animals to eat; maybe he had more children than his thin-skinned brother, or maybe he could live closer to shore while his brother stayed out to sea. And if each generation there were fewer thin-skinned

squid-like creatures in one place but more of the thick-skinned, well then those with the thickest skin of all would have even more of an advantage, and eventually, the skin became a shell. [Note that these are just examples of how natural selection could work, not necessarily how specific species came to be!]

Now, we have three pictures left. Which two go together to make a pair? Let's look at the foot and the footprint first. Do you know what kind of foot this is? (Bird is a good enough answer.) Can you guess what kind of footprint this is? (Dinosaur is the answer; if learners are curious, tell them that it is from an ancestor of *Tyrannosaurus rex* called *Eubrontes giganteus*.) What might you hypothesize from looking at this foot and this footprint? We used to think that dinosaurs were closely related to today's reptiles, especially alligators and crocodiles, but by studying their footprints, their feet, and the bones of their front legs, scientists discovered not long ago that today's birds are a kind of dinosaur! So while we say that the dinosaurs all died a very, very long time ago, it's not quite the whole truth. One small part of the very big family survives. Just think: at Thanksgiving, we're eating dinosaur!

Now, let's look at the picture of the chimpanzee. What do you notice about him? (Let learners make their observations, which will probably include that he looks very human.) This is where a lot of people get stuck with the Bible and science. It's very hard for most of us to think that we're special in God's eyes *and* that we share a common ancestor with chimpanzees. Some people say it has to be one or the other, not both. But DNA makes both possible. What are some ways that human beings are like chimpanzees? (Let learners answer.) What are some ways that we are different? (Let learners answer.)



This is what we think we know about how chimpanzees and humans got to be so different even though we are so much alike. Between 6 and 13 million years ago, which is a very, very long time in the past, but not nearly as long as the big dinosaurs like *T. rex* lived, a group of animals that looked a lot like chimpanzees but weren't chimpanzees lived in Africa. We don't have a name for this group officially, so let's call them the Last Common Ancestor, or LCA, for now.

One very small group of the LCA got separated from the larger group, possibly by an earthquake or maybe by a flood or a fire. So the larger group and the smaller group couldn't share DNA by having children together. The two groups were very much alike for hundreds of thousands of years, but slowly, natural selection began to change them. The large group, which became chimpanzees, probably lived in a nice forested area where it made sense to be able to climb trees and to balance using both feet and hands on branches. Living in the forest, the hair on their bodies didn't make them too hot, and it also protected them from sunburn, so their skin did not get dark. They could move through the trees for long distance, so there was no advantage to being able to walk upright; instead, their feet changed to make hanging on to branches easier.

The smaller group probably found itself in grasslands where it was harder to find food. Without trees to live in and move through, natural selection led to more upright walking over time, and also to a change in their feet; they couldn't grasp tree branches with their feet and toes after many, many generations. Also without trees, they were exposed to the sun much more, which meant that their body hair made them too hot. Over time, they lost

body hair and gained a pigment in their skin called melanin, which protected them from sunburn and made them very, very dark skinned. After millions of years passed, there was no way for the small group to have children with the large group because they had each changed too much.

The larger group became chimpanzees, and later bonobos when another split happened. The smaller group became the ancestors of modern human beings. We know this because chimpanzees, bonobos, and human beings have almost 99% of the same DNA in the same basic order. When God made all the laws that made DNA possible, God set something amazing in action!

There's one very important way that we are different, at least as far as we know. Chimpanzees and other close primate relatives can't start a sentence with "I wonder..." The ability to wonder came from adaptations in our brains. We've seen that wondering helps us understand the world and we know it helps us understand how God works in the world. If chimpanzees can't do that, then that makes us very special. We are the only ones on earth who can look for evidence of God. We are the only ones who can pray to God. We are the only ones who can worship God. So it is possible that we are very close cousins to our chimpanzee friends AND that we are very special in God's eyes. All because of DNA!

## **Recreation**

**Play** Charades focused on guessing animals, “Fruitbasket Turnover,” or “Zookeeper” (instead of fruit, use animals) focus on life and help learners use energy to be prepared for Laboratory Reports time.

Games that require observation such as “I Spy” or “Twenty Questions” continue the overall science theme and may appeal to a broader age or ability range among learners.

## **Snack Time**

**Bless** Follow the community’s tradition for blessing food, or ask for a volunteer to lead a prayer or sung grace.

**Serve** Fruit from the Rosaceae family (cherries, peaches, strawberries, etc.), yogurt or cheese, and Dinosaur (chicken) Nuggets. (Snack time is optional.)

## **Laboratory Reports**

**Say** Let’s tell Sophia what wisdom we gained today. Sophia, can you come out? (Record the learners’ observations while Sophia leads the discussion; this will be important for subsequent sessions.)

**Sophia** Tell me what you saw on your nature walk today. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me what you learned about the kinds of life on earth. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me what you learned about the ways that life is connected. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Does anyone who didn't speak have something they want to add?

I'm excited that humans have learned so much about biology and how all life is connected. The people I taught long ago could not have known what you know, so when they wrote down what I said, they could only tell what they understood. Let's add to our new proverb now to show the wisdom you have gained.

Find a partner to work with (encourage older learners to partner with younger ones who might not be able to write) and sit in the circle with your partner. You can choose the same person as the last session or someone new.

Pass out sticky notes and pencils.

Sophia: (Show poster board.) Let's start today with, "God connected all life on earth by..." Now your job is to finish the sentence with something you've learned today.

Give the group about three minutes or watch for signs that pairs are done.

Sophia: Now let's share this part of our new proverb. Together, we will read our board, and then each pair can read what you wrote. This will be like a chorus and a duet each time. We will start with (names) and go around. Ready?

Read "God connected all life on earth by..."

Response Continue pattern until all partners have shared.

Sophia: That was wonderful! You are very good writing partners. I will see you at the next session.

Say Thank you, Sophia. Let's collect what you wrote so we can have it for tomorrow. Can we sing our theme song one more time?

Sing Chosen theme song

Say Share announcements, thank learners for coming.

Pray Benediction

## WHAT DO BACTERIA LOOK LIKE?

Suggested images can be found at [http://www.richscholar.com/wp-content/uploads/IMG\\_3746.jpg](http://www.richscholar.com/wp-content/uploads/IMG_3746.jpg) and [http://pixabay.com/static/uploads/photo/2013/05/05/07/17/bacteria-108895\\_640.jpg](http://pixabay.com/static/uploads/photo/2013/05/05/07/17/bacteria-108895_640.jpg)

## WHAT ARE PROTOZOA?

Suggested images can be found at

[http://1.bp.blogspot.com/\\_WnEI9VUg2SU/SzZU5l3KFBI/AAAAAAAAABKU/WOeIZRZRu5Q/s400/Protozoa-picture.jpg](http://1.bp.blogspot.com/_WnEI9VUg2SU/SzZU5l3KFBI/AAAAAAAAABKU/WOeIZRZRu5Q/s400/Protozoa-picture.jpg) and [http://farm6.staticflickr.com/5101/5690523177\\_851ed42fd9\\_z.jpg](http://farm6.staticflickr.com/5101/5690523177_851ed42fd9_z.jpg).

CHROMISTA IS A BIG FAMILY!

A suggested image can be found at

<http://photography.nationalgeographic.com/wallpaper/photography/photo-tips/nature-landscape-photos/pebbles-kelp-beach/>.



An image of a chicken foot can be found at <http://nourishedkitchen.com/chicken-feet-stock/>.

An image of a squid can be found at  
[http://www.fishwatch.gov/seafood\\_profiles/species/squid/species\\_pages/market\\_squid.htm](http://www.fishwatch.gov/seafood_profiles/species/squid/species_pages/market_squid.htm).

An image of a razor clam can be found at  
[http://wdfw.wa.gov/fishing/shellfish/razorclams/graphics/razorclam\\_1.jpg](http://wdfw.wa.gov/fishing/shellfish/razorclams/graphics/razorclam_1.jpg).

An image of a snail can be found at <http://www.npr.org/sections/krulwich/2013/08/02/208236477/why-dentists-should-fear-snails>.

An image of an ant can be found at <http://www.calvin.edu/chimes/2013/04/24/researchers-track-ants-discover-secrets-of-formic-careers/>.

