The Origin of Life: A 3-Discipline Approach

Abstract

The field of geology reveals significant, naturally preserved information about the earliest forms of life on Earth and the timeline in which they appeared. Geologic evidence also gives testimony to the rare balance of environmental conditions on our planet that are especially suited to the flourishing of human life. Biology shows that life is a continuum, received by individual organisms through generations of parents and grandparents. Evolution is a biological process that has profoundly influenced life on Earth, but its role is simply to shape, not to originate, life. Theology, which is itself a science, explores the data revealed by God about Himself. Biblical accounts of creation, of which there are several, are noteworthy for their presentation of humanity as fundamentally good, the product of God's specific, creative will.

Geology, biology, and theology should be considered not inimical, but complementary. Through the convergence of faith and reason and the harmony of these three distinct disciplines, there arises a unified perspective concerning the origin of life. According to this perspective, the physical world with its abundant life bears evidence of a design that transcends chance and empirical measurement.

Introduction

Are science and theology irreconcilable with each other on the subject of the origin and development of life? We think they are not, and we bring together thoughts from three distinct fields of study in search of truth. Some philosophers believe that ultimate reality proceeds from

the mind of man or from God, whereas many others over the last two centuries believe that the physical universe of matter and energy are the only reality. This latter view obviates the need for a creator but has trouble accounting for the addition of "information" to the matter/energy mix.

There are several competing theories that attempt to explain how life on Earth began. Creationism, as it is now defined, posits a young Earth and calls for a literalist interpretation of the creation story in Genesis. Intelligent design uses arguments from logic and "inference to the best explanation" (Lipton 1991) to infer design, but not the designer, as the source of information in the coded sequences in DNA. Other "natural" theories appeal to RNA as the source of the first information, (Gilbert 1986) but these seem more interested in denying design than in explaining the origin of the information. Natural selection based on random mutation explains some of the changes observed over time but does not account for the first life. Behe provides a thorough analysis of the limits of natural selection (2007) while Fowler & Keubler provide a comparison & review of the competing theories (2007). On this subject, Pope Benedict XVI explains, "The Christian idea of the world is that it originated in a very complicated process of evolution but that it nevertheless still comes in its depths from the Logos. It thus bears reason in itself. (Ratzinger 2007).

Extensive fossil evidence for life on Earth exists, dating back approximately 3.8 billion years (Ga). There are various explanations for its origin, including the addition of energy (perhaps in the form of lightning or shock from meteor impact) to a mix of carbonaceous materials. This occurrence would not require a creator; it would, however, require a method to

cause simple amino acids to grow first into large molecules, then cells, and eventually organisms. Again, how did the coded information come into being? The existence of a designer would ease the explanation of this progression.

All life, whether it be plant, animal, or human, possesses information in the living cells. This information is used to replicate individual cells and even whole organisms. Whereas matter and energy follow physical laws that are either known or yet to be discovered, life is unique in that it exhibits information in the DNA code that is not present in crystals or other natural forms of matter. This is analogous to the zeroes and ones in a computer; unless they are arranged in a meaningful order, they contain no information. For example, the binary code 1100001 can be used to represent the character "a," whereas 1000001 represents "A". Before the American Standard Code for Information Exchange (ASCII) experts set forth the equivalence of binary numbers with alphabetical and other characters, there was no information in the binary sequence. In like manner, the DNA sequence carries more than chemical data. It also carries instructions for building an organism.

If we define human life as *Homo sapiens*, fossil evidence takes us back about 200,000 years. While some people have argued for an Earth that is only 6000 years old, based on the generations recorded in the Old Testament, that age is clearly out of line with the radiometric date of 4.5 billion years. Few scientists still maintain the young Earth hypothesis, and even fewer subscribe to creationism. The assertion that the Earth with its plants and animals existed for only five days before the appearance of man on the sixth day makes the young Earth hypothesis

difficult to accept; the hypothesis is even more improbable if one considers a series of catastrophes to account for the observable geologic features of the Earth. Catastrophism has largely given way to uniformitarianism, which claims that the geologic processes of the past were similar to those seen today. Uniformitarianism does not preclude catastrophes such as earthquakes, volcanic eruptions, floods, and the like, but it does allow for an old Earth. Notably, the Old Testament makes no direct claim for the age of the Earth, and even the Genesis order of creation is consistent with the evolutionary appearance of species. The only event that is out of order is Day 4 when God is said to have created the sun, moon, and stars.

From three different perspectives, we shall endeavor to demonstrate the convergence of faith and reason and the harmony of distinct disciplines, leading to a unified perspective concerning the origin of life.

