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Learning from the Past

Overview

For most of human history, there was no distinction between the disciplines of science and religion. Our knowledge of ancient civilizations reveals that cultures ascribed the workings of the natural world to deities. The Greeks formulated philosophies that explained natural phenomena as having been caused by natural forces. These ideas were in some ways rejected by early Christian theologians, but the power of the pagan philosophies could not be ignored, and ways were found to incorporate these understandings into Christian theology. During much of the Middle Ages, the handmaiden formula allowed for investigations into the natural world as long as they helped to support scripture and further the understanding of God. By the end of the Middle Ages, it was becoming more acceptable to investigate natural philosophy apart from religious studies. In the fourteenth and fifteenth centuries a movement of rationalism and empiricism emerged from a period of political and social turmoil and crises regarding church authority. This new approach led not only to the birth of modern science, but to a transformation of society known as the Enlightenment. Reactions to the Enlightenment emphasized a return to personal experience, imagination, and emotion. In this era can be seen the beginnings of the division between science and religion that exists today.

Introduction

For some of us, acquiring knowledge of the past is an engaging, interesting enterprise that stimulates us intellectually and has implications for our understanding of present-day events and attitudes. For others, the pursuit of history appears to be a fruitless survey of endless dates and names. Although our fast-paced, ever-changing world may require all of our efforts just to keep up with current advancements, history does play an important

role in our lives. If we simply examine our world today and exclude the past, we deny ourselves the understandings our ancestors worked so hard to achieve. Our culture, our current questions, and our current answers may be ones which inspired, angered, or even outraged our forebears. Did they possess some wisdom that we can adapt? Did they have answers we haven't? How did they influence what we think and believe today?

The subject of history is not just an interesting study of long forgotten and irrelevant events and people in the past. By analyzing what came before us, we may come closer to understanding who we are and how we got to this point. And maybe some light will be shed on our current problems. Therefore, our journey into the entanglement of science and religion today will begin by taking a look at their relationship in the past. In the space of just a few pages, we will examine some of the most important people and concepts that shaped Western culture and Christianity. By no means is this an inclusive study: the events and individuals mentioned represent only a small portion of history. Linear and logical relationships are highlighted, but it must be understood that this is a very basic introduction, and the actual history is rich in diverse ideas and involves individuals and controversies well beyond the scope of this book. Rather, this chapter is intended as an all too brief introduction to some of the works and ideas that helped to shape both science and theology. It provides a setting, a stage if you will, that can be filled with various other characters and events of the period. With an understanding supplied by this stage and an appreciation of the ideas and events of the past, we can better comprehend what we have today.

The relationship between science and religion today is very different than what it has been in the past. As we shall see, for most of recorded history, there was no distinct separation between the two disciplines. This may come as a shock to many of us living in this modern society, for example in the United States, where the separation of church and state, and the notion that science is somehow the antithesis of religion, is the norm. But in the past science represented a way of glorifying and understanding God. Science was often done by religious clerics and, as knowledge was in the hands of the church for many centuries, the teaching of science was conducted with the approval of the Christian authorities. This did not mean the relationship was always smooth, but it is fascinating to examine the attitudes of the earliest scientists and theologians and their influences on religion, science, and culture.

We will begin our investigations in the pre-Christianity era with the ancient Greeks and see how they helped to shape Christian thought. We will then look at the Middle Ages, the Enlightenment, and the reactions to the Enlightenment. You may find it interesting to look at the development of modern science and the development of Christian theology as parallel pathways: both disciplines began and grew strong in the same tree, and then separated into the branches representing our present situation. We will discuss modern methodologies and notions of science and theology in chapter 2.

And What of the Greeks?

We begin our discussion at the dawn of civilization, with existing written records that reveal what our ancestors thought about science and religion. We find the first of these

in Mesopotamia and ancient Egypt. Within these cultures, there are some stunning examples of truly good science, such as detailed astronomical observations and the creation of calendars. Therefore, we know these ancient peoples were not ignorant of natural phenomena. But why did they have such knowledge? Why was it important for them to study these phenomena? Stargazing for us today may be a leisurely activity, but for these early cultures it was a necessity. Observations of celestial movements provided information to create calendars, which in turn provided knowledge of the seasons, a necessity for successful agriculture. Other scientific notions at the time related to agriculture included the breeding of plants and animals. Additional natural observations focused on illnesses and diseases. Regardless of the scientific facts these cultures discovered, the observed phenomena were ascribed to the workings of the gods. It was the gods who moved the stars and planets, and who wept to make the rain. In many instances, nature itself was considered divine, and humans and other creatures as created by divine forces. Polytheism was the norm, and the earthly images of gods were often associated with animals. The world was not eternal, and sickness was due to divine displeasure (we will examine some of these notions further in chapter 5).