An image of a chimpanzee can be found at  
<http://animals.nationalgeographic.com/wallpaper/animals/photos/chimps/young-chimp/>.

Photo taken along the Connecticut River in Holyoke, Massachusetts, by William D. Richards for use in this curriculum. © William D. Richards, 2015. Used with permission.



### Day Five: Astronomy (Cosmology)

Science Goal: Learners will explain basic features of the solar system, the galaxy, and the universe.

Learners will describe the Big Bang Theory of universal origins.

Faith Goal: Learners will describe the way that God used the laws of physics to create the universe, our galaxy, our solar system, the earth, and the moon.

### **Daily Theme Time**

GATHERING SONGS

THEME SONG

REVIEW AND INTRODUCTION OF DAILY THEME

Prepare ahead:

Type out the responses to the proverb statement from the previous session and make copies for learners or otherwise have it available to read. It is not necessary to start every statement with “God connected all life on earth by...” Also prepare a poster board with “God created the universe, the galaxy, and the solar system by...” for laboratory reports time.

Say       Who remembers what Lady Wisdom said about the creation of the universe? (Elicit answers, correct or add as necessary.) We’re writing our own proverb about the science of God’s creation in this course. We’ve worked on it for four sessions now. Let’s call Sophia out to help us read what we’ve written so far.

Sophia   Hello, everyone! I’m glad to see you again. I really like what we’ve written so far. Let’s read the whole thing now.

Read Proverb

Sophia It's getting pretty long, isn't it? That's because you have learned so much about the world and how God works in creation. I can't wait to help you with another part of our proverb later on. Enjoy your laboratory time!

Say Thank you, Sophia. She's right: We have learned a lot! Everything we've learned so far has been about the laws that God put in place to make everything in creation and about how those laws work on earth. Today, we're going to see how those laws work in the universe, from the very moment the universe came to be until right now and until the end of the universe. The big field of study is called astronomy, which means study of the stars. We will also do a little work in a field of science called cosmology, which means the study of the universe.

## SCIENCE DEMONSTRATION AND INTRODUCTION OF ASTRONOMY

Prepare ahead:

Big Bang: Obtain a cherry tomato and a glass pan large enough to put your foot into. Inflate and tie off one round balloon. Using a permanent marker, carefully draw several spirals to represent galaxies on the surface of the balloon. Inflate and then deflate a second round balloon. Draw spirals on the balloon to cover as much of the surface as possible.

Solar Scale: Using the table below, cut strings of yarn for the small scale model. Note that the length of the string for the sun's circle is  $\pi d$ , or  $1.4 \times 3.14159$  (4.4 meters). Tie the sun loop. For

fun facts about Pluto, review the article here:

[http://www.npr.org/sections/13.7/2015/07/07/420806520/driving-to-pluto-how-long-](http://www.npr.org/sections/13.7/2015/07/07/420806520/driving-to-pluto-how-long-would-it-take)

[would-it-take](#) and the New Horizons Mission homepage here:

[https://www.nasa.gov/mission\\_pages/newhorizons/main/index.html](https://www.nasa.gov/mission_pages/newhorizons/main/index.html).

Object and suggested color for distance scales	Distance from Sun in kilometers (KM)	Small Scale Model 1 CM = 100,000 KM, in meters	Large Scale Model 1 M = 1,000,000 KM, in meters	Object for Large Scale Model
Sun's Diameter yellow	1,400,000	.14 (14 centimeters)	1.4	Yarn circle made from string 4.4 meters in length
Mercury orange	58,000,000	5.8	58	Marble
Venus green	108,000,000	10.8	108	Walnut
Earth blue	150,000,000	15	150	golf ball
Mars red	227,000,000	22.7	227 (this is probably the last distance possible to lay out safely)	acorn
Jupiter pink	779,000,000	77.9	779 (to show distance, wind yarn in balls and compare sizes)	basketball
Saturn gray	1,428,000,000	142.8	1,428	soccer ball
Uranus purple	4,506,000,000	450.6	4,506	Softball
Neptune white	5,913,000,000	591.3	5,913	small grapefruit
Proxima Centauri	39,900,000,000,000	About 40KM/ 25 miles (39.9KM)	About 400KM/ 247 miles (399KM)	Map familiar places at those distances

Demonstrations:

The Big Bang Show learners the inflated balloon. Tell them that it represents the universe as we see it today, with galaxies spread out as far as we've been able to see so far with our telescopes, which is a very, very long way. 13.8 billion years ago, the universe was once much, much smaller. So small, in fact, that we don't even have the technology to see anything that small now.

Put the tomato in the glass pan and set the pan on the floor. Explain that the seeds in the tomato are about 2 millimeters long, which is trillions of times bigger than the particles that were there at the very beginning of the universe. But we can learn from this tomato. Ask learners what they think will happen if you step on the tomato. Explain that the laws of physics that give order to the whole universe work in such a way that all the very tiny particles crammed in that tiny, tiny space got so squished together that it all exploded and started to expand, just like the tomato when it gets stepped on. Step on the tomato to prove the point.

Take out the uninflated balloon. Explain that this balloon represents the universe when it was very, very young, not even a billion years old. Show learners the small spirals and note how close together they are. Then start to blow up the balloon, one breath at a time, and ask learners what they observe. You can say that each breath is a billion years, or even two billion years if they are deep breaths. Do not over inflate it. Say that the universe, as far as we can tell, is still expanding. Unlike our balloon, it won't get so big it explodes (we don't think it will, anyway), but it's possible that someday the universe will start to shrink. Start letting the air out of the balloon slowly. When all the air is gone, crumple it as small as it will go. Ask the learners if they think the whole cycle could start again. Scientists think that's a possibility, but we will never know for sure!

Solar Scale: Galaxies are made of stars and many of those stars, we're discovering, have planets in orbit around them. Our sun is a star and we live on a planet in orbit around the sun. There

are 7 other planets in our solar system. Have you ever thought about just how big the sun is? Or how big the solar system is? Let's find out.

Have a small group of learners lay out the small scale model sun loop in a circle on the floor. Allow other learners to lay out the other small scale yarn segments with one end touching the sun loop; this does not need to be in any particular order.

Ask if they can guess which yarn length represents the distance from the sun to the earth. Go through each planet's distance from the sun and see what the group knows about each planet (it may be helpful to have an assistant prepared to look up facts on a reliable website such as <http://curious.astro.cornell.edu> or <http://coolcosmos.ipac.caltech.edu/asks>). Establish that Jupiter is the largest planet and Mercury is the smallest. Explain how far away the nearest star would be if the sun were this size (50 miles or so).

#### DAILY THEME SCRIPTURE

Read Psalm 8

“Lord, our Lord, how majestic is your name throughout the earth!

You made your glory higher than heaven!

<sup>2</sup>From the mouths of nursing babies you have laid a strong foundation

because of your foes, in order to stop vengeful enemies.

<sup>3</sup> When I look up at your skies, at what your fingers made—

the moon and the stars that you set firmly in place—

<sup>4</sup> what are human beings that you think about them;

what are human beings that you pay attention to them?

<sup>5</sup>You've made them only slightly less than divine,

crowning them with glory and grandeur.

<sup>6</sup>You've let them rule over your handiwork,

putting everything under their feet—

<sup>7</sup> all sheep and all cattle,

the wild animals too,

<sup>8</sup> the birds in the sky,

the fish of the ocean,

everything that travels the pathways of the sea.”

Say        This Psalm sounds a lot like the story Sophia read to us at the beginning, doesn't it? The person who wrote this Psalm knew about wonder, and though he or she couldn't have been a scientist like we have today, the questions and connections that the writer makes sound much like the ones a scientist might ask. We know that the universe is very, very, very big. Now days, we know that the earth isn't even at the center of our solar system, never mind our galaxy or the universe. And we know that the earth goes around the sun once a year and that the earth spins around once a day - that's how we get a year and how we measure a day. But once upon a time, people thought that everything you can see in the daytime sky and everything you can see in the nighttime sky moved around the earth and that the earth stood still! Imagine that! People in Bible times probably couldn't imagine visiting the moon. Now human beings have walked on the moon and we've explored Mars with robots. We're getting pictures from Pluto and we landed an explorer on a comet. We've sent spaceships off beyond Jupiter and Saturn and Neptune into the



galaxy beyond our own solar system and now we can look into galaxies so far away it's hard to imagine the distance. It's all very exciting because it teaches us ever more about creation. One thing that hasn't changed since Bible times is our knowledge that God created everything. We understand it differently than our friends in the Bible ever did or even could because of our abilities, but that makes it even more amazing. Tonight, we're going to explore that creation out beyond the earth, including the moon, our solar system, our galaxy, and galaxies far, far away. You know what's really wonderful about exploring space? When we study galaxies far, far away, we're looking back a long time ago!