Geological Perspective

Cosmology

According to the big bang theory, the universe is calculated to be roughly 13.7 billion years (Ga) old, based on extrapolating the current rate of expansion backwards. Geologic and astronomical evidence shows that the Earth formed about 4.5 billion years ago, by condensation of gaseous nebular material, followed by accretion into planetary bodies, followed by chemical differentiation on the Earth into core-mantle-crust. Shortly after the Earth's differentiation, it was struck by a large (Mars-sized) body. The impact sent debris into Earth's orbit, and that debris accreted to form the moon (Hartman and Davis 1975). Therefore, the composition of the

moon is similar to the Earth's mantle. Recent studies using isotopic ratios and computer simulations (Ćuk and Stewart 2012) have attempted to refine the time and conditions of impact, but the basic impact theory remains generally accepted. However, the nature of the collision does matter, because size of the impactor and the geometric configuration of the impact could affect the Earth's tilt. Inasmuch as the Earth's tilt controls the seasons, the origin of life could be affected (Canup 2013).

Geology

Geologists partition time into eons, eras, periods, and epochs, from longest to shortest. Along the same scale, those who study history can be: astronomers, geologists/planetologists/paleontologists, anthropologists/archeologists, and historians. The work of biologists and theologians, meanwhile, applies throughout this time scale.

Early History of the Earth

To obtain some understanding of the milestones involving life on Earth, we must consider both relative and absolute dating methods. In relative dating, the law of superposition says simply that the strata above are younger than the strata below. While relative methods are useful in the field under certain circumstances, they do not establish the absolute age of rocks and ultimately cannot reveal the age of the Earth. For absolute dates, geologists need radiometric methods.

Various means of absolute measurement all confirm that Earth's age is approximately 4.5 Ga. These methods include long-lived isotopes such as ^{238}U, ages of meteorites and lunar rocks

and the luminosity of the sun (Dalrymple 1991). Other "nuclear clocks" such as Rb/Sr and K/Ar also give ages for old rocks, and the oldest found to date on Earth are approximately 4 Ga. Although carbon dating is familiar to most people, it is not a useful technique for establishing the Earth's age, because it can only be used to date formerly living things that died within about the last 50000 yrs. The uniformity of these radiometric results makes the age of our planet undisputed and renders a young Earth hypothesis untenable.

Early Life

The earliest recorded fossil life on Earth consists of single-celled prokaryotes going back more than 3 Ga—after the end of a period of heavy bombardment. The early atmosphere is thought to have contained little or no free oxygen, making it suitable only for anaerobic organisms. The origin of the Earth's oceans is not well established, but the water could have been adsorbed on the original accreting grains, or it may have been brought in by comets or asteroids (Drake and Campins 2006). The oceans probably formed early in Earth's history during the time of heavy bombardment (4.1-3.8 Ga). Comets and meteorites could also have served as a source of amino acids and other simple carbonaceous compounds delivered to a water-rich Earth. The oxygen-rich atmosphere is believed to have originated about 2.5 Ga as the result of photosynthesis by ubiquitous single-cell blue-green algae, which were part of sedimentary-layered structures called stromatolites. The banded iron formations common near Lake Superior date to about this time and are thought to have formed by the reaction of dissolved ferrous iron in the oceans with the newly formed oxygen-rich atmosphere, resulting in the precipitation of ferric iron oxides. The constitution of the early atmosphere factors significantly

in the discussion of life's origin. If the early atmosphere contained oxygen, then amino acids could not form; if oxygen was not present, then ozone could not form to protect early life.

The temperature at the surface of the early Earth was likely sufficiently warm for life, even though the sun was 30% less intense 4.5 billion years ago (Ward and Brownlee 2000, 32). It also endured a flux of high-energy x rays, UV, and particles from the sun (Ribas 2009). Volcanic carbon dioxide and methane, together with water vapor and the greenhouse effect may be partially responsible for temperature stability, as may the CO_2-rock thermostat. The latter mechanism involves a temperature-dependent chemical equilibrium among silicate rocks, atmospheric CO_2, and both siliceous and carbonate plankton.

Early life consisted of microbes, some of which may have existed in extreme environments (Rothschild and Mancinellli 2001). Even today, extremophiles exist that can tolerate or even necessitate extremes of temperature, pressure, salinity, pH, or radiation. However, nothing in these environments suggests an origin from a non-living precursor. From that point at about 3 Ga, it took roughly 2 billion more years for life on Earth to develop from simple to complex, during which time the atmosphere became oxygen-rich and the oceans may have frozen and thawed several times. By complex life, we mean multicellular simple eukaryotes, such as protozoans, sponges, algae, and fungi, all of which were widespread by 1 Ga.

The Cambrian explosion of species occurred at about 545 Ma, and from this point, the timeline of fossil species follows the order in the creation narrative in Genesis, chapter 1. The process of growth and development transpired over a period of approximately 600 million years, however, rather than seven days. The fossil record is extensive from the Cambrian onward, with many new species appearing but few transitional forms preserved. Mass extinctions occurred at least five times since the Cambrian, and the mass extinction at the Paleozoic-Mesozoic boundary (250 Ma) caused the loss of about 90% of the Earth's species. The cause of these extinctions is not known with certainty, but climate change and extraterrestrial impact are among the most frequently posited triggers. Extraterrestrial impact, of course, causes temporary climate change, so the two claims are interrelated.

