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SCIENCE AND THE BIBLE. The extent to which biblical authors convey accurate scientific information about their world has been a topic of discussion from the first encounters between Greco-Roman authors and their Jewish and Christian counterparts. This article concentrates on: 1) the attitudes toward empirical observation and logical reasoning used by biblical authors in constructing their worldview in an ANE context; and 2) the role of the Bible in discussions about science from antiquity to the present.

- A. Defining Science
 - B. Science in the Ancient Near East
 - C. Attitudes toward Empirical Investigations in Israel
 - D. Cosmology
 - E. Medicine
 - F. Weight and Measures
 - G. The Bible and the History of Science
 - H. Conclusion
- Bibliography

A. Defining Science

The definition of *science* remains hotly contested. As used by modern scientists, *science* describes the systematic attempt to understand the universe through evidence derived from one or more of the five natural senses and/or logic. Methodological naturalism, which refers to the assumption that only natural causes should be used in explaining natural phenomena, also is an essential part of modern science.

Under this view, all supernatural phenomena, including miracles, are undetectable through scientific methods. In particular, two general definitions of miracles have been at issue. One is that miracles constitute violations of natural law. Objections to this position center on the fact that the existence of universal natural laws is itself an untestable claim. Other scholars define a miracle as an event effected by the direct agency of a supernatural entity. Under such a definition, miracles become irrelevant for scientific explanations because supernatural agency cannot be detected scientifically (see MIRACLE).

Although biblical authors assume that all phenomena were ultimately controlled or caused by Yahweh they also recognize that some events were beyond routine human experience. Seas did not part every day, and time-keeping devices did not normally reverse course (2 Kgs 20:10). Such extraordinary events often were described with variants of the Hebrew root *pl'* (פלא) in the OT (e.g., plagues on Egypt in Exod 3:20). The Greek words *teras* (τέρας), *dynamis* (δύναμις), and *sēmeion* (σημεῖον) are used similarly in the NT (e.g., Matt 7:22; Acts 2:22). Insofar as such events were viewed as special acts of a deity, the word *miracle* represents an adequate translation.

Given these preliminary remarks, the presence of science in the Bible is not an all-or-nothing scenario, but rather one of proportion. Biblical authors have a predominantly non-scientific view of the cosmos and its components. However, we can still detect attitudes and explanations that use empirical observation and reasoning to understand the world.

B. Science in the Ancient Near East

In the predominant historical view, Greece is the birthplace of scientific thinking. By the 6th cent. BCE, Thales of Miletos attempted to explain the origin of the world through purely natural phenomena. Aristotle (4th cent. BCE) argued that true knowledge derives from inductive conclusions about the world through experience. These conclusions can then be used to make deductions and predictions about new experiences. Some of the works attributed to Hippocrates (5th–4th cent. BCE), “the father of medicine,” explicitly argued against supernatural causation.

However, many Assyriologists contend that Mesopotamia offers the first indications of scientific thinking, particularly in the form of divinatory texts, which predict events on the basis of observations of liver anatomy or a variety of other events (e.g., a dog crossing one’s path). Such omens were often expressed in the form “If X is the case, Y will occur,” which can be found in genres ranging from law codes to medical texts. Regardless of its accuracy, divination attempts to draw causal links between observations and events. Consequently, recordings of astronomical phenomena became more precise, and such recordings led to genuine predictive abilities for eclipses, among other events.

Many Egyptologists argue that Egypt generated the earliest scientific achievements. According to James Henry Breasted (1865–1935), the eminent American Egyptologist, the Edwin Smith Surgical Papyrus (approximately 1550 BCE) is the earliest known scientific document. This medical manual lists physical conditions based on observation, presents diagnoses devoid of supernaturalistic language, and recommends purely naturalistic therapy.