“I WONDER...”

Say        What would you like to explore in the laboratory tonight? I have some ideas. Maybe you have some others.

I wonder...if there's a way to understand how big the planets in our solar system are. I wonder...if there's a way to make an even bigger scale model of our solar system.

I wonder...why the moon looks the way it does. I wonder...why the same side of the moon is always visible from earth.

I wonder...how stars and planets formed.

## Laboratory Time

Prepare ahead

Solar System: Lay out scale model objects and cut lengths of yarn according to the table above.

Have an M&M or Smartie available. Mark a map or otherwise make a list of places that are about 150 miles away from your location. This might work better in a parking lot or yard, given the space required.

Moon Madness: Print or prepare to show this photo of the surface of the moon, or another of similar quality: [http://www.virtualtelescope.eu/wordpress/wp-content/uploads/2013/06/moon\\_23jun2013.jpg](http://www.virtualtelescope.eu/wordpress/wp-content/uploads/2013/06/moon_23jun2013.jpg). Prepare several 9"x13" pans with a layer of flour (about 2 cups) packed firmly on the bottom and a layer of cocoa (about 1/2 cup) sifted on top. Set out stones. Blow up a beach ball; number sections or mark 4 longitudinal quadrants in permanent marker. Establish a place for the very bright light source so that it shines at little higher than average head height.

Accretion Disks: Set out modeling clay or dough.

Laboratory Exploration:

Solar System: As in the demonstration time, repeat the layout of the solar system with yarn. Ask learners if they can guess which object represents each planet. Place objects at the proper distance from the sun. Show the candy piece. Ask learners if they can guess what object in the solar system would be that size in the scale model (the earth's moon).

Moon Madness: Ask learners to describe the moon.

Explain that the moon formed in a different way than the sun and the planets; it came out of the Earth's "stuff" very, very early, back when the surface of the earth was like the inside of a volcano. We know this because the astronauts who went to the moon brought back rocks and other samples that scientists examined. Most of those rocks matched ancient rocks from Earth. There were also rocks that didn't match Earth; scientists have made a very good guess that another very young planet hit the Earth and that's how we got the moon. The other planet was destroyed in the collision.

Sometimes, we hear about meteor showers that we can see at night from here on Earth. It's pretty rare for a meteor to hit the Earth because these rocks that orbit the sun (meteoroids) usually burn up in Earth's atmosphere. But our moon does not have an atmosphere, so meteors often do hit the surface of the moon. In the picture of the full moon, you can see where meteors have crashed (if any of the rock remains, it is called a meteorite) because they cause impact craters. The force of the impact causes the same thing that happened when we squashed the tomato earlier: stuff flies everywhere. When there's an impact, what flies out is called ejecta. We can see the ejecta from the impact of meteors on the moon's surface in many places in this picture. (Show the picture; point out the "rays" around the crater at the bottom center and the craters in the upper left.)

Divide the group so that every group of 2-3 learners shares a prepared pan. Have each learner pick a stone and stand over the pan. On the count of three, everyone should drop a stone straight down into the pan. What happened? Let them drop 2 or 3 more stones to see if the same thing happens from different heights and angles. What do they observe?

Have learners form a circle with one learner in the center. Turn on the light source (turn off other lights and adjust placement if necessary). What do they notice about the light? Is anyone in the shadow? Give the beach ball to a learner in the most shadow, which should be the learner sitting with his or her back directly in front of the light source (new moon). Have learners pass the beach ball around the circle. What happens? Explain that the phases of the moon are due to the way that the earth's shadow falls on the moon as the moon orbits the earth. Demonstrate one person at a time as the ball goes around again.

Swap the center learner if desired. Can anyone guess why we only see one side of the moon? Have the learner with the least shadow, whose face gets the most direct light from the light source, (full moon) hold the beach ball so that the number 1 faces the learner in the center. Now ask the learners to pass the ball around the circle slowly, turning the ball as they do so. The quadrant opposite 1 should face earth when the ball is at new moon and 1 should face earth again when full moon. Ask learners what happened.

A full day and night on the moon takes the same amount of time as the orbit of the moon around the earth, which means that we only see one side of the moon from earth. We have to send satellites, and maybe someday astronauts, to explore that "dark" side of the moon.

Accretion Disks: Give each learner a handful of clay. Let them work with it as you begin the explanation and model the play for them if you choose.

Gravity was a very important part of making stars and planets out of all the stuff that got spread across the universe as it expanded. Ask learners if anyone can guess how gravity might have worked to make stars and planets. Encourage guessing; someone may get close or hit on the right idea. Did you know that they all, every single one of them, started as circles?

Ask learners to take a tiny pinch of their clay in their hands. Continue the explanation as you model with your own clay.

Stuff—tiny particles of matter—was attracted to other stuff, and as more stuff came together (add a little more clay and work it in, shaping your medium into a disk. Encourage learners to follow your lead each time), the resulting “pile of stuff” began to spin, creating gravity, and attracted more (add double the amount) and more (add double that) stuff from the universe (add whatever remains). When we add clay, we are doing what gravity did. At first, all this stuff was flat like a pancake, just like this. But gravity was not done. Gravity kept pulling this stuff tighter and tighter, which made the disk bulge up in the middle at first (demonstrate by draping your disk over your fist like a pizza round and pushing slightly upward, spinning it if you dare). Then that bulging disk spun faster and all that stuff at the edges moved toward the center (show this by starting to roll the clay into a ball against a flat surface or the palm of your hand). When the stuff was as small a ball as it could be, one of two things happened. Can you guess what those two things were?

Encourage guessing. Some learners may know that this is how nuclear fusion begins in the heart of stars.

If the ball is big enough and there is so much pressure and heat deep inside the star to start a special kind of fire, then a star is born. A process called nuclear fusion begins to turn hydrogen into helium, which is what's happening in our own sun today. Sometimes only one ball in an area will be a star, like in our solar system. Sometimes, there are two or three or even five balls big enough to become stars in an area of space. The other balls of stuff in that same area which are too small to create a star will become planets in orbit around the star or stars. They are very, very hot to start out, like lava in volcanoes, but then cool over long periods of time. How amazing and wonderful is it that God's laws provided for all of this?

## **Recreation**

Play Any favorite version of tag can be modified for a space theme, or play Astronaut Hop Tag: players must hop instead of run or walk. Astronaut Hop Relay is another good game to help learners use energy to be prepared for Laboratory Reports time.

Games that require observation such as "I Spy" or "Twenty Questions" continue the overall science theme and may appeal to a broader age or ability range among learners.

## **Snack Time**

- Bless** Follow the community's tradition for blessing food, or ask for a volunteer to lead a prayer or sung grace.
- Serve** Mars bars, Milky Way candies, and/or have learners make Astronaut pudding (do before blessing: 1/4 cup milk mixed with 1 tablespoon instant pudding mix in a zip-top bag, mix thoroughly, and refrigerate for 5-10 minutes before serving with drinking straws, which is how astronauts in space eat and drink almost everything). Freeze-dried ice cream is available for purchase via several internet sites if budget and time allow. (Snack time is optional.)

## **Laboratory Reports**

- Say** Let's tell Sophia what wisdom we gained today. Sophia, can you come out? (Record the learners' observations while Sophia leads the discussion.)
- Sophia** Tell me what you learned about the solar system. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?
- Tell me what you learned about the moon. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Tell me what you learned about gravity and the formation of stars and planets. (Let learners share. Make sure everyone who wants to speak has a chance to add to the conversation.) What do you wonder now that you know what you know?

Does anyone who didn't speak have something they want to add?

I'm excited that humans have learned so much about the universe beyond the planet earth. The people I taught long ago could not have known what you know, so when they wrote down what I said, they could only tell what they understood. Let's add to our new proverb now to show the wisdom you have gained.

Find a partner to work with (encourage older learners to partner with younger ones who might not be able to write) and sit in the circle with your partner. You can choose the same person as the last session or someone new.