Biodiversity recovered from this extinction over the next tens of millions of years, which geologically speaking is only a short time. It seems improbable that random mutation could design the complex structures evident in these new species so quickly. Regarding probability, Teilhard said,

> "In terms of physics and chemistry, the phenomena of life are essentially characterized (in precise contrast to those of matter) by an evolution toward the *least probable*. Improbabilities in the huge and unstable molecules accumulated by organic matter; improbabilities in the incredibly complicated structure of the smallest protozoon; improbabilities of a rapidly increasing order in the formation of higher animals and their development into various and progressive types throughout the geological ages; finally the supreme improbabilities of appearance, conservation, and organization of thought on earth. Man is supported by a giddy scaffolding of improbabilities, to which each new progress adds a new platform." (Teilhard de Chardin 1966).

To say that chance rarely produces improbabilities would be a tautology.

Is the Earth Unique?

Estimates of the number of other planets similar to Earth range from ten trillion (10^{13}) to none (Earth is unique) (Ward and Brownlee 2000, xxiv). Many people, such as Carl Sagan in the 1970s and earlier, argued statistically that there must be many Earth-like planets capable of supporting life (Sagan and Shklovskii 1966). In fact, the Search for Extraterrestrial Life (SETI) is an ongoing program using radio telescopes to search for information-containing radio signals that might indicate an intelligent source. The statistical argument is known as the "mediocrity principle," and its assertion is that the Earth is not special, so there should be many similar planets. The mediocrity principle is challenged by two paradoxes. First, is the Fermi paradox, which asks: *If* the probability of extraterrestrial civilizations is high, *and* the universe is old, *then* why do we lack evidence for or communication with them? The second paradox, called the Great Silence, is posed in this way: *If* life is common, *but* travel is hard, *then* why do we not hear from them by radio?

An alternative to the mediocrity principle is called the rare Earth hypothesis, by Ward and Brownlee (2000). They argue that the Earth's size, location, composition, and other characteristics are unusual and necessary for complex life, defined as higher animals, including man. For example, Earth is at the right distance from the right star to produce a habitability zone with liquid water, moderate and consistent temperatures for carbon-based life, and a constant-output sun of medium size. But there are many more requirements beyond existing in a habitability zone. The Earth also has a *planetary mass* suitable to hold an oxygen-rich

atmosphere and the oceans. Ever since the great bombardment, the Earth has had a *low impact rate*, as most objects are "swept up" by Jupiter's planetary mass. The Earth also exhibits *plate tectonics*, which are responsible for uniform crustal recycling processes punctuated with catastrophic events, such as volcanic eruptions and earthquakes. The movement of tectonic plates is also responsible in part for stabilizing the Earth's temperature. Internal heat from long-lived radioisotopes and residual heat of accretion produces convection currents in the mantle that drive movement of tectonic plates and generate the Earth's *magnetic field* to shield the surface from charged particles. Because of hydrogen bonding, ice is less dense than water, thereby preserving aquatic life in low temperatures. Are these mere "anthropic coincidences," or are they evidence of a design laid specially for the flourishing of mankind? Although the Earth's characteristics are suitable for carbon-based life, is it not possible that other forms of life (e.g., silicon-based) could exist elsewhere? The answer is no, because the properties of all 92 stable elements are known, and they are demonstrably unsuitable for complex animals.

So, what is our position in the universe? For a thorough discussion of this question, see *The Privileged Planet* by Gonzalez and Richards (2004). The authors of this present paper would not be surprised if there were other civilizations similar to ours, because, if the biological information we find here was designed, then the designer could have designed a similar world elsewhere. However, the authors would be equally unsurprised if we were alone in the universe.

Biological Perspective

How Did Life on Earth Originate?

From the biological perspective, the origin of life is traditionally considered to be heterotrophic bacteria. These were bacteria that fed on carbon sources from the environment more than 3 billion years ago (Lazcano 2010). Although these microbes contained information coded in their DNA, another two billion years passed before the Earth saw evidence of "complex" organisms. Initially, complex life meant the ability to exhibit distinctive shapes, manifested by such organisms as sponges and mollusks. Complex life continued to progress though, and matured into the species *Homo sapiens*.