The ancient Greek philosophers are revered in history as they were the first to reject the notion that natural events are caused by supernatural forces. According to their philosophies, natural phenomena were not caused by vengeful and whimsical gods; rather, nature behaved in a constant and uniform fashion. Therefore, to the Greek philosophers, it was irrational to ascribe the workings of the natural world to gods. This does not mean they rejected the notion of one or more deities: as we shall see, both Plato and Aristotle argued for a type of divine being.

At this time, the study of nature – what we would call "science" – is referred to as natural philosophy. For the most part, the study of natural philosophy was undertaken no differently from any other philosophy. Logic and reasoning were applied to problems and questions surrounding the natural world, but there was no formal system of experimentation, such as we have today, to test ideas and gain more information. Hence, "natural philosophy" is a fitting term for the beginnings of science.

The first recorded use of natural explanations for natural events can be traced back to Thales (c.625–547 BCE), Anaximander (c.611–547 BCE), and Anaximenes (c.585–528 BCE). These philosophers focused on the basic material from which all things are made. For example, Thales believed that water was this basic material. He held that the Earth rested on water and that earthquakes were the result of the movement of the Earth on the water. Thales was not using supernatural forces or magic to account for earthquakes – he invoked natural causes. We also see the beginnings of careful observation and even some rudimentary experimentation with the Greeks, particularly in the area of medicine. Hippocrates of Cos (c.470–c.377 BCE) and his followers asked, "If diseases are not caused by the gods, then where do they come from?" The answer to this important question required the analytical skills that we recognize today as the root of science.

Socrates (c.470–399 BCE) used logic and reasoning to construct a rational system of ethics. He employed a method of questioning to help determine the knowledge and beliefs of others, which, in fact, helped the respondents to see the contradictions in their own philosophies. This approach is known as the Socratic Method. Plato (c.427–347 BCE) was a student of Socrates. He used the style of dialogues (Socratic dialogues, in which Socrates is often a character) in his written works, many of which survive. Plato's

subjects included metaphysics (the nature of being and existence), epistemology (the nature of knowledge), human physiology, and politics. In his work *Timaeus* Plato presented a cosmology where a single deity created the world from a chaos that already existed. This monotheistic concept is a characteristic feature of many of the Greeks who studied natural philosophy. The deity, however, is abstract, impersonal, and out of reach (beyond the sky) and so, as we said before, natural events are not explained by invoking the supernatural.

Aristotle (384–322 BCE) was a student of Plato, and his philosophy impacted science and religion for over 2,000 years. Like Plato, he valued reasoning and wrote on a wide range of subjects. However, Aristotle also felt that observation, and the collection of facts and data, were important in studying the natural world. Among his works are writings that comment on the structure and operation of the universe, and provide detailed accounts of animals and human behavior. His ideas are sound and reasonable when he could study his subjects directly. For example, due to his observation and dissection of marine animals and reliance on the authority of the fishermen he interviewed, Aristotle's work in zoology is quite remarkable for his time. On the other hand, most of his notions of physics and cosmology were based on either common sense or his own assumptions, and therefore his conclusions were horribly flawed. Many of these fallacies could have been corrected had Aristotle done some simple experimentation. For example, his notion that larger, heavier objects fall faster than smaller, lighter ones could easily have been tested during his time. His writings about the natural world, many of which survive, were so complete and comprehensive that Aristotle became *the* authority regarding natural phenomena, and all knowledge was thought to be contained in his writings. For centuries, science (natural philosophy) consisted of commenting on Aristotle. His work was translated into Arabic and had a major impact on the development of Islamic philosophy. Aristotle's approach to studying nature made use of observation and logical deduction from facts; unfortunately, this aspect of his efforts was almost completely disregarded by his followers. It was not until the sixteenth and seventeenth centuries that his ideas were finally challenged and modern science emerged.