Pass out sticky notes and pencils.

Sophia: (Show poster board.) Let's start today with, "God created the universe, the galaxy, and the solar system by..." Now your job is to finish the sentence with something you've learned today.

Give the group about three minutes or watch for signs that pairs are done.



Sophia: Now let's share this part of our new proverb. Together, we will read our board, and then each pair can read what you wrote. This will be like a chorus and a duet each time. We will start with (names) and go around. Ready?

Read "God created the universe, the galaxy, and the solar system by..."

Response Continue pattern until all partners have shared.

Sophia: That was wonderful! You are very good writing partners. You have written a wonderful proverb this week (or this unit, etc.). I hope you will find ways to share what you've written so that others will have a chance to know more about God's creation and how it came to be.

Say Thank you, Sophia. Let's collect what you wrote so we can have it for our celebration. Can we sing our theme song one more time?

Sing Chosen theme song

Say Share announcements, thank learners for coming.

Pray Benediction

### Celebration Ideas

Note that the celebration can be sharing the proverb and the theme song in the community worship service(s) or a sixth session to which the community is invited. If the latter option is chosen, ask learners to choose one laboratory activity from each session that they want to show and explain to others. The session can be set up the same way, with one short demonstration from each session and the activities chosen by learners.

Sample Proverb (created in July 2015 by the Vacation Bible School learners at The United Church of Schellsburg United Church of Christ):

Sophia, Lady Wisdom, was with God from before the universe was created. She teaches us to wonder and helps us to figure out the answers to the things we wonder. When we learn new things, we grow wiser. And then she helps us praise God for our new wisdom!

Praise God for gravity and magnets and all the laws that make the universe possible!

Praise God for elements and chemical reactions that make everything around us!

Praise God for earthquakes and continental drift that shape our earth even today!

Praise God for bacteria and cherries and snails, all linked by DNA!

Praise God for planets and stars and galaxies, every one known to you!

Praise God that we can wonder about what we experience.

Praise God that we can learn about the world and the entire universe.

Praise God for wisdom and understanding that grows every time we answer a question  
by experimenting and exploring your creation!

In the Learners' Own Words Samples (created in July 2015 by the Vacation Bible School learners at The United Church of Schellsburg United Church of Christ):

### *Physics*

We wondered about the laws that God wrote to make the universe happened. Scientists who study physics are working to understand these laws, and they learn more every passing year.

These laws are amazing!

Because of these laws, we can...

...make ping pong balls float in the air from a blow dryer

...use magnets to move metal things around, and even get our fingers pinched when really strong magnets come together!

...make ice cream by taking energy out of simple ingredients to make them freeze

...bend light with mirrors

...glow in the dark!

### *Chemistry*

We wondered about all the ways things are made from the basic elements God's laws make, like carbon, oxygen, and hydrogen. Scientists who study chemistry discover more new ways to combine elements every passing year.

These elements are amazing!

Because of these basic elements, we can...

...make slime from glue and starch

and silly putty from glue and borax

...make balloons blow up with vinegar and baking soda (which will also explode)

...make awesome cupcakes to share with people we love

### *Geology*

We wondered about how the planet earth was made according to God's laws. Scientists who study geology have figured out some amazing things in the past and they learn more every year.

The earth is made in amazing ways.

We discovered that...

...magma from under the earth's crust comes up out of volcanoes and makes new islands

...the center of the earth is made of iron

...the continents are drifting on the surface of the earth and that's why kangaroos and koala bears and

emus are only found in Australia

...buildings that are strong and flexible do better during earthquakes than other kinds of buildings

### *Biology*

We wondered about life on earth. Scientists who study biology have taught us that all life is linked, and every year, biologists help us discover even more ways that we humans are linked to the tiniest bacteria.

When we studied life, we learned that...

...DNA is God's recipe for life

...DNA is in every single living thing on earth

...DNA is made of four basic ingredients

...DNA makes 20 proteins and those proteins

are all the building blocks God needed to make life

...birds are modern cousins to ancient dinosaurs

...human beings are the only animals who can say, “WOW!” and ask questions about creation, which is  
what makes us special to God  
...because we are special to God,  
we have a responsibility to take care of all life on earth

### *Astronomy*

We wondered about the universe and how God could be everywhere in it and yet so close to us.  
Scientists study astronomy to learn more about planets, stars, galaxies, and other things that make up  
the universe.  
Astronomy teaches us that...  
...the universe was once so tiny that even now,  
we don't have a way to see anything that small  
...the universe exploded in the Big Bang about 14 billion years ago and it has been expanding ever since  
...the universe might expand forever or it might start to shrink;  
scientists don't know yet which is more likely  
...gravity pulled stuff together to make stars and planets out of accretion disks  
...Jupiter is almost big enough to have become a star and if it had,  
life could not have started on earth because it would be too hot  
...Kepler 452B is a planet very much like earth in a solar system about 1400 light years away  
...the moon's surface looks the way it does because of meteorites and asteroids that hit it  
...we only see one side of the moon from the earth

## Additional Resources and Bibliography

Generally speaking, videos on any of these subjects from Khan Academy

(<http://www.khanacademy.org>, under the “Subjects” tab, look for “Science”) or Crash Course

(<http://www.youtube.com/user/crashcourse/featured>, use the search feature to find videos within each category) are helpful to any instructor who wants to know more or to refresh material before teaching.

In particular, Crash Course Biology lessons 10 and 11 take about half an hour total to provide a solid understanding of the structure of DNA and the process by which amino acids are made:

Episode 10: <http://www.youtube.com/watch?v=8kK2zwjRV0M>

Episode 11: <http://www.youtube.com/watch?v=itsb2SqR-R0>

The Amoeba Sisters have some terrific videos on their YouTube Channel that walk through cell reproduction, including DNA and amino acids.

For an excellent visual presentation of scale to expand the Astronomy experience, the animation at [http://www.onemorelevel.com/game/scale\\_of\\_the\\_universe\\_2012](http://www.onemorelevel.com/game/scale_of_the_universe_2012) is very helpful.

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## **Chapter Five: What I Still Wonder...**

If ever I had doubts about this project, they were fully laid to rest on February 12, 2016. I was the substitute for a high school science teacher whose lessons for the day included evolutionary mutations in DNA. The other teacher on the team actually taught the lesson, but I was helping students with questions in each class period. A student in one class had identified me as a pastor at the beginning of the period. When a different student that period asked for my help with a genetics problem, she quietly asked me if it was a sin for a Christian to believe in evolution. I think she expected me to say yes by her surprised reaction to my “absolutely not”, but the smile on her face when I explained why was worth the moment or two of my time. She told me that she hopes to be a geneticist someday but wondered if doing so would condemn her in God’s eyes because her church teaches that studying genetics is tantamount to endorsing atheistic evolution over God. My heart aches for her; she will continue to wrestle with this for years or until she can find a more open community of faith where her talent and drive will be applauded and supported. I wish there had been a way to bend the ethical boundary to invite her to come to our church, but I will have to leave that possibility in God’s hands.

When I wonder with the children and youth who participated in the science-based programs I have run over the last six summers about their experiences, the constant theme is that science in church is more fun than science at school. I know that this is in part due to the lack of tests, but I also think this is because our science teachers have been hamstrung by the amount of standardization expected in the learning environment and by the sheer amount of knowledge they are required to impart into our children and youth for measurement each year, both of which curtail the creativity of teachers and the native curiosity of young people far too much. Without

those expectations, what I can do in the realm of science is far less limited. The reflections below have been collected in a combination of casual conversations with individuals, often initiated by the other party, and in group conversations in which I invited responses to the statement, “Tell me what you liked about Vacation Bible School.”

I have noticed that my contingent of youth “helpers” is much larger each year since I started doing science-based curricula than it was when our focus was more traditional. I asked F.P., now a high school junior, why he was coming back as much as he could despite summer work and sports practices; he said, “It’s fun and we get to make messes. And it’s awesome when the little kids figure things out that I didn’t know until I was older.” P.E., a senior, echoed that sentiment unprompted. P. also reminded me that he went from hating science through seventh grade—and nearly failing seventh grade because he failed science that year—to being an A-B student in science after our first science Vacation Bible School (VBS) because he finally “got it.” He is particularly observant now of how weather conditions affect the performance of his many stringed instruments, which, he says, is “science in action.” He would like me to design some experiments around sound in future curricula.