Abiogenesis

Scientists have no definitive, mechanistic answer for the origin of life on Earth. A theory of abiogenesis exists but remains weak for its failure to account for all the known data. Of particular note, abiogenesis does not explain the origin of information coded in the DNA molecule. The theory stems from a set of experiments conducted in 1952 by Stanley Miller and Harold Urey at the University of Chicago, in which they attempted to test Alexander Oparin's hypothesis that organic life on Earth could originate from inorganic compounds (Miller and Urey 1959). By testing this hypothesis, Miller & Urey were hoping to provide an explanation for spontaneous creation of life. In the course of their experiments, they correctly synthesized more than twenty different forms of amino acids by passing electrical discharge through a mixture of water, methane, ammonia, and hydrogen. Although seemingly a success, amino acids are the

building blocks of proteins, not nucleic acids, and it is nucleic acid molecules that encode details for instructing the cell to make amino acids. Nucleic acid is a prerequisite for amino acids, and the Miller-Urey experiments failed not only to generate nucleic acid, but also to thoroughly explain how information is coded in DNA.

Furthermore, there is mounting evidence that Earth's early atmosphere contained additional components of which Miller and Urey were unaware. Despite being the most well known, Miller and Urey were not the first to hypothesize abiogenesis. Nearly a century earlier, experiments were conducted to test the same question, and the results similarly offered strong evidence against the validity of spontaneous generation. Among this group of experiments, perhaps the single most influential experiment to discredit spontaneous abiogenesis was conducted by Louis Pasteur in 1861. During his experiment, he proved that primitive biological life such as fungi and bacteria could not spontaneously generate even in the presence of abundant nutrients (Oparin 1953).

Numbers Game

The logical alternative to abiogenesis is biogenesis, meaning that a living thing must be born of another living thing. How is it, then, that life is capable of evolving from single-celled, non-diverse organisms to multi-celled, complex organisms capable of independent thought? *Homo sapiens* possess an estimated 100 trillion cells and 3 billion DNA base pairs in each cell, which combine in different patterns to make humans a diverse species (Purves 2008). The Human Genome Project, which undertook the goal of sequencing the entire human genome, discovered that DNA within the entire *Homo sapiens* species is over 99.9% similar (International

Human Genome Sequencing Consortium 2001). Therefore one person's DNA can differ from another's by no more than 0.1% or 1 in 1000 nucleotides. Taking the maximum possible nucleotide difference between two humans and accounting for the almost 7 billion people on earth, there are 2.1×10^{30} opportunities for genetic differences among all human beings. With the opportunity for such variable combinations to form, how is it that human after human is created essentially the same? How is it that the 0.1% that makes each of us unique is so finely tuned to account for clear differences in hair color, eye color, skin tone, and even more subtle differences, like different wiring patterns in the brain, the amount of beats your heart will give you during your lifetime, and what conditions predispose you to certain diseases? It would seem difficult to attribute these similarities to natural factors or chance alone (Meyer 2009).

Evolution

A prevailing theory in the modern world proposed to account for genetic differences between species is evolution. Evolution can be defined as the change in genetic composition of a population during successive generations. Note that chance is neither specified nor required. In any critical discussion of evolution, the mechanisms of genetics are not in question. However, neither the ability of DNA to carry information nor the source of that information is addressed in Darwinian evolution. These phenomena are more plausibly the result of design.

We want to state clearly we are not arguing against evolution. Evolution played an essential role in making life what it is today and will continue shaping life in the future. The distinction to be understood is that evolution can be credited for influencing life, but not for

originating life on Earth. Briefly, Darwinian evolution is made up of common ancestry and natural selection acting on mutations. Common ancestry postulates that all species descended from a mutual relative, rather than evolving in parallel. Natural selection is often described as survival of the biologically fittest, where biological fitness is defined as the production of a large number of offspring (Darwin 1859).

There seems to be a limit, however, on the number of random changes to cellular information that can produce favorable effects. Science has accepted that the most common mechanism of evolution is mutation, of which there are three possible outcomes: neutral, advantageous, or deleterious. Deleterious mutations are usually extreme and often result in embryonic lethality, or at least a significantly reduced lifespan for the affected organism. These mutations are difficult to see for the above reasons. Neutral mutations are relatively common, but, precisely because they are neutral, natural selection does not act on these very often. The third and least common form of mutation is a positive one. A widely referenced example of a mutation affecting a population broadly for the better is a gene mutation in hemoglobin, the protein responsible for carrying oxygen in the blood. The malaria virus relies on normally shaped blood cells to invade the human body, but if an individual has one copy of the mutation in hemoglobin that causes sickle cell anemia—a disease in which the red blood cell is sickle-shaped instead of round and circular—they acquire immunity from malaria, and thus the mutation is considered beneficial (Behe 2007).

Of these random mutations, two, three, or more are often required to confer beneficial effects and natural selection has trouble explaining such occurrences. After all, if one random mutation is deleterious and causes lethality, two or three random mutations will never arise. In the case of malaria, approximately 1 in 10^{20} is the chance of acquiring a double mutation with a positive outcome, according to Behe. Clear evidence is offered beyond the numbers, as well, since chance mutations do not support the possibility that evolution is able to create storage information systems with ways to access, replicate, proofread, use, and degrade the information.