Some of Aristotle's ideas were very much in line with Christian theology. For example, he believed in teleology, the notion that there is a goal or purpose for everything (he called this the "final cause"). However, many of his concepts contradicted Christian doctrine and were threatening to the church:

- Aristotle believed that the world was eternal, that it had no beginning and no end. This was in direct opposition to the biblical accounts of *ex nihilo* creation of the Earth.
- Aristotle believed in a divine spirit he called the Unmoved Mover, who was not the creator of the world, and not even aware of its existence, but was the cause of the movement of the planets and orbs around the Earth. This was ultimately responsible for all motion in the world. This is in contrast to Plato's *Timaeus* and it also conflicts with the Christian notion of a living God personally involved with the world.
- Aristotle defined the soul as the source of life that could not be separated from the body. He identified three kinds of souls, and argued that souls could perish with the body. Christian doctrine identifies the soul as separate from the body and contends that it is immortal.

These and other problems caused the church to question the pagan ideas of the Greeks and to reject them. Early Christian theologians, such as Tertullian (c.160–c.220 CE), denounced Greek philosophy. Tertullian thought the Greeks were vain and trivial and, of course, heretical. He espoused simple faith above the reasoning of the Greek philosophers. And Paul (3–67 CE) warned the Colossian Christians not to be influenced by philosophy:

> See to it that no one makes a prey of you by philosophy and empty deceit, according to human tradition, according to the elemental spirits of the universe, and not according to Christ. (Colossians 2:8)

Based on these attitudes, one could conclude that the Greek philosophies would be disregarded in Christianity. However, the situation is much more complex. The early theologians were well versed in the Greek philosophies, having been educated extensively in the methodologies; the philosophical underpinnings were deeply engrained in them. Most theologians of this time were philosophers who later converted to Christianity and attempted to integrate the two belief systems. In addition, their defense of Christianity required them to engage in dialogue with non-Christians, and so these early theologians needed to be well versed in the Greek philosophies to communicate with those who did not accept the faith. And, ultimately, theologians who denied the usefulness of the philosophers and considered them to be heretics still employed the pagan arguments. Basically, they were not against all natural philosophy but only what was considered dangerous to the Christian faith.

Augustine (354–430), the bishop of Hippo in North Africa, was among these early Christian thinkers. His influence on the development of Christianity was enormous. Augustine stressed that reason could not answer all the questions about human existence. For him, faith needed to come first. Empirical knowledge, the knowledge we gain from our senses, was secondary to knowledge from revelation, what is revealed to us by God. But reason could be employed to further understand faith. Augustine did not fear the consequences of natural philosophy as his predecessors did. He believed all truth to be God's truth. However, he changed the tenor of its purpose. Augustine employed what is known as the handmaiden formula: the use of natural philosophy in the service of theology. Natural philosophy should not be pursued for the sake of knowledge alone. However, it could be valuable as a means to an end: if natural philosophy could help us to understand scripture, its study was legitimate and could be undertaken. The handmaiden formula became the prominent view in the Middle Ages. Some might argue that this ideology was detrimental to scientific progress, restricting the advancement of knowledge of the natural world. However, it was the church that provided a place for natural philosophy in the curriculum of the expanding educational systems. The church may not have encouraged science specifically, but it kept science alive.

The Middle Ages

After the barbarian conquest of the Western Roman Empire, intellectual pursuits had a low priority. In the early Middle Ages, from about 500 to 1000, the institutions of learning were the monasteries in Europe. Here, Greek writings were translated into Latin, and

commentaries were written about them. Although there was not much advancement of science during this time, the preservation of the existing works is of great importance, and the inclusion of natural philosophy in the curriculum transmitted the ideas to succeeding generations.

In the eleventh and twelfth centuries, there was a renewal of culture in Europe, with revivals of the political, economic, and social systems. This resulted in an expansion of educational institutions into the university system in the major cities. There was still a commitment to religion, but other subjects were given prominence as well. There was more instruction in the classics (including Plato's *Timaeus*), the use of natural explanations for natural phenomena, and the application of reason to explain human activity. And more of the Greek classics, preserved in Arabic, were translated into Latin, among them the works of, and commentaries on, Aristotle. With greater access to the Greek philosophers and an increased emphasis on natural philosophy, the tensions between science and religion started to grow.

Anselm (1033–1109) lived just prior to the influx of Aristotelian ideas into Europe. He was a follower of Augustine, and put faith above reason. He believed, however, that reason could clarify faith and provide proof for faith. Anselm used an abstract argument to prove the existence of God. He contended that God is the ultimate being, and that we cannot conceive of a being greater than God. Therefore, God must exist not only in thought, but also in reality. For, if God is the greatest being who we can conceive, but exists only in contemplation, then one who actually exists would be greater. Therefore, God must exist in reality, not just in thought.