C. Attitudes toward Empirical Investigations in Israel

Whether Greece, Egypt, or Mesopotamia is the birthplace of scientific thinking, one perennial issue centers on why ancient Israel did not develop science even as far as those neighboring cultures. At least two answers have been proposed. The first is that the Bible is not concerned primarily with the physical world, but rather with ethics and Israel's historical relationship with Yahweh. Sometimes "scientific" knowledge is presupposed, but not explained in certain stories. For example, the story of Bathsheba demonstrates that the relationship of the menstrual cycle to pregnancy was understood. Briefly, in that story the narrator emphasizes that David had sexual relations with Bathsheba after her menstrual cycle (2 Sam 11:4), leaving no uncertainty about David's responsibility for Bathsheba's pregnancy.

Another view centers on the antipathy of some biblical authors toward the natural senses in making conclusions about the world. For example, the Deuteronomistic History exhibits an "audiocentric" strand that prefers hearing over seeing, as illustrated by Deut 4:12: "Then the LORD spoke to you out of the fire. You heard the sound of words but saw no form; there was only a voice." The denial that the Israelites saw any form of Yahweh is directly linked to a warning not to make any visual representations of Yahweh or anything else in the world (vv. 16-19). Furthermore, this passage affirms that hearing was sufficient for Israelites to receive correct information about Yahweh's will.

But the antipathy toward sight was not restricted to divine beings. In 1 Sam 16:6, Samuel relies on his vision, and mistakenly concludes that Eliab, the oldest brother of David, was chosen by Yahweh as Saul's replacement. Yahweh responds, "Do not look on his appearance or on the height of his stature, because I have rejected him; for the LORD does not see as mortals see; they look on the outward appearance, but the LORD looks on the heart" (1 Sam 16:7).

This aversion to the use of vision, and the concomitant recommendation to rely on "seeing with the heart," may have deterred the systematic use of empirical observation. However, such a theory must be balanced by the fact that many Greek authors also devalued sight as the most certain means to gather information. Moreover, not all biblical authors preferred hearing over seeing (e.g., Job 42:5).

By the time we reach Second Temple literature, we find reference to the classic five senses (and more) as a proper means to acquire information (e.g., Sir 17:5-7; *T. Rev.* 2:4-6). Yet an anti-empirical stance may have continued into early Christianity. For example, the author of the Gospel of John may be distinguishing his view of Christian epistemology from Hellenistic empirico-rationalism in Jesus' response to the skeptical Thomas, "Blessed are those who have not seen and yet have come to believe" (John 20:29; compare 1 Cor 1:22-23).

D. Cosmology

Although biblical authors do not undertake systematic empirico-rationalist investigations, their view of the world was typical in the Near East. The Bible has a pre-scientific and telic (purposive) understanding of the origins of the earth as a place meant for human beings (Gen 1:26-27; Isa 45:18). While no one systematic picture of the cosmos is presented, a tripartite structure, consisting of sky, earth, and sea, is presumed in Gen 1 (see also Deut 5:8). Each domain is associated with particular creatures (e.g., flying creatures with the sky).

A tripartite view of the universe also can be found in the Greek *Iliad* (15.187-93), which states that "all things are divided into three domains" to which a god is assigned: heaven (Zeus), seas (Poseidon), and the underworld (Hades). The earth constitutes a fourth zone where all beings are equally welcome. The allotment of different portions of the earth to different gods is attested in the Bible (Deut 32:8-9).

However, the Bible evinces no clear evidence of the planet's true shape. The earth apparently was conceived as a flat disk surrounded by water, and with a metallic dome for a sky (raqia' [רָקִיעַ]; Gen 1:7). The sky was supported by pillars (Job 9:6). Water is stored above this dome. The "circle of the earth" in Isa 40:22 is probably a reference to the circle traced by the horizon rather than a reference to any spherical shape of the earth. Such views are duplicated in Mesopotamia and other neighboring cultures.