K.F., who is now a freshman in high school and a self-avowed scientist in the making, told me that she was happy to experiment in any science subject without having to pass a test afterward and that I should never plan to do anything with dissections because “that’s gross.” HT., a sophomore, said that she enjoys helping at VBS because she learns more by doing than by listening to lectures or by reading; she is currently taking biology and noted that her grades are better in marking periods when she has lab experiences than when most of the assignments involve lectures and worksheets, as well.

In response to the open-ended statement, H.M., a fifth grade student, said that continental drift made more sense to her after VBS than it had when they covered it in fourth grade science because the way we learned it was more enjoyable. She also said it was fun to create earthquakes and that learning about planet Kepler 452b, which was in the news the week we had VBS in 2015, was “amazing.”

Second grade student S.K. loved the nature walk and learning about how all life is linked by DNA. Her classmate, L.M., said that she just likes doing anything to learn with her hands and loves to get messy on purpose; she also liked making ice cream but said we should use better zipper-top bags next time because too much salt from the super-cooled ice got into the actual ice cream and it did not taste as good as it did the year before (a very scientific observation).

Seventh grade student K.O. does not like science in school at all. She specifically asked for more science this summer anyway because what we do helps her perform better in science at school (I confess that I did a little internal dance of joy at that comment!).

M.A., who is in sixth grade, loved the blow dryer experiments with the different kinds of balls and making the model of the solar system with yarn and objects. She also thought that the polymer lab was “cool” and that it is very interesting that I can eat all the peaches I want, but have to be careful about how many cherries I eat and cannot eat almonds at all because of a chemical that is more concentrated in almonds than cherries and more concentrated in cherries than in peaches. “Bodies are weird,” she said, “and allergies are the weirdest!” She should know; her family has a history of anaphylactic reactions to peanuts and to seafood.

L.K., who is now in seventh grade, told me that he was sad when he realized he could not participate in VBS in 2015 due to his competitive sports schedule. His favorite VBS so far was the archeology program in 2012 because he learned how science helps us know more about the

Bible and the people whose stories it tells. He really enjoyed the “marshmallow fling” experiments in 2013 VBS experience, which helped us understand how machines can make humans be stronger in real ways (Samson was the “superhero” for that lesson). His favorite activity, though, was in 2010 when we visited a unique, and very local, geological wonder: a limestone cavern with a wall of fossils that was once on the floor of an inland sea.

B.K., who participated in the 2010 experience as a rising Kindergarten learner, must have taken in much more than any of us realized. His mother asked me, when his second grade class started studying dinosaurs in the fall of 2012, what the United Church of Christ says about the age of the earth because she wanted to be able to guide him accordingly. I assured her that what he would learn in school is in line with our understanding of creation and forewarned her to expect push back from parents who did not agree. Sure enough, a group of parents sent a letter to each student’s house decrying the lie that the earth was “billions of years old” when the Bible teaches us that it is only 6,000 years old. B.K. had his own answer to that. When one of his classmates said that dinosaurs and humans lived on earth together (as taught by some Young Earth Creationists), B.K told his class that the Bible proves that’s not true because Jesus would have ridden a *Tyrannosaurus Rex* into Jerusalem instead of a donkey. He also said that dinosaur bones would not be as deeply buried if the earth wasn’t so old. These may not be the most accurate answers, but they certainly demonstrate an ability to reason and to connect information that is vital to learning about science.

My own personal favorite, however, came from a parent of a visiting learner to our 2010 program. She called me about eight months later with this story. Her son R.J.’s second grade teacher had called the day before. She had written the letters “DNA” on the whiteboard at the beginning of science period and asked the class if anyone knew what that was. As a veteran

teacher, she said, she had no expectation that anyone would because no second grade student ever had before. But R.J. piped up right away with, “It’s deoxyribonucleic acid and it’s God’s recipe for life!” The teacher told R.J.’s mother that after she collected herself, she asked R.J. where he had learned that. R.J. replied, “At church!” Then the teacher asked the mother where this church is located and noted, sadly, that 90 minutes one way is a little too far to drive for church every week.

I have had a number of adult learners, assistants, and teachers through these programs, as well. Many of the learners were just glad to have a reason to spend time with our children and youth, while others came because they were truly curious about how science and faith work together. Some of the assistants and teachers volunteered because their children were participating, while others did so because they were interested in the subject and wanted to learn as well as teach.

Adult learners have told me over the years that getting reacquainted with scientific reasoning has helped them to think about many other subjects in different ways. An unexpected outcome in one instance was a change in political affiliation when a couple began to examine the claims of their preferred candidates against evidence in everything from history to medicine. This couple is now independent (“unaffiliated” in Pennsylvania) rather than registered with either major party and they take much more seriously the need to examine the statements and positions of political candidates before choosing for whom to vote. Another person noted that she has become far less of a Biblical fundamentalist because of what she has learned by participating in two of our science-based programs and our regular Bible study (in which we are reading through the entire Bible over several years); before those experiences, she was not really



aware of just how literal her beliefs were and how much they conflicted with other areas of her life.

F.S. loves biology and enjoys sharing that love of all things nature-related with our young people. She taught the biology lesson in 2015 with great enthusiasm, in no small part because of the way that evolution is included and explained. She also likes to see the children and youth become interested in science, especially the girls, because so often girls are systematically, if unintentionally, dissuaded from pursuing science past high school. She once wondered to me if part of the reason she did not go on to pursue a college degree was an implicit bias against her interest in science from teachers and counselors.

K.P. likes astronomy; she extended the lesson in 2015 to include Kepler 452b and led us into a conversation about life on other planets. We were both delighted when the group decided that because God created everything in the universe out of love, God would love life in the universe wherever it happens. We were further delighted when they decided that it would be okay if “people” on other planets had different understandings of God than we do, just like it is okay that people here on earth know God differently in different places and through different religions.

Because I have only been doing this for six summers, I have no long term data to provide about whether teaching science in church promotes pursuit of further study of science past the mandatory classes in high school and college. I do wonder if that will happen over time; so far, only one participant in any of these VBS programs has gone on to major specifically in a science field in college but several have pursued or are pursuing engineering degrees or certificates that require knowledge of physics. At least three of the participating youth who are approaching graduation in the next year or two have expressed interest in pursuing further education in a field

of science; though they could not say specifically that their VBS experiences led them to that decision, as one said, “It sure didn’t hurt!”

The impact on adults is more easily seen. One of my informal congregational advisors on this project came to the congregation from a different denomination with his wife several years ago because of the overall attitude of the United Church of Christ toward science and my personal interest in science in particular. Our congregation has gained three new families since February 2015 based on our openness to science as a realm of knowledge; one family stayed because I included the phrase “God loved the universe into creation over millions and billions of years” in a communion liturgy (see Appendix A, “Faith, Science, and Technology Sunday 2016”). As noted above, participants have changed and grown in faith and in other ways that they encounter the world. Even though we have no way to measure the true effectiveness of prayer or to discern how it works, we as a congregation are prayer warriors now in ways we were not when I arrived nearly 10 years ago. I think that this is due to the way that I preach and teach “improbable” rather than “impossible” based both on faith and science (see Appendix B, “Improbable But Not Impossible”). We pray more for healing now than we once did, though in many cases healing is vanishingly improbable...because we understand that improbable is *not* impossible and that miracles, in the form of the improbable, happen every day. I wonder how much more we will grow in the years to come as we continue to explore the connections between science and faith across the life of our congregation.

I also wonder how well this program will do “in the wild.” Because I wrote the liturgy for the United Church of Christ for our 2016 “Faith, Science, and Technology Sunday” on February 7, 2016 (Appendix A), I have had the opportunity to share the concept of teaching science in a community of faith with colleagues from across the denomination—social media is a wonderful

tool for conversation. Several have asked to be included as test sites if such are required before full publication of the curriculum and if not, want to know as soon as a version of this is available for purchase. I was asked to write the liturgy because Kimberly Whitney in the national offices in Cleveland has been a champion of this project since we met in 2012. She saw right away the need for this in the wider church. I know that I will have to put significant energy into revisions for use in other congregations; I am looking forward to that challenge almost as much as I look forward to seeing the outcomes of its use in other congregations.