By the thirteenth century, the power of the knowledge assembled by the Greeks and the Arabs to explain nature was well understood, but the problem of contradiction with church dogma was growing. As we saw, Aristotle's ideas of an eternal world, his cosmology, and his concept of the nature of the soul, in conjunction with his reliance on reason (in other words, the exclusion of revelation as a source of truth), proved problematic for theology. How could the valuable philosophy of the Greeks be utilized without contradicting the teachings of the church? The handmaiden formula was certainly an option, but the issues were too complicated to argue simply for the application of natural philosophy to theology. More clarification, and a fuller integration, was needed. This was accomplished primarily by Thomas Aquinas (c.1225–74).

Aquinas was known from a young age for his amazing intellect and became a Dominican monk when he was 18. He was a prolific writer, his most famous work being the multivolume *Summa Theologica*, begun in 1265 and completed after his death by his secretary. *Summa Theologica* contains detailed discussions of God's nature, perhaps the best written in all of Christianity. Aquinas is often cited as the most important Christian theologian in the history of the church.

Aquinas argued that philosophy was constructed by human reason, and many truths regarding the nature of God can be known by reason alone. Thus, Aquinas ascribes to philosophy an authority it does not have in the works of Augustine or Anselm. One of his famous arguments is his proof of the existence of God. Aquinas's proof differed from Anselm's in that Aquinas took into account sensory experience (empirical observations) whereas Anselm used only intellectual concepts.

But the truths necessary for salvation, Aquinas argued, are beyond reason. Revelation, through God's grace, is the way God makes these truths known. This does not destroy

or undermine natural knowledge, but instead complements it. There can be no contradiction between philosophy and revelation since both are from God. Philosophy and religion can each stand alone, but they converge when considering the nature of God. In this sense, reason must be perfected by divine revelation in scripture. Faith is a kind of knowledge, and we can gain more knowledge of God by grace than by natural reason.

With regard to Aristotle, Aquinas incorporated his ideas into church doctrine, and in some cases "corrected" his philosophy for being wrong. By the end of the thirteenth century, there was an integration of Aristotelian philosophy into the Christian church and a reliance on these ideas, especially regarding the workings of the natural world. Theology still prevailed, in that divine freedom and omnipotence could not be contradicted. In one sense, this actually helped to advance science: ideas in natural philosophy could now be considered that were not contained in Aristotle's works. For example, if God could do anything, then he could, if he desired, create a void, something which Aristotle did not believe in. If a void did exist, what would it be like? How would objects move inside this void? The exploration of these ideas, the speculations and the possibilities, allowed for advancement in natural philosophy.

The Scientific Revolution

From the thirteenth through the fifteenth centuries, Aristotelianism was deeply rooted in the university systems in Europe. It was the basis for the curriculum, and consequently the basis for intellectual thought. However, the tide was turning as to exactly what natural philosophy was and what it should be used for. Natural philosophy became an important undertaking in and of itself. It no longer had to be tied to Christian theology. But, as we shall see, it could not contradict theology, and it was still used to provide understanding of and evidence for God.

Europe in the fourteenth and fifteenth centuries experienced much turmoil, including the Hundred Years War (1337–1453) and the Black Death (1347–50), which killed approximately one-third of the population. The church was under stress during this time, due to the political problems of the Avignon Papacy (1305–79) and the Papal Schism of 1378–1417. Science did not progress much during this period. Recovery from these events led to a time of high art, including the works of Michelangelo (1475–1564), and an intertwinement of art and science, as seen in the works of Leonardo da Vinci (1452–1519). It was also during this time that the Gutenberg Bible was first published (1455), signaling the beginning of the use of the printing press, a technology that would make it possible for ideas to be spread throughout Europe much more quickly. This technology helped to popularize recent translations of Greek literature (including the works of Epicurus (341–270 BCE) and Lucretius (c.99–55 BCE)), and it helped to shape the Protestant Reformation.