Genesis 1 provides the most familiar biblical cosmogony, which begins with a chaotic mass of water stirred by a divine wind. God shaped that mass by division and differentiation, and added, through the divine spoken word, many of the entities that populate it. A watery beginning also is posited by some Greek cosmologists (Thales) and by *Enuma Elish* ("When high above"), the Babylonian creation epic (early 1st millennium BCE). Differentiation, consisting principally of polar opposites (light/dark; male/female; hot/cold), is central to many Near Eastern cosmogonies, including the one in *De rerum natura* (*On the Nature of Things*, 1st cent. BCE) by Lucretius, perhaps the most systematic expositor of anti-supernaturalism in the ancient world.

By the 5th cent. BCE in Greece, we find explicit recognition that the earth is spherical and that it might be suspended in space. By the 3rd cent. BCE, Eratosthenes, an astronomer at Alexandria, had calculated the circumference of the earth with relative accuracy. Aristarchus of Samos (3rd cent. BCE) proposed a heliocentric universe long before Copernicus. In contrast, biblical authors seem to assume that the sun moved (Josh 10:12) over an immovable earth (Ps 93:1).

Although biblical authors acknowledged the initial creation of all types of living things, they recognized that the generation of new organisms required certain pre-existing conditions. For example, one must plant seeds and water fields in order to harvest crops (2 Sam 23:4; Luke 20:9; 1 Cor 3:6). Biblical authors

recognized that certain environments could support only a finite amount of herding (Gen 13:5-6).

The need for increased precision in scheduling agricultural, military (2 Sam 11:1), and building activities was a major factor in the emergence of systematic observations of the heavens (see Gen 1:14-18). The origin of the seven-day week is uncertain, but many link it to knowledge of seven planets, although identification of specific stars or constellations is debated (e.g., Orion and the Pleiades in Job 9:9). By the time the Bible was penned, the lunar cycle of 29½ days was common knowledge. The fact that the lunar cycle and solar year were not in synchrony was a well-known fact, and contrasts between lunar and solar calendars became a significant issue reflected in the Dead Sea Scrolls, among other Jewish writings of the Second Temple period. The non-canonical book of *Jubilees* (ca. 3rd cent. BCE) prefers a solar calendar in opposition to the lunar calendar that became normative in Judaism.

There seems to be no recognition of the celestial mechanics behind the phases of the moon or eclipses, which were portentous events in the ANE. Some Greek astronomers, in contrast, clearly understood the mechanics of both lunar and solar eclipses. The recent extended decipherment of the famed Antikythera mechanism (ca. 1st cent. BCE) reveals that highly sophisticated celestial timepieces could be manufactured in ancient Greece.

In the Bible, the ability to predict future events was, as it is in modern science, a sign of the reliability of a person's understanding of the world. In contrast to modern science, biblical prediction was principally based on a prophet's special access to Yahweh. However, discussions about how to recognize true prophecy (Deut 18:20-21) reflect that genuine epistemological issues were recognized with the use of prediction. For example, Jer 28:8-9 notes that war is so common that it is not as useful a sign of true prediction as is peace.

Closely tied to cosmology are meteorological phenomena. Yahweh's character as a storm god is illustrated in, among other passages, Exod 15:8, where he is described as blowing wind through his nose and mouth. Yahweh was associated with earthquakes and volcanic activity (Exod 19). Rain is controlled by God (1 Kgs 17:1; Job 5:10). But observation also was used to conclude that north winds signal rain (Prov 25:23) and to identify general rainy seasons (Jer 5:24). See COSMOGONY, COSMOLOGY.

E. Medicine

Medicine, in the sense of a naturalistic approach to the explanation for, and healing of, illnesses, did not exist in the Bible. However, such was the case in almost every other neighboring culture. Approaches to illness were intimately related to how biblical authors viewed the origin and nature of human-divine relations. According to Gen 2:7, humanity was formed from clay, a fragile material (Job 4:19). Divine breath is needed to

bring the clay to life. Wind and breath were viewed as related phenomena insofar as both involved movement of air. Thus, biblical authors understood that air flow, or what we could call "respiration," was essential to human life (see 2 Kgs 8:15). Life was also thought to reside in the blood (Gen 9:4).