I am tempted to say that I do not wonder whether God has been present in the creation of this project. I could say that “I know God has been present,” but that implies a kind of certainty I do not feel justified to assert. Rather, “I believe God has been present” because beliefs cannot be proved in empirical ways; I could not prove to an agnostic or atheistic scientist that God has indeed been present and active in the process of creation of this project. My belief that God has been guiding and directing me as I have worked is exactly that: a belief, and so I do wonder at some level whether God has been and is present in this project. The scientific corollary is that scientific facts cannot be “believed in” because they can be demonstrated to be more likely true than not. I wonder how many scientists mistake proofs for certainty and then find themselves rewriting their textbooks because they have forgotten that even empirical knowledge does not tell the whole story and that uncertainty is where further exploration occurs.

The role of uncertainty in an active and engaged life of faith has been the most important personal takeaway in terms of my own faith. I have as an adult always thought that doubt is an important part of an active and engaged life of faith, but I also thought for a long time that the opposite of doubt is certainty and thus that there should be a balance between doubt and certainty in mature faith. I have learned in the course of my studies and the preparation of my project that

the opposite of doubt is not certainty but belief. Certainty is inflexible and stagnating, where belief is flexible and life-giving, allowing for new experiences and knowledge to change my relationship with God, with others, and with all creation. I wonder what I will learn next...

## Appendix A: At Play with Wisdom

United Church of Christ Science and Technology Sunday  
Service of Holy Communion  
February 7, 2016

*Psalm 8, Proverbs 8:22-31, Colossians 1:15-20*

### CONTEMPLATIVE THOUGHTS

“When I went to the moon I was a pragmatic test pilot. But when I saw the planet Earth floating in the vastness of space the presence of divinity became almost palpable and I knew that life in the universe was not just an accident.” - *Edgar Mitchell (Apollo 14 Astronaut)*

“We go about our daily lives understanding almost nothing of the world. We give little thought to the machinery that generates the sunlight that makes life possible, to the gravity that glues us to an Earth that would otherwise send us spinning off into space, or to the atoms of which we are made and on whose stability we fundamentally depend. Except for children (who don’t know enough not to ask the important questions), few of us spend much time wondering why nature is the way it is; where the cosmos came from, or whether it was always here; if time will one day flow backward and effects precede causes; or whether there are ultimate limits to what humans can know.” - *Carl Sagan (From an introduction to “A Brief History of Time” by Stephen Hawking)*

"Science is not only compatible with spirituality; it is a profound source of spirituality. When we recognize our place in an immensity of light-years and in the passage of ages, when we grasp the intricacy, beauty, and subtlety of life, then that soaring feeling, that sense of elation and humility combined, is surely spiritual...The notion that science and spirituality are somehow mutually exclusive does a disservice to both." - *Carl Sagan*

“From religion comes a man's purpose; from science, his power to achieve it. Sometimes people ask if religion and science are not opposed to one another. They are: in the sense that the thumb and fingers of my hands are opposed to one another. It is an opposition by means of which anything can be grasped.” - *William H. Bragg, British physicist, chemist, and mathematician. Awarded Nobel Prize in 1915*

“We are in the position of a little child entering a huge library filled with books in many different languages. The child knows someone must have written those books. It does not know how. It does not understand the languages in which they are written. The child dimly suspects a mysterious order in the arrangement of the books but doesn't know what it is. That seems to me, is the attitude of even the most intelligent being toward God. We see a universe marvelously arranged and obeying certain laws, but only dimly understand those laws. Our limited minds cannot grasp the mysterious force that moves the constellations.” - *Albert Einstein, in a 1929 interview, in Denis Brian, Einstein: A Life (NY: J. Wiley, 1996), p. 186*

**CALL TO WORSHIP** (*Inspired by Psalm 8*)

One: Wonderful God! Awesome God!  
How majestic is your name in all the universe.

**All: Wonderful God! Awesome God!**  
**How majestic is your name in all the universe.**

One: Your glory is woven through the fabric of the heavens.  
Everywhere we turn, below us, beside us, above us,  
all that we experience is evidence of your presence.  
Soil, grass, water, sun, moon, and stars,  
all of them proof of your work in the universe.

**All: Wonderful God! Awesome God!**  
**How majestic is your name in all the universe.**

One: We wonder: why do you care about us?  
What are we compared to the galaxies spread across time and space,  
or to the amazing worlds of life too small for us to see  
or to the great animals of land and sea?

**All: Wonderful God! Awesome God!**  
**How majestic is your name in all the universe.**

One: You have called us to be caretakers,  
giving us curiosity and wonder that drive us to explore  
the entirety of creation  
from the microscopic worlds of bacteria and atoms  
to the telescopic worlds orbiting stars billions of miles away.

**All: Wonderful God! Awesome God!**  
**How majestic is your name in all the universe.**

One: We are called to care for every life here on earth,  
and to seek out life that may exist out there in your universe,  
all life everywhere a part of your sacred work of creation.

**All: Wonderful God! Awesome God!**  
**How majestic is your name in all the universe.**

**PRAYER OF CONFESSION** (*Inspired by the UCC Statement of Faith in the Form of a Doxology, 1981 and Proverbs 8*)

One: You, the God of our Savior Jesus Christ and our God, call us into being.

**All: You have given us the choice between life and death.**

One: Forgive us, God of Creation, for the times we have chosen death over life.  
We have caused death to plants and animals as we have abused technology.  
We take more than we need of the resources made so abundant in creation.  
We have caused death, actively or passively, among our brothers and sisters.

We have chosen to fight for oil and water, for minerals,  
and for land we think we need as our hunger for more things grows.

**All: You seek to save us from aimlessness and sin.**

One: Forgive us, God of curiosity and wonder,  
for the ways we have wasted our time, our talents, and our treasure.  
We have valued entertainment more than knowledge and opinion more than wisdom.  
We have taken away the tools of those you called to be explorers of the world.  
We have made ourselves slaves to technology  
instead of using technology to improve the world for all life.

**All: Wisdom calls to us.**

One: God of atoms and evolution, you reveal yourself in all that is created.  
And yet, we often disregard science, the close study of creation,  
because we are afraid of what it will tell us.  
We experience the world not as it is but as it appears,  
and so we sometimes refuse to believe the truth,  
and declare your laws of physics to be nonsense.

Still Speaking God, as our understanding of the world grows,  
so does our wonder at your presence in ever-evolving creation,  
leading to a way of life abundant on earth.  
And yet, our limited understandings sometimes sets limits  
on what we believe you can do.  
We think, if evolution is true,  
how can we who are human bear within us your image?

**All: Wisdom is at play in the world.**

One: At the same time, God of all time and all space,  
We are tempted to make an idol of scientific understanding and modern technology.  
Forgive us when we discount ancient wisdom as its own form of understanding  
revealing truth that science has not yet discovered.

**All: We seek to change our ways.**

**Help us, Holy One, to evolve and to change  
and to seek you wherever you are to be found.  
Grant us courage.  
Grant us understanding.  
Grant us wisdom.  
Show us the path  
so that we will no longer live aimlessly but with purpose,  
called and prepared to give blessing and honor, glory and power unto you.**

## WORDS OF ASSURANCE

One: Hear these truths:

God creates us in love to be love.

God loves us even in our imperfections.

God forgives us through the life, death, and resurrection of Jesus Christ, Love Incarnate.

**We bear within us the image of God that empowers us  
to choose life over death  
to act wisely using the gifts given to us,  
to live without fear,  
to understand truth.**

Let us claim that image of God within us,  
that we might show God's unchanging love, mercy, and  
grace to the world as we have seen and experienced it ourselves.

**Thanks be to God, Creator, Wisdom, Spirit!**

## SERMON PROVOKER

*What if the vision that Lady Wisdom shares in Proverb 8:22-31 is still being cast? How might we, who know that God is still speaking through scientific understanding and exploration, write that vision down today? What does it mean that Lady Wisdom "delights" in playing with humankind? If, as the author of Colossians says, all things in heaven and earth, visible and invisible, are created "in" or "by" Jesus Christ and Christ is that which holds all things together, can we then understand scientific exploration and experimentation as expressions of faith?*

**COMMUNION LITURGY** *using the chorus and part of verse four of "In Chaos and Nothingness" by David Lee, (c) 2012, found at <http://www.servicemusic.org.uk/hymn/creation.htm>.*

## Invitation

One: We gather this morning at the invitation of our God,  
who has been saving us since we first cried out in awe, aware for the first time of God,  
who has existed since before time began.  
This is the table of all God's people, young and old and in between,  
all gender identities, married and partnered and dating and single,  
confident and questioning and confused,  
cynical and naive, sated and famished.  
There is a place card for you at this table which reads,  
"My Beloved Child."  
Come, let us feast in fellowship with Jesus Christ and all the saints.