Unrepeatability

Genetics are central to the generation of human life, but they do not solve the fundamental question of origin. With so much similarity in DNA among human beings, it is easy to understand why there are only a limited number of genetic traits. That hair color, for example, is limited to four broad categories (brown, black, blond, red) is not astonishing. Certainly people can exhibit varying degrees of hair color (strawberry blond, dark brown, etc), but if there were only four options, all non-bald humans (excepting those grown gray or white) would fit into one of the four categories. Neither is it uncommon for people to be mistaken for other people; sometimes, people even appear to have an unrelated "twin" on account of such a similar combination of physical characteristics. It remains true, nevertheless, that physical characteristics are both fleeting and reproducible.

Regardless of how similar people may be in appearance, everyone innately accepts the fact that no two people are exactly the same. It is often observed, for instance, "no two

individuals are alike." The distinguishing attributes that make humans unrepeatable, it would appear, are interior characteristics with a deeper-than-physical (i.e., metaphysical) basis.

When Does Human Life Begin?

Having explored the manner in which life first originated biologically, let us shift our focus to the manner in which human life originates today. A widely debated concept is the precise moment when human life begins. The crux of the debate for most people is whether an accumulation of cells in the womb constitutes life, but this is actually unquestionable. The mass of cells (embryo) is most certainly life, because the "cell" is the smallest unit classified as a living thing (Alberts 2002). The mass of cells grows only by the union of two other cells, both of which are living in their own right (Scientists for Life 1975, 8).

Much of the world, then, is searching for an answer to the wrong question. To ask when the life of a particular organism begins is nonsensical, because biological life is a continuum, not a finite experience. Life is continuous from individual organisms back through parents, grandparents, etc. The question that many people intend to ask is, "When does a mass of cells become a person?" Our instincts rightly tell us there is more to "being" than simply organizing a group of cells within close proximity of each other; otherwise, all human beings are simply indistinct masses of animated cells. While the biological evidence testifies that a distinct (though not independently viable) organism is formed at conception, the moment at which that organism can be considered a "person" animated by a soul is less clear. Vigorous debate continues between those who advocate the theories of immediate and delayed infusement, but this is not a

biological debate (May 2008). It is clear that transmission of life occurs from mother to child, but the question of when a new person is established lies outside the discipline of biology.

Theological Perspective

Theology as a Science

In the modern age, the relationship between theology and science is commonly understood as a tension. The understanding of many centuries, however, is quite different. Theologians of ages past and present would not describe the interplay of theology and science as a tension, since theology, itself, is a science (Aquinas).

What is a "science"? It is a body of knowledge characterized by system and rigor. Like other sciences, theology possesses an organizational system, including various branches and academic methods. It also exemplifies rigor, since the task of theology is to explore in a disciplined manner that which is contained in revelation (i.e., the knowledge God communicates to man about Himself) (Nichols 1991, 32). All sciences accept certain first principles, which are held to be universally true. In the case of the physical sciences, these first principles derive from what can be observed in the world and are called "laws." In mathematics, they are called "axioms." In the field of theology, these first principles are ascertained from the deposit of revelation.

When theology is properly understood as a science, it is able to contribute knowledge not only of physical realities, but also realities that lie beyond the physical.

Sacred Writings

Early Creation Myths

Historically, belief in a creator god is common to the religions of every great civilization of ancient times. Written evidence of this shared aspect of faith is present even in civilizations that could not possibly have had contact with one another. The religion of ancient Babylon, for example, crafted the famous Enuma Elish creation story. This Mesopotamian myth tells the tale of Marduk, the god of light, who is chosen to wage battle against Tiamat, a sort of primordial dragon. Marduk achieves victory by splitting the body of Tiamat into two halves. These halves Marduk then fashions into the Earth and the heavens. Thus, the Babylonian creation story depicts a sinister world that, at its very core, is founded upon rebellion, divorce, and evil.

The Bible

Many similar stories from ancient religions have been discovered. One might reasonably expect clear parallels among other ancient Near East traditions. What is found, however, in the Judeo-Christian Scriptures, despite certain similarities, is an overall radically new worldview. It is a striking novelty of these sacred writings that the foundation of the world is not portrayed as demonic. The Bible, in a major historical breakout, asserts that the world arises instead from the reason of God and rests upon His Word. The distinguished theologian Joseph Ratzinger (later Pope Benedict XVI) refers to this novelty as an "enlightenment" (Ratzinger 1995, 14).

The primary text in the field of Christian theology concerning the origin and development of life is the Book of Genesis. It is important to note, however, that there are several creation stories provided in the Old Testament. In fact, there are two distinct accounts of creation in Genesis alone. In addition, there are further creation accounts given in the Psalms and others in the Wisdom literature. The creation accounts extend even beyond the Old Testament, with "the conclusive and normative scriptural creation account" (Ratzinger 1995, 15) being found in the prologue to the Gospel of John (John 1:1-18).