Yahweh was ultimately responsible for healing and illnesses, including injuries that had a visible cause (e.g., an arrow in 1 Kgs 22:34). Because of the biblical emphasis on monolatry, Yahweh's responsibility for both illness and healing (see Job 5:18) contrasts with that found in polytheistic cultures where the deity who sent the disease may not be the same as the one who cures it. In the NT, much as in polytheistic cultures, demons are held responsible for illnesses (Mark 5:1-13).

Nevertheless, there are instances where biblical authors concluded, perhaps on the basis of empirical trial and error, that certain natural substances had curative properties. These include balm for healing wounds (Jer 8:22; 46:11) and figs for curing certain skin conditions (2 Kgs 20:7). The recommendation that a little wine was good for the stomach (1 Tim 5:23) may be based on empirical trial and error.

Although some scholars have claimed that the Israelites recognized the contagious nature of some illnesses, the evidence is weak. The expulsion from the community of those afflicted with the illness often mistranslated as LEPROSY (*tsara'ath* צַרַּעַת) is sometimes cited as evidence (see Lev 13:44-46). That illness probably encompasses a number of skin ailments that were not were contagious (e.g., psoriasis, vitiligo). Equally debated is the idea that health concerns were the reasons for recommending circumcision or the prohibition of pork. Health reasons are certainly not the stated motives in the biblical texts (Gen 17:11; Lev 11:7-8). See DISEASE; HEALING; HEALTH CARE.

F. Weight and Measures

The rise of commerce and bureaucracies is intimately related to the development of metrology, the science of weights and measures. Measures of weight and capacity are useful in transporting and selling foodstuffs. Dimensional measurements are used in activities ranging from building to property exchanges. Israel's metrology was largely adapted from its neighbors. For example, the cubit (approximately 18 in. long), the basic unit of linear measurement, apparently derives from Egypt. The longest measures mentioned usually were reserved for long-distance journeys (Jonah 3:3).

But the types of mathematics used in biblical metrology never reach beyond commercial, military, and proprietary concerns. This contrasts with Greece, where, by the 3rd cent. BCE, Eratosthenes of Alexandria reportedly measured, by means of parallax, the distance to the moon. On the other hand, even Lucretius thought that the sun and stars were only as large as we see them (compare Rev 6:13). See WEIGHTS AND MEASURES.

G. The Bible and the History of Science

While "religion" and "science" may be largely modern constructs, the difference between natural and supernatural explanations was clearly made in ancient Greece and Rome (Hippocrates; Lucretius). Accordingly, there are two basic historical positions concerning the relationship between science and the Bible: incompatibilism and compatibilism.

Incompatibilism argues that the biblical view of the world is incompatible with conclusions drawn from scientific investigation. Compatibilism argues that the Bible (or religion) and science are harmonious, and disharmony arises from misunderstanding of the Bible or from the improper application of science. Thus, the church father Tertullian (ca. 160–220 CE) pioneered the idea that nature and Scripture are two complementary revelations of God's workings.

Second Temple Judaism exhibits the first attempts to defend biblical authors against the charge that the Bible had faulty science or that biblical authors did not develop the advanced sciences in Greco-Roman cultures. Josephus (*Ant.* 1.164), the famed Jewish historian of the 1st cent., responded that it was actually Abraham who had taught Egyptians astronomy and mathematics. For Josephus, the transmission of scientific knowledge could be schematized as follows: Mesopotamia (Abraham, the Chaldean) > Egypt > Greece. Thus, Josephus anticipated modern debates about whether Egypt, Mesopotamia, or Greece had priority in the development of science.