The time was ripe for a renewal in spirituality in Christianity, and the events of the Protestant Reformation are tied in with the beginnings of modern science. The break from the Catholic Church instigated by Martin Luther (1483–1546) and John Calvin (1509–64) involved many issues. Two of these concerned the road to salvation (which, according to Protestants, comes only through the mercy of God and not through works

or intrinsic merit, as the Catholic Church taught), and the precedence of the Bible over reason, tradition, and experience (new Protestant notions stressed that everyone can speak to God directly through prayer, and that the Bible can be understood and interpreted by individuals, that is, without the mediation of the clergy, as was held by the Catholic Church). The reaction to the Reformation by the Catholic Church (in addition to excommunications, inquisitions, and executions) was a series of reforms and decrees stemming from the Council of Trent (1545–63), known as the Counter-Reformation. At Trent, meetings of bishops, cardinals, and theologians took place to counter the Protestant challenges to papal authority and the theological disagreements regarding doctrines and other matters of faith. The Council also attempted to correct a lack of discipline within the Roman Catholic Church, and reaffirmed the faith with a more literal interpretation of the Bible. It is arguable whether science was helped by the Reformation. Whatever the answer, there certainly was an impact on both the methodology of science and the acceptance of what came out of scientific investigations.

This sets the stage for the first figure who would propel science into the modern age: Nicolaus Copernicus (1473–1543). Copernicus wrote *On the Revolutions of the Heavenly Spheres* (1543) where he proposed a heliocentric (Sun-centered) solar system (this issue will be explored in greater detail in chapter 4). The Catholic Church rejected this notion for the prevailing geocentric (Earth-centered) solar system. This opposition was probably due as much to the pressure on the church from the Reformation as well as theological, philosophical, and common sense arguments. Philosophically, Aristotle had said the Earth was at the center, and common sense tells us we are not moving. Theologically, the biblical texts provide several examples to support the notion of the Earth standing still while other bodies move around it, as in the story of Joshua:

> On the day the Lord gave the Israelites victory over the Amorites, Joshua prayed to the Lord in front of all the people of Israel. He said, "Let the sun stand still over Gibeon, and the moon over the valley of Aijalon." So the sun and moon stood still until the Israelites had defeated their enemies. Is this event not recorded in The Book of Jashar? The sun stopped in the middle of the sky, and it did not set as on a normal day. (Joshua 10:12–13)

In 1616, *On the Revolutions of the Heavenly Spheres* was placed on the *Index of Prohibited Books*, a listing of books the Catholic Church considered immoral or containing theological flaws that could corrupt the faithful. Galileo Galilei (1564–1642), a good Catholic, advocated the Copernican system, and took it upon himself to interpret the Bible. He was tried by the Roman Inquisition in 1633 and placed under house arrest for the remainder of his life. As we shall see in chapter 4, a new technological advancement, the telescope, provided the evidence Galileo used to support the Copernican theory. Johannes Kepler (1571–1630), on the other hand, was able to convince his fellow Protestants that Copernicanism could be reconciled with the Bible through the principle of accommodation. This notion, based on the work of Augustine and used by theologians and scientists, stressed a figurative interpretation of the Bible (the same argument Galileo used). Scripture clarifies purpose, they stated, and should not be taken as explaining scientific matters. By about 1700, most scientists had fully accepted the heliocentric universe.

Another aspect of science that was advancing during this time was mechanical philosophy, based on the recently translated works of Epicurus. Mechanical philosophy

was the attempt to explain all natural phenomena in terms of matter, motion, and collision. This excluded any kind of action-at-a-distance (as with God) and denotes another example of a rejection of Aristotelianism. Mechanical philosophy worked very well for the new physics being developed at the time, but it posed several problems for the Catholic Church and resulted in much skepticism. Some of the main problems were divine providence, the soul, and transubstantiation.

- Providence is God's sovereignty over everything. If all events could be explained through the action of matter, then where is God, and what of miracles?
- The religious notion of the soul was difficult for theologians to explain in light of mechanical philosophy, specifically with regard to the origin of the soul and its nature and immortality.
- Transubstantiation refers to the belief that the bread and wine used in the Eucharist is changed into the actual body and blood of Jesus Christ.

Pierre Gassendi (1592–1655) and René Descartes (1596–1650) laid the foundations for how mechanical philosophy should be used, and how science should be done. Gassendi was a Catholic priest, and he tried to modify mechanical philosophy to make it acceptable to the church. He supported the notion that God created and endowed atoms with motion, and that atoms colliding in empty space constitutes our physical world. God has complete freedom and can violate the laws of nature at any time. Humans have free will and an immaterial and immortal soul. Gassendi advocated empiricism in scientific methodology; he thought that, if God could intervene anywhere at any time, then we need to engage in experimentation and gather data to understand the properties of matter. Reason could not inform us, if God can intervene.