Each account uses its own diverse imagery. The Wisdom accounts, which have the latest dates of composition, employ new images specifically tailored to confront the emerging Hellenistic milieu. This multiplicity of images is, itself, telling. One might first accuse these various accounts of being contradictory and senselessly collected together under the cover of one Bible. We might, alternatively, view their divergence as witness that the images are not ends in themselves, but vehicles intended to convey latent truths.

The Book of Genesis, like every biblical book, attempts to convey a truth, albeit not necessarily in a strictly historical way. Genesis is not a history by genre, and it should not, therefore, be expected to conform to that genre or to convey history in the same way as would a work of history. In fact, the genre of history as we understand it today is a category created only in modern times. Because adherents of "creationism" wrongly treat Genesis and other scriptural sources as though they were science textbooks, they are forced to make claims about the origin of

Earth that are in direct contradiction with the findings of geology and biology. No such contradictions arise when the context and genre of biblical texts are taken into account and respected.

What can be learned from the various creation accounts of the Christian Scriptures? The first account (Genesis 1:1–2:4a) is the familiar story of the seven days on which the Lord spoke into being light, sky, oceans, plants, stars, animals, and finally mankind. It tells the reader that God fashioned the world out of nothing (*ex nihilo*) and that man is molded in the image of God (*imago Dei*). This passage underscores the points that God's creation is good and that man is placed in dominion over it. Perhaps the most overarching truth conveyed in this text is that the world is not simply a chaos of forces that are mutually opposed to each other; rather, it is ordered—even designed.

The second creation account of Genesis (Genesis 2:4b-25), which was actually composed considerably earlier than the account in the preceding chapter, demonstrates a decidedly distinct approach to the etiology of the world. Instead of breaking down the order of all creation and leading up to man, this second creation myth begins with the formation of man and then proceeds to God's adornment of the world with the rest of creation. The clear focus on the creation of mankind in this story exalts humanity as the crown of God's creative work and conveys the sense that all the things of the world are made for His sake. This account, moreover, stresses the uniqueness of the human person and the original unity of man and woman. Of particular interest in this story is verse seven: "The Lord God formed man out of the clay of the ground and blew

into his nostrils the breath of life, and so man became a living being" (Genesis 2:7). At a definite moment in time, we learn from this text, God chose to place the living spirit of humanity with Adam, the first man. The language of breathing life into nostrils, while symbolic, nevertheless makes clear that the creation of a human person results from the voluntary action of God at a specific moment. Here we receive the framework for an answer to the question, raised above, of when a distinct person is formed.

The first words of the prologue to the Gospel of John, "In the beginning," deliberately return to the first words of the Book of Genesis. In using these words, the author seems to intend that readers should not forget, but actually call to mind, the truths conveyed in Genesis. To these truths, John adds the influence of the Word (*λόγος*) of God, Jesus Christ, Who "became flesh and made His dwelling among us" (John 1:14). The use of the term *λόγος*, which means both "word" and "reason," ingeniously combines the creative Word of Genesis with the personified character of Wisdom in the Book of Proverbs and with the principle of intelligibility in Greek philosophy. Owing to this synthesis, John's prologue boldly contends that faith is reasonable, supporting the perennial belief of the Church that faith and reason "mutually support each other" (*Dei Filius* 1870). John asserts that "the reasonableness of creation," which is so evident in the Genesis accounts, "derives from God's Reason." (Ratzinger 1995, 17). The Gospel further claims that "all things came to be through Him [the Word]" (John 1:3), such that all life descends from the life of God, Himself.

What, then, should one conclude about the Bible's testimony concerning the creation of man? The Genesis accounts, the Psalms, and John's Gospel all speak of man's origin in God. They describe humanity as fundamentally good, and man is portrayed as the product of God's specific will to create him.

Christian Philosophy and Theology

Philosophers and theologians, including those of Christian faith, have long sought to account for the origin of life. Many thinkers have proposed that the essential character of living beings is to be found in the divine qualities they exhibit. On this understanding, the life of man—and of all living things—is really a participation in a greater life. It is not that man is a perfected form of animal, and the divine a perfected form of man. Counter to the *Origin of Species* argument, Christian thought holds that life does not draw from below. Rather, in the divine, we find perfection, and man is an imperfect representation of the divine.

Inasmuch as perfect life is rooted in the divine, the only giver of life is God. An expression of this is the episode involving Michelangelo, who rejoiced at the completion of his statue of Moses. Gazing upon his marble masterpiece with an unhealthy satisfaction, the mortal sculptor made bold to assume a higher role as he commanded his statue to come alive, crying, "Speak!" Yet, the statue remained stiff and speechless, for life can only be granted from above and expressed from within. Although man is made co-creator with the divine in the context of marital union (Pope John Paul II 1999, 46), life can never be independently imposed upon the lifeless from without, save by the source of all life (Sheen 1979, 19).