Similarly, Christian compatibilists developed their arguments in encounters with non-Christian authors who ridiculed many of the stories found in the Bible. Origen (185–254 CE), the early Christian apologist, defended the biblical account of Noah's flood in light of the objections of his famed opponent, Celsus, who used empirical observations to conclude that the ark was too small to support the number of species known to exist.

In light of such problems with the biblical record, Augustine (354–430), the influential church theologian, developed an "accommodationist" view in which God's revelation was tailored to the simpler understanding of human beings. Not everything in the Bible should be interpreted literally. Yet Augustine also proposed divine miracles to explain scriptural statements (e.g., angels ferrying animals to Noah's ark from distant islands). Accommodationism became one solution through the medieval period, where theology was regarded as the highest of the sciences by Thomas Aquinas, among other major theologians. Nevertheless, the idea that biblical authority superseded natural observation dominated.

The Renaissance and Enlightenment periods saw the first clear expressions of incompatibilism in Western cultures, especially because new instruments (e.g., the telescope by 1610) brought results that were incompatible with biblical cosmology. In particular, Galileo Galilei (1564–1642) sought to confirm the theory, developed by the Polish astronomer Nicolaus Copernicus (1473–

1543) in his *De Revolutionibus Orbium Coelestium* (1543; *On the Revolutions of the Celestial Spheres*), that the sun was the center of the universe. Based on Ps 93:1, among other passages, the Catholic Church argued for a geocentric universe. But even Galileo still thought that the Bible needed to be reinterpreted, not rejected, as a scientific authority.

Further steps toward incompatibilism were taken by the Protestants Johannes Kepler (1571–1630) and Francis Bacon (1561–1626). In his *Novum organum* (1.65), Bacon explicitly rejects the use of the Bible, reinterpreted or not. For Bacon, the Bible was a source for moral guidance and higher truths, and not an authority on science. With Kepler and Bacon we see a clear dichotomy between the realm of science and the realm of biblical theology.

More complete rejections of the Bible came with geologists such as Charles Lyell (1797–1875), who shifted from viewing the Bible as irrelevant to science to viewing the Bible as an obstacle to science. A more developed "warfare" attitude has been attributed to Andrew Dickson White, the president of Cornell and author of *History of the Warfare of Science with Theology in Christendom* (1896), which is actually a plea for understanding "true" religion in light of science. Today, the main representative of the view that religion is completely incompatible with, and hostile to, science is biochemist Richard Dawkins, the author of *The God Delusion* (2006).

Gaining ground is the complexity thesis proposed by John H. Brooke, who argues that religious ideas sometimes led to pathbreaking scientific investigations. Isaac Newton (1643–1727), one of the greatest scientists in history, was motivated by religious agendas and yet made discoveries that required no religious premises. At other times, reliance on the Bible hindered scientific understanding. Repeated surveys, for instance, find that the overwhelming majority of Americans reject evolution in large part because they believe it contradicts religious or biblical beliefs.

"Creationism" is particularly prominent in current conflicts between science and the Bible. Modern creationism is a response to the rise of evolutionary theory, initially expounded in *Origin of Species* (1859) by Charles Darwin. Moreover, the 20th-cent. development of "Big Bang" cosmology, which posits that our entire universe derives from the expansion of an infinitesimally small and dense entity some 13–15 billion years ago, also seemed to contradict the Bible.

Eventually, two major creationist positions developed: 1) old-earth creationism; and 2) young earth creationism. The former adheres to a twenty-four-hour-day creation. The latter admits that modern scientific measurements of the age of the universe are accurate, and "days" in Gen 1 have been reinterpreted to mean longer periods. A third option, theistic evolution, is chosen by most theologians and believing scientists.