In contrast, Descartes contended that God is not a deceiver, and we can use reason to gain knowledge about the created world. He argued that matter has geometric properties and the laws of motion show God's immutability. Descartes believed that matter fills all space and can be divisible; therefore there are no atoms and no void. Movement is a property of a body, and God created matter together with movement. God is immutable and does not interact further with the creation. Any change in movement was due not to God, but rather to the interactions of the created matter. Descartes contended that everything tends to be preserved in its state with regard to motion, the opposite of the Aristotelian notion that all bodies tend to rest. The world was independent of the creator, a concept that led to deism. Descartes's ideas were not favored by the church, and his book, *Principia Philosophiae*, published in 1644, was placed on the *Index of Prohibited Books* in 1663 because it attempted to explain transubstantiation in the Eucharist in mechanistic terms.

In practice, two figures represent how mechanical philosophy was used in the seventeenth century. As we shall see, both were not just focused on the theological implications of this methodology but actually used scientific methods to gain knowledge of the divine.

Robert Boyle (1627–91) employed mechanical philosophy to explain chemical phenomena. He argued that matter was composed of particles that moved and could combine. He used the newly fashioned air pump in experiments to understand the properties of air. Boyle believed God created matter, endowed it with motion, and created

natural laws that God could violate. Like Gassendi, Boyle believed experimentation was necessary, as reason could not be used if God wished to violate these laws. For Boyle, souls were spiritual, not material. He saw his work of investigating nature as a way to gain greater knowledge of God and creation.

Isaac Newton (1642–1727) is widely known for his contributions to mathematics and science, but is not as well recognized for his theological ideas or his investigations into alchemy (which are discussed further in chapter 4). Newton accepted the premises of mechanical philosophy early in his career. He thought, however, that some things, such as gravity and the properties of light, could be explained not through matter, but through forces of attraction and repulsion, which ultimately led to the extensive use of mathematics in physics. Matter was passive and under the power of God. Gravity was not an innate property of matter, but instead came from God. Newton's interest in science grew from his desire to find evidence for God's activity in the world. He felt reason alone was not sufficient to understand either God or the natural world. For him, physics and his cosmology were to reveal the creator's work, to prove the existence of God.

One of the major problems of mechanical philosophy was deism, the theological notion that God does not act directly in the world. God created the universe and the natural laws, but is no longer involved in the creation. Deists accept the doctrine of creation, but not of redemption. Newton rejected deism. However, the notion took hold after his death. Newtonian physics provided great explanatory power for the movement of bodies on Earth and in the heavens. But Newton always left a place for God. He believed God intervened in the motion of the planets, as he could not explain through gravity how they could remain in their orbits around the Sun. Using Newtonian physics, Pierre Laplace (1749–1827) finally demonstrated that the solar system is a stable system.

The period beginning with Copernicus and ending with Newton is sometimes referred to as the Scientific Revolution. It denotes a period in Western culture when science stepped out of the shadow of philosophy to become its own discipline. It is the beginning of modern science, and, as we have seen, a great many factors influenced the birth of this new methodology. What is even more remarkable is that this new era had a major impact on theology. Let's consider where we've just been.

- From the end of the Middle Ages, the church went through some substantial challenges resulting from internal problems and the Protestant Reformation.
- In addition, much of Aristotelian philosophy had been rejected by newly emerging science, another blow to the Catholic Church, which had embraced this philosophy for so long.
- A new era of experimentation and empiricism, aided by new technologies, was being developed, which helped to establish the methodology of science. This rationalism was impacting theology as well.
- The fields of science and religion are still intimately tied together, with science being used to glorify and understand God and creation.

In all of this, there was an overwhelming sense that we can know things; we can use reason, experimentation, and empiricism to understand our world. There is order in the universe, and its laws can be understood. The world is amazing in its workings, and it is good. This attitude permeates religion, and brings us to the Enlightenment.

The Enlightenment and Beyond

Before continuing our discussion, we should make a quick note of clarification regarding terminology. The terms "Scientific Revolution," "Enlightenment," and "Age of Reason" can be used to describe essentially the same period of time (or, at least, overlapping and closely related periods). The differential use of these terms denotes more of a focus on particular issues and trends of the time in particular areas, rather than identifying unique and distinct eras.