Despite his exalted status in creation, man's life does not truly belong to him, for he is not his own cause. The life of man, rather, is a participation in the divine life of God, Who alone can serve as both the efficient and final cause of man. When a new person comes into being, it is not, strictly speaking, a new life. In seamless fashion, rather, life is passed from parent to child, such that life is conserved, not created (Scientists for Life 1975, 5-9). A new individual develops, but not truly a new life. From the Christian perspective, the only true life is the life of the Trinity, and all life on Earth is but the shadow of that Trinitarian life.

Ensoulment

Because Christian anthropology conceives of man as a union of body and soul, the question of man's origin cannot be reduced simply to a question of the physical order. The human body never represents merely biological life and can never be understood as simply material. (Pope John Paul II 1994) A person, rather, is a composite unity of that which is physical and that which is spiritual. Death, for the Christian, is defined as the moment when the spirit is separated from the body. On the other end of the spectrum, the moment of a person's origin could reasonably be understood as the moment when his or her body and soul become joined.

In some of its magisterial teachings, the Catholic Church refers to the question of when the soul is infused, yet it resists defining a specific moment (Congregation for the Doctrine of the Faith 1974). It seems wise at this time to avoid a definitive statement, as theologians continue to debate the issue of ensoulment. Perhaps the most direct ecclesial treatment of the issue comes from the Pontifical Biblical Commission in its decree concerning the historical character of

Genesis, chapters one to three. Therein, the Commission upholds the notion that the creation of a human person necessarily entails the direct handiwork of God. "The Commission, with its very high authority, requires, therefore, that a special intervention of God in the creation of man must be admitted; but it does not determine in what consists this special intervention" (Ruffini 2008, 148). The nature and scope of this necessary "special intervention" has bearing on the delimitations of scientific possibilities. It affects, for example, whether one can sensibly subscribe to strict Darwinian evolution, or perhaps to its mitigated form of transformism, which posits the evolution of the human body but not of the human soul.

From the standpoint even of pre-Christian, strictly Aristotelian philosophy, it is problematic to assert that a zygote or fetus is merely a clump of tissues that later will develop into a human person. Those who make such a claim "are talking metaphysical nonsense. That implies that a being changes its nature, which amounts to magic, rather than sound metaphysics" (von Hildebrand 2011). If one argues that the newly conceived fetus has a nature other than that of a human person, there arises the subsequent burden of offering a compelling argument to explain how its nature changes into that of a human person at some later time. Making this argument within the framework of Aristotelian and Thomistic metaphysics would seem exceedingly difficult.

Unified Perspective

The search for truth lies within the purview of both science and theology. Physical and biological scientists search for it both empirically, by making observations, and deductively, by extending established laws. Theology uses reason, revelation, and tradition to ascertain truth. These are complementary approaches when studying the origin of life. Both seek truth, although in separate ways. Whereas scientists read only what is written in the physical book of creation, philosophers and theologians study also what is written in the metaphysical book of being (Schönborn 2007).

Points of Agreement

The independent consideration of geology biology and theology reveals several significant points of agreement. First, all three disciplines concur that there was a period in history when Earth came into being. Secondly, all three disciplines maintain that there was a moment in history, subsequent to the formation of the Earth, when mankind came into being. Thirdly, each discipline supports the notion that the world—and especially the human person—bears evidence of a design that demands explanation.

Geology and biology agree with regard to the broad timeline of human history, which can be shown not to conflict with the Christian scriptures when properly understood. Biology and theology are both eager to describe the transmission of life in terms of continuity rather than disjunction, which is an approach for which geology allows.

These three disciplines also agree that one of the most difficult questions to answer is the question of when a person becomes a person. Insofar as souls leave no fossil record and cannot be measured in moles, the answer to this question lies outside the realm of the physical sciences. While the moment of ensoulment remains an unsettled question, is it at least reasonable to suggest that the safest practice is to presume the presence of a soul from the formation of the zygote? Asked another way, is there any reason not to consider the soul present from the moment of conception? "With regard to the embryo in the mother's womb, science itself highlights its autonomy, its capacity for interaction with the mother, the coordination of biological processes, the continuity of development, the growing complexity of the organism. It is not an accumulation of biological material but rather a new living being, dynamic and marvelously ordered, a new individual of the human species. . . . We may say with Tertullian, an ancient Christian writer: 'the one who will be a man is one already' (*Apologeticum* IX, 8). There is no reason not to consider him a person from conception" (Pope Benedict XVI 2010).

Reductionism

In the contemporary debate over the origin of life, there often seem to be battle lines drawn between people of faith and people of science, as though there could be no crossover and no middle ground. The debate has frequently been framed as creationists versus rationalists. The ancient dictum teaches us, however, that "virtue stands in the middle" (*virtus in medio stat*).