One hallmark of modernity, particularly in America, is the use of the legal system to define the role of the Bible in science. One famous example is the John Scopes Trial (1925), wherein a Tennessee schoolteacher was prosecuted for teaching evolution. Supreme Court decisions urging a stronger separation of church and state, particularly in the 1960s, led to the development of "scientific creationism," which claimed an ability to show, without any recourse to biblical statements, that the universe was created. In the landmark case of *Edwards v. Aguillard* (1987), the U.S. Supreme Court ruled that "scientific creationism" was not science because it ultimately presented a biblical view of the universe.

The Edwards decision generated a movement known as Intelligent Design (ID), which has been even more reluctant to appeal to the Bible to make its arguments that the universe is designed. Instead, concepts such as "fine-tuning" or the "anthropic principle" center on the large number of pre-existing conditions that had to be "right" for life to exist on earth. For example, if the charge of the electron or proton were different, then life would not be possible. Likewise, if the earth were not positioned where it is in our solar system, then it might be either too cold or too hot for life to exist. The large number of improbable conditions that need to be present for life to exist is what leads proponents of ID to argue, without the use of biblical texts, that the earth was created for life.

Opponents of ID argue that it expresses another version of the teleological argument found already in William Paley's *Natural Theology* (1805), which defends, through purely natural observation, biblical views about the purpose for the earth (compare Isa 45:18). Opponents also note that all the improbable preconditions needed for human life are also necessary for the existence of undesirable phenomena (e.g., the AIDS virus, infantile disabilities), but few ID advocates argue that these undesirable entities were designed. As in the case of "scientific creationism," a federal court ruled (*Kitzmiller v. Dover*, 2005) that Intelligent Design was not science, but rather another form of biblical creationism.

H. Conclusion

The history of the Bible and science is one of reversals. Prior to the Enlightenment, nature was primarily interpreted in light of the Bible. After the Enlightenment, the Bible was primarily interpreted in light of nature. As even the Intelligent Design movement illustrates, the ability to demonstrate biblical claims without appeal to the Bible is the dominant approach among believing scientists and theologians. Yet biblical interpretation still affects scientific research on, among other areas, stem cell research and AIDS. Moreover, some scholars have opted for postmodernist approaches that question the objectivity of science, or that argue that science is ultimately as much a faith system as religion. But most modern Jewish and Christian scholars and scientists remain accommodationists, who adjust biblical inter-

pretation to the findings of science. See CREATION; NATURE, NATURAL PHENOMENA.

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SCIENCE, EGYPT. The concept of "science," understood in the sense of comprehending the world through observation, testing, and the formulation of axioms, is demonstrated in pharaonic EGYPT in different ways, the combination of which bears witness to this nation's well-earned reputation for ingenuity in antiquity. On an immediate level, the Egyptians' practice of science can be gleaned from physical evidence retrieved by archaeologists. Artifacts attest to their ability to solve the complexities involved in areas such as metallurgy, demonstrated by the casting of copper, gold, and the creation of alloys. The process of mummification, whereby preservatives were developed to prevent the decaying of bodies, likewise indicates knowledge of chemistry, as does the creation of cosmetics, paints, dyes, and sundry drugs. The Egyptians' familiarity with physics and engineering is vividly seen from the monumental remains at places like Giza, which show their skill in overcoming problems surrounding the movement of stone. While most of the written sources concerning the theory behind such technology have disappeared, pictorial evidence has survived, portraying stupendous feats as workers pulling a colossus in the Twelfth Dynasty, and the conveying of a gigantic obelisk by ship from Aswan to Thebes during the reign of Hatshepsut (Eighteenth Dynasty).

Fortunately, a few texts indicate that Egyptian scribes did devote thought to the mechanics involved in these endeavors. For example, a limestone flake of the Old Kingdom refers to the construction of an arc at the base of Snefru's pyramid. A so-called "Satirical Papyrus" (P. Anastasi I) of the Nineteenth Dynasty contains "examination" questions, which variously deal with the erection of obelisks, the creation of ramps for raising heavy blocks into place, and the logistical requirements for labor forces. In terms of the mathematical prowess for these endeavors, papyri attest to the use of a detailed