The emphasis on empiricism in the sciences, and the resulting enthusiasm, caused a dramatic shift in society. The prevailing attitude was that we can know everything, and that reason would lead the way to this knowledge. We could discover laws, similar to natural laws, that would help us understand society. We would then be able to control how humans behaved, which would allow for the abandonment of governments. Human nature was seen as good, not as sinful as church doctrine claimed. Humans were corrupted by society and ignorance, and so, if we changed society and educated the people, we could indeed find perfection. Science would bring happiness, salvation, liberation. Evil would vanish. Justice would prevail.

This attitude has its roots in the sciences, as exemplified by Newton. He represented the way science should be done. We had uncovered a mechanistic universe that was deterministic. If we know all the forces acting on a particle, then we can predict its movement. Exact natural laws allow for cause and effect, and all future events are already determined, based on these laws. This was an approach known as reductionism, which was applied not only to science but to all human activities, including theology. The progression of ideas in theology parallels the rise of reason in science. Faith in God and an understanding of moral conduct based in Christianity was prevalent prior to the Enlightenment. Reason could be used to confirm our understanding, and design in nature (natural theology) showed the completeness of the universe. The emphasis on empirical data, however, led to skepticism about events in the Bible, and resulted in a reliance on natural theology, not revelation, to provide understanding of God. This led to deism, the notion that God was not actively involved in human existence. However, the view of God as impersonal left many people questioning the necessity of worship and prayer, and resulted in reduced commitment to and involvement in faith communities. Some rejected religion altogether.

The pendulum had swung far from revelation, far from tradition. It reached an apex at the end of the eighteenth century which could not be sustained. Some looked at the results of the Enlightenment (such as the horrors of the French Revolution) and rejected it. The tide was turning, and the reaction caused several important new movements. One of these reactions is Romanticism, which revitalized the characteristics that had been "lost," such as emotion and the imagination, amid the passion for reason and rationalism. Romanticism first found expression in literature, where we see a revival of these qualities, and a critique of the limits of science. The contrasts between the two world views are striking (see table 1.1). Romanticism, like the Enlightenment, had an impact on religion. God was no longer seen as a creator distanced from creation. Instead, God is seen as a spirit, a force that pervades nature and can be known through human experience. Pietism, which emphasized this individual experience, flourished in Germany.

Table 1.1 Contrasting emphases in Enlightenment and Romantic thinking

	Enlightenment	*Romantic*
Epistemology (ways of knowing)	Abstract rational principles	Concrete human experience
Metaphysics (the nature of things)	Atomism and reductionism	Organic wholes and unity – an entity is more than the sum of its parts
Focus	Unchanging laws; reliance on universal and general principles	Growth and development, dynamic processes, individuality and self-expression
Forces for change	Determinism	Freedom and creativity
Role of science	Technology and reason will result in happiness	Human misery brought about by technology shows the limits of society for salvation

It is not dogma or reason, but rather the gospel and personal devotion, that lead to an understanding of God. The Methodist movement in England focused on Christ as personal savior. Science was valued if it had practical application and demonstrated God's wisdom, but mere mortals could never know everything about God's design, as some scientists claimed they could. Although deism was popular in the United States (Thomas Jefferson and Benjamin Franklin were deists), the fervor died down in the nineteenth century, and the Bible and personal experience gained in popularity.

The Philosophers

We cannot discuss this history without focusing on the ideas of three additional philosophers: Bacon, Hume, and Kant. In this section, we will briefly examine some of their ideas and how they impacted the Scientific Revolution and the Enlightenment, and religion and science to this day.

Francis Bacon (1561–1626) practiced law and was a member of the courts of Elizabeth I and James I. Many cite Bacon as being influential in the Scientific Revolution: indeed, some consider him to have instigated the new method of investigation and regard him as the father of modern science. He did not develop a philosophy himself, but rather advocated methods to develop systems of thought. During this period, deductive reasoning was a common method of attempting to arrive at the truth. This method relies on incorporating new data into previously determined laws or ideas. It's not surprising that this methodology was well used: after all, science was regarded as whatever Aristotle said it was, and so any new discoveries were integrated into his existing principles. Bacon advocated inductive reasoning, whereby we first observe phenomena and gather facts, and then derive laws based on our observations (we will look at deductive and inductive reasoning further in the next chapter). Inductive reasoning could be employed in all aspects of philosophy, from natural philosophy (science) to religion. However, Bacon

considered philosophy to be based on reason, and religion to be based on revelation, and therefore religion was irrational.