The strengths and weaknesses of the various theories for the origin of life have been reviewed and compared by Fowler and Keubler (2007), but our purpose is not to differentiate theories. Rather, we attempt to integrate science and theology. The extremists in this debate,

ironically, appear to be marked by the same fallacy, which might well be called reductionism. In the case of creationists, their fault is to reduce the Bible to merely a science textbook. This approach unjustly obscures the character of Biblical texts, failing to appreciate their variety of genre and nuance of composition. In the case of rationalists, their fault is to reduce creation to mere scientific episodes and phenomena. This approach unfairly divorces God from creation, unwilling to recognize the ultimate source of science. In both cases, the fallacy of reductionism renders their arguments unsatisfying in the end. There is clearly a need for a more balanced approach. Only at the intersection of the natural and supernatural worlds are we ever to discover the ultimate truth that all scientists seek.

Balanced Approach

There is, in fact, a middle way. There are men and women who profess faith as well as science and who work toward a holistic understanding of the origin of life. Any scientist with a little experience in his or her field is aware of phenomena that were unknown a few centuries ago. Examples of these include the vast energy stored in the nucleus of the atom, the mechanism of heredity, and the movement of the continents driven by heat from the Earth's interior. Some knowledge was heretofore unknown and now is known, and some will be discovered in the future, but there are processes that are likely unknowable from physical evidence, such as why living organisms are designed as they are. However, physical evidence is not our only source of knowledge. Reason and revelation also contribute to our understanding.

In the view of the Catholic Church, God is mysterious, and yet He does not desire to remain an elusive mystery. He wants, rather, to be known by the people He has created. The

tools He has provided to deepen this knowledge include not only the physical world, but also reason and revelation. Reason is the mental capacity to apply logic and make judgments based on physical evidence. Revelation, as defined earlier, is the process of God's self-communication in history, which reached its climax in the Incarnation of Jesus as a man. The etymology of the word "revelation" is meaningful, since it refers to "removing the veil" that shrouds the deepest truths in mystery. The bearer of revelation is the Church, which Jesus established and entrusted with safeguarding and handing down the content of revelation.

Why Both Science and Church are Necessary

Neither science nor theology will be able to ascertain the whole truth alone. Both need to teach the other discipline the truths that derive from either natural laws or supernatural laws. Pope Leo XIII wrote in his encyclical, *Providentissimus Deus* (1893), words that Pope John Paul II reiterated on several different occasions: "truth cannot contradict truth" (1996). Therefore, since both science and faith seek and respect the truth and both disciplines do so in the light of freedom, they must be interconnected and cannot be opposed to one another. It is necessary to look for the truth from both directions. Science and faith must operate in tandem if satisfying answers are to be given to the most fundamental questions of existence.

Today, in an ironic state of affairs, the Church is often portrayed as an opponent of science. This is ironic because many of the great scientists of history were people of faith; Gregor Mendel, Nikolaus Copernicus, Roger Bacon, and many others were actually Catholic priests; the scientific method was shaped in no small part by men who were profoundly influenced by their Christian faith. The Catholic faith acknowledges the authority of scientific

teaching when it comes to theories such as evolution, but it retains the authority of spiritual teaching. From the perspective of faith, all genuine scientific inquiry is good, because it leads one to a better understanding of the intricate details of God's creation. In the words of the twentieth century Jesuit paleontologist, Pierre Teilhard de Chardin, "There is less difference than people think between research and adoration" (1995, 250). While one should not expect to understand God's creation fully, understanding it as best we can should lead us to realize that its design is a tangible sign of God's love for us.

It benefits man's knowledge if scientists admit that observation is not the only source of knowledge and if theologians recognize the validity of the scientific method. Hypotheses can be tested by reason and not just empirical observation. Despite erroneous theories, science generally increases our knowledge over time. Theology, for its part, is able to contribute knowledge of that which lies outside the realm of what is measurable, testable, and observable. The sum of our knowledge is richest when faith and reason are treated harmoniously rather than dichotomously.

Conclusion

The three disciplines we have herein represented, when applied to the most fundamental questions, are not independent, but inter-dependent; they are not inimical, but complementary; they are not separate, but distinct. There is much agreement among these three sciences, and there are also many truths concerning the origin of life that remain unknown. While traditional scientists struggle to accept theology as a legitimate way of attaining knowledge, we propose that

genuine collaboration among these fields will lead to the fullest and broadest knowledge possible. If this divide can be bridged, our understanding of life and its origins, albeit still imperfect, will be deepened, clarified, and strengthened.

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End Notes

Calculated by multiplying the total number of base pairs per human being (3 billion base pairs per cell x 100 trillion cells per human) times 7 billion humans by 1 mutation per 1000 base pairs to arrive at total number of possible mutations between two human beings.