## Thanksgiving

One: God be with you.

**All: And also with you.**

One: Lift up your hearts.

**All: We lift them up to God.**



One: Let us give thanks to our God.

**All: It is right to give our thanks and praise.**

One: It is always right to give thanks and praise to you, our God,  
who creates the universe  
while Holy Wisdom delights in all that is within it.  
Creative Wisdom, we stand in awe of your imagination.  
out of which came the laws of physics that define the behavior of all matter.  
We laugh with joy to see all that chemistry does for us,  
from baking soda and vinegar explosions  
to medications that save the lives of our loved ones.  
Mountains and valleys, forests and beaches, lakes and oceans  
all exist because of the geological processes that shape and form the Earth.  
We rejoice in DNA, which unites every living thing on Earth  
from the smallest bacteria to the great humpback whales and marks us all as yours.  
The vastness of space amazes us.  
From the moment you created matter  
out of nothing at the beginning of the universe,  
you have sought the unity of all things in you.  
Through millions and billions of years,  
you have loved into existence galaxies, stars, and planets  
and perhaps life on those other planets, as well.

And yet you, Holy God, Creator, Wisdom, and Spirit,  
have so much love to share that you seek relationship with each one of us.  
You care enough to love each of us and to know us by name.  
You save us with your love as you saved the Israelites before us.  
Through teachers and prophets, you have called us to relationship,  
keeping the covenant promises through the ages on Earth.  
And so, with your people on Earth and all the company of heaven,  
we praise your name and join the unending hymn,

**All: Holy, holy, holy Lord, God of power and might.  
Heaven and Earth are full of your glory! Hosanna in the highest!  
Blessed is the one who comes in the name of the Lord. Hosanna in the highest!**

One: Christ, Holy Wisdom, who holds all things together,  
from the smallest quantum divisions of matter and energy  
to the entire universe,  
from each individual human heart, mind, and spirit  
to the Church Universal,  
is the One in whom and by whom all creation has come to be.  
What a marvel it is for us to know that  
the One who is before all things  
was pleased to dwell in human form  
in the person of Jesus of Nazareth,  
to reconcile all creation to you, our Creator,

through the power of the cross and the empty tomb.  
Jesus taught and preached your love for us,  
inviting people to experience your love  
in tangible, hopeful ways.  
When Jesus gathered with his disciples for the last time,  
they told another story of how you, our God, sought to save us,  
and then Jesus gave us a new way to remember your salvation.  
He broke bread for his disciples and said,  
“Take and eat, for this is my body, broken for you.  
Do this to remember me and all that I have taught you.”  
At the end of the meal, he poured out the last cup of wine, the cup of blessing, for them,  
saying, “Take and drink, for this is my blood of God’s new covenant with you  
for the forgiveness of sins. Do this to remember me and all that I have taught you.”  
We do this today in remembrance of these, your mighty acts in Jesus Christ,  
and we offer ourselves in praise and thanksgiving as a holy and living sacrifice,  
in union with Christ’s offering for us, as we proclaim the mystery of our faith:

**All: Christ has died. Christ is risen! Christ will come again.**

One: Transcendent and immanent, God ever three, ever one:  
We praise you and worship you, Father and Spirit and Son.

**All: We praise you and worship you, Mother and Spirit and Son.  
Invisible God, given visible image, you came,  
Breathed order and life:  
Jesus Christ, Name above every name.  
All honor and glory is yours,  
Almighty God, now and forever. Amen.**

#### **Prayer after Communion**

One: Let us pray:

**All: Holy God, Creator, Wisdom, Spirit, we have been nourished  
in this meal at the table you set for us.  
As we go from this place, may our encounter with holiness  
inspire us to explore creation in new ways.  
May we be unafraid to experience the joy of discovery,  
the wonder of unexpected outcomes,  
and the peace of knowing that  
all creation belongs to you.  
Amen.**

#### **Hymn Suggestions:**

—“*In Chaos and Nothingness*,” lyrics and tune by David Lee, (C) 2012. For the main page of the hymn, visit <http://www.servicemusic.org.uk/hymn/creation.htm>, from which a .pdf of the

hymn set to the tune and commentary on the hymn are both accessible. Mr. Lee is generous with copyright permissions, as outlined on his site.

—“*Earth and All Stars*” verses 1, 2, 5, and 6 by Herbert Brokering, to the tune “Earth and All Stars” by David Johnson; for a list of hymnals including this hymn, visit

[http://www.hymnary.org/text/earth\\_and\\_all\\_stars](http://www.hymnary.org/text/earth_and_all_stars).

—“*God Who Stretched the Spangled Heavens*,” lyrics by Catherine Cameron, tune traditionally “Holy Manna” by William Moore; **The New Century Hymnal 556**.

***A Service with Communion for Faith, Science and Technology Sunday*** was created by Rev. Ruth E. Shaver, Pastor and Teacher, The United Church of Schellsburg United Church of Christ, Schellsburg, Pennsylvania. Shaver is a candidate for the Doctor of Ministry Degree at Lancaster Theological Seminary; her project is designed to encourage people of faith to engage in scientific exploration and experimentation as a practice of faith.

### **UCC Faith, Science and Technology Sunday**

It is with collaboration and theological imagination that many UCC churches are joining with ecumenical and interfaith partners who celebrate “Evolution Weekend” in the month of February connected to the Clergy Letter Project. The UCC formally designated Faith, Science and Technology Sunday in February ‘closest to Darwin’s birth date on the 12<sup>th</sup> that does not conflict with another named Sunday.’ Taking a broad view that celebrates all the sciences, this particular Sunday is designated broadly for all the sciences: including evolutionary biology, and those who study and teach them.

The United Church of Christ’s decades-long advocacy for engaging faith, science and technology inspired a full year of church wide study with the pastoral letter *A New Dawn Arising: Faith Engaging Science* <http://www.ucc.org/not-mutually-exclusive/pdfs/pastoral-letter.pdf> which may be used as a follow up to a science & tech themed worship as an education and formation study piece.

Connections between spirituality, science and technology continue to be sparked by the work of the late UCC physicist, Nobel laureate, and Templeton award winner: Charles Townes. Also by the groundbreaking work of the UCC’s late Ian Barbour, and all those who are passionate about the intersections of science in medicine, technology, ethics, astronomy, geology, climate, to name a few - and the religious imagination.

## **Appendix B: Improbable But Not Impossible**

United Church of Christ Science and Technology Sunday

February 7, 2016

Rev. Ruth E. Shaver

Luke 7:1-10, 9:28-36, and Colossians 1:15-20

“With God, all things are possible.”

“Nothing will be impossible with God.”

“If you have faith like a grain of mustard seed...nothing will be impossible for you.”

“I can do all things through Christ who strengthens me.”

We blithely make these statements about our faith and use them, quite often, as firewalls when we are faced with challenges that seem impossible to overcome or need a miracle to turn events our way. For a long time in my own faith journey, I wasn't entirely sure I believed these statements, but now I am convinced of their truth and, as odd as it sounds, it's all because of science.

Physics, particularly, and to be very precise, quantum physics.

The hard part about quantum physics is that although the laws by which the entire universe exists operate at the “quantum level,” we can't see that level. It's mostly math that tells us it even exists, but the math is incredibly elegant even if it's not simple. I'm not a mathematician, so I am grateful for the many scientists who have tried to put complex equations into words that I can wrestle with as I seek to understand them. So, a short primer first:

Everything in the universe is made of matter. Think elements like hydrogen and carbon and silicon. Atoms are the smallest “whole” object in the universe; an atom of carbon is just as

much carbon as a diamond is carbon, though too small to see without a scanning electron microscope. Scientists used to think that atoms could not be destroyed, but the advent of the nuclear age proved that untrue. We know now that atoms have particles called electrons, protons, neutrons, and a whole family called quarks named up, down, strange, charm, top, and bottom.