Many, if not most, interpretations of Bacon's writings have led to the popular conclusion that Bacon saw science as domination over nature. The methods he advocated for studying the natural world required a victimization of nature: nature was a slave or a woman to be conquered and subdued. Man is an invader, a conqueror of nature. Nature is to be utilized by man and is functional in its utility to us. This interpretation of his work may have influenced how we investigate the natural world and our attitude regarding our role in the universe and how we revere nature. However, the extensive history invoking this interpretation of Bacon's ideas has been challenged. Bacon also stressed patience in our observations of nature, and the necessity of viewing ourselves as servants and interpreters. Nature can be subdued, but only by submission on our part. Unveiling its secrets is a game of give and take, a way of playing that is subtle and coaxing. We need to understand, on a theoretical level, what the natural world is about. We rely on the utility of nature, but the truths and theories that are out there are also important and critical. Knowledge that cannot be used today to improve our comfort, Bacon said, would indeed be useful tomorrow. So we should study nature for utility and for theoretical understanding. Central to this is the understanding, so pervasive in the Enlightenment, that nature can be studied and understood.

David Hume (1711–76) emphasized the role of observation and empiricism in knowledge, but rejected the emphasis placed on reason by the Enlightenment. Hume concluded that all we know is based on the impressions we get from the natural world, and we have no innate ideas in our mind. Our brain interprets these impressions and, through repetition, we compare observations, see patterns, and make theories. Cause and effect are not evident: the cause of a certain incident cannot be reasoned; it can only be concluded from the repeated observations and experiences that allow us to associate an event with its consequence. Because of this association, we tend to see the world as predictable – we expect the future to resemble the past. The conclusions we arrive at from our observations and our associations lead to theories and laws in science. However, these are not universal or certain as they are based only on human experience and the mind's ability to organize and connect events.

Hume's notions of causation had an impact on theology, as a result of his attacks on deism and natural theology. As we are dependent on our senses, he argued, we cannot draw conclusions on what we have not experienced. Since we have no experience of the attributes and operations of God, we cannot understand God. The argument from design contends that we know that God exists because nature is ordered and organized, and humans would build the world in a similar fashion if they could. Therefore, God must have designed it. Hume claimed this reasoning is faulty: we have never observed God creating, and therefore we cannot use the analogy of human design. We can only infer from our own observations, and the works of a supernatural power are beyond our scope of observation. Hume also showed other flaws in the argument. For example, if we continue the analogy of God being similar to a human creator, then God's mind is finite, implying that error and imperfection exist in God. This is contrary to theological doctrine. Hume used natural examples to argue that order is an inherent biological process and does not have to come from a supernatural force. For example, a relatively simple seed produces, via growth and development, a complex plant. This does not

require an external force, but rather an internal inherent drive. Neither can our perceptions help us to determine first cause, so we cannot conclude that God plays this role. We also cannot prove or disprove the existence of God, so therefore we must reserve judgment on the issue.

Hume acknowledged the role of imagination in human thinking. He showed that imagination is necessary in thinking about something when our minds are not receiving a direct impression of it. Imagination is also necessary when we try to connect our impressions to each other and to the world we already know. So we believe in things we do not see at a particular moment in time and relate different impressions into a "whole." If I park my car when I go to work, I know my car is in the parking lot, even though, when I'm working at my desk, I cannot see the car (I'm receiving no impressions from it). Likewise, my view (impression) of my car as I get out of it is different from my view when I walk back to it, but I still know it's the same car. In addition, Hume commented that imagination can help us to incorporate past impressions to formulate general and abstract ideas, and imagination can help fill in the gaps in our knowledge. Imagination allows us to extend our understanding beyond what our senses can perceive. Adam Smith (1723–90) made use of Hume's ideas on the imagination and related them to creativity in science. He emphasized the importance of the imagination on scientific discovery. When we find something unexpected in nature, this gives rise to surprise and wonder. The mind tries to order what we observe and uses imagination to fill in the gaps. A scientist may find continuity between events that others would not, owing to the imagination connecting separate past impressions. Smith said this ultimately leads to a sense of admiration of the natural world. The pursuit of science, Smith argued, brings pleasure, and therefore should be engaged in as in any other endeavor that brings joy to our lives. Smith concluded that, since science is constructed from generalizations