It's these particles that most interest me because of what we can and cannot know about them at any given time. The math tells us that we can know the location of a particle or we can know the velocity of a particle but we cannot know both simultaneously. If we know the location, the speed can only be known within a range of probabilities: if a top quark is at position X now, it could be moving at any speed between 12 and 47 miles per hour, for example (that's just a simple example!), with the highest probability between 23 and 39 miles per hour. If we know it's speed, say, 32 miles per hour, we can know it will be somewhere between position X and position Z with the highest probability at position Y. Thus, any position between X and Z is possible though some are more probable than others.

If this makes no sense to you based on experience, it's okay. We don't experience the world or the universe in probabilities; we experience it as cause and effect. If we do A, B happens: objects in motion tend to stay in motion, objects at rest tend to stay at rest—unless acted upon by an outside force. It takes more effort to move a heavy object than a light object. For every action, there is an equal and opposite reaction. We use those observable laws every day to do things as simple as walk and drive our cars or ride our bikes and they work really, really well for us most of the time.

Except that our theology is based on those laws of cause and effect, making miracles inexplicable and easily dismissed by skeptics. When miracles do happen, if this cause and effect

theology is what we practice, then somehow we've earned the miracles or done something to cause the miracle. When they don't happen, we think we've somehow failed.

But a theology that is anchored in probabilities, like quantum physics, takes away that sense that we can do something to cause miracles and, surprisingly, makes them a part of the very fabric of the universe because that's the way God wrote the laws that make the universe run. Though miracles are highly improbable in this kind of theology, they are *possible*. How awesome is it to think that God could have imagined miracles before the universe even existed?

The three readings today speak to different aspects of things that our rational brains say are impossible (two of them are actual miracles), yet that we know to be deeply true:

—Jesus healed people. He healed them because they believed and he healed them because others who loved them believed. We don't know the how, but we know it happened and these healing stories tell us important things about God's power.

—Jesus was transformed in a way that reminded his disciples of the stories of Moses and Elijah. Maybe the disciples believed the stories were absolutely true, maybe they thought they were fairy tales; after witnessing the transfiguration of Jesus, they knew those stories to have deep and powerful meaning about God's power.

—The author of Colossians, who was not Paul but could have been a student of Paul, connects Jesus to the creative power of God directly. Creation is because Jesus is and everything is connected through Jesus Christ.

We take these stories and many more like them as tenets of our faith. These events happened and were recorded 2000 years ago and still have power.

Some would tell us these stories have power because we're deluded into thinking that God exists by them and we aren't mature or rational enough to let go of the idea of God. These same people will, if you allow them, go on at length about how modern science has disproved the existence of God and shown that faith is a residual and unintentional byproduct of the evolution of humans as a social species.

And yet...

Modern science has revealed some fascinating truths about the universe that the Bible presented in a different way 2000 years ago and more.

Modern medicine has given us a tremendous arsenal of treatments to help cure diseases: antibiotics, chemotherapies, radiation, transplant procedures, surgical advances. We can manage diseases with no cure in ways that allow people to live good quality lives for many years beyond the natural progression of their disease: dialysis for kidney disease, medications for congestive heart failure, synthetic thyroid for hypothyroidism, etc. We can even prevent diseases with vaccines. But even with all of this, people still get sick and die. And even with all this, there are people who are completely healed with no treatment or after all treatments have failed and there are never good explanations for these hearings except miracles.

Could it be that miraculous healing happens because of something that happens to electrons, protons, neutrons, and quarks in the atoms of cells? If God wrote the rules that govern the universe, and these miraculous healing experiences can eventually be explained by highly improbable but entirely possible activity at the sub-atomic level of cells, then it means *that God wrote these miracles into the very fabric of the universe*. Perhaps Jesus, as God incarnate, had an ability or power that allowed him to influence quarks and muons and fermions toward the

healing process. Perhaps others do, as well, either through prayer or physical touch. Improbable? Absolutely. Impossible? Not according to science.

What of the transfiguration?

If I started to glow right now, you'd all probably run, someone would call 9-1-1 and no doubt a hazmat team would be dispatched along with the ambulance and fire crews, and I'd no doubt be put in isolation and studied inside and out for weeks until the glow could be explained and treated or dismissed as a mass hallucination. Our immediate thoughts would go toward an exposure to radioactivity— but I have to tell you that the jokes of my classmates about me being in “glowing health” after I visited the old Soviet Union within a few months of the Chernobyl accident were only funny the first three times.

Did you know all of us really do glow in the dark at least a little bit? We do, thanks to some of the chemical reactions that take place in our bodies, though on a smaller scale than the reactions that make fireflies glow and algae in bodies of water light up in the waves and currents.

The disciples fished on the Sea of Galilee. They would have seen bioluminescence in the waters and probably on the shore, as well. But they would have had no way to explain what they saw and very likely would never have seen a person glow except, perhaps, when they were in the water or wet with it. They had no doubt seen meteors streak across the sky and perhaps had even seen one smash into the earth, though they would have been unable to explain that what they had seen was debris from outer space. But they knew the story about Moses, who had what amounted to a face-to-face conversation with God and forever after had to wear a veil over his face because he shined so brightly that his face made people's eyes hurt. They knew about the chariot of fire that carried Elijah up into heaven when his earthly prophetic mission was completed, which



reflected Elijah's glory into the world. So when it happened to Jesus, they knew something very special and very rare was going on.

What if...the same science that makes all of us glow a little bit sometimes makes people glow a whole lot? If God wrote the rules that govern the universe, and these chemical reactions that happen to humans every day sometimes get so big that the light can be seen in broad daylight, then it means *that God wrote these transfigurations into the very fabric of the universe*. Improbable? Absolutely. Impossible? Not according to science.

I'll pause here to say that none of this makes the existence of God less likely or God's power any less amazing or life-changing. In fact, for me, it makes God more real and God's power more phenomenal because it means that the basic laws that govern our very existence allowed for the possibility of miracles. Explaining them makes them no less miraculous: we know how babies are conceived and born, but is any child any less a miracle because we know? On the contrary, it's such an unlikely evolutionary mechanism that knowing the details of how it works makes it that much more incredible.

Our God wrote miracles into the very fabric of the universe because according to Colossians, Jesus IS the fabric of the universe: "in him, all things hold together." I would find it hilarious if the old joke about scientists discovering the ultimate purpose of the universe only to find that theologians had been there for millennia came true, which is what this passages says. God's glory is the purpose of creation and Jesus Christ is the ultimate evidence of God's glory. Think about what it means for the fullness of God to dwell in Jesus Christ if we put that whole passage together: the fullness of God dwells in Jesus Christ who is the very fabric of our universe. That is a heady theological concept, isn't it? It connects all of creation in and through Jesus Christ and makes the idea of reconciliation to God much more real, doesn't it?

Here's what science tells us: Particular measurements are exactly right for the universe to be the way it is; if any of those were different by even one one-millionth of a unit, we would not be here to contemplate all of this because things would never have unfolded into our universe. Everything in the universe is connected from the moment of the big bang until the end of the universe. Every quantum particle in the universe is paired with at least one other one, possibly many more, and each entanglement works across time and space instantaneously, which should be impossible because nothing is supposed to move faster than the speed of light in a vacuum. We are made of elements that were born in the hearts of stars that went nova or supernova billions of years ago. The existence of the universe is highly improbable, yet here it is. Our sentience is highly improbable, yet here we are. Why? *Because God wrote the laws that govern the improbable but not impossible things that we encounter every day.*

What I have discovered on my journey toward my doctorate is that science, far from turning me away from faith, has deepened and broadened my faith. Knowing more about the mechanics of the universe gives me greater appreciation for God's imagination. Now I can wonder, could God have created a completely different universe with different values for the essential measurements, and if so, would life have evolved in that universe to look up and say, "Wow!"? Our science says no, for now.

Then again, what science doesn't know dwarfs what it does know even today. My hunch is that because God wrote the laws, and because Jesus Christ is the very fabric of the universe, we are going to discover many, many more impossible things are not, in fact, impossible but are just very, very unlikely. Like the healing stories we read, like the Transfiguration, especially like the Resurrection, we may only be able to speculate about the true nature of these things. But science tells us that these things can be true and real even if we never experience them for

ourselves. And there is nothing wrong with undergirding our faith that nothing is impossible with God with a bit of scientific knowledge that proves exactly that. So the next time you hear someone say that something is impossible, remind them that nothing is impossible. Often, what seems impossible is just highly improbable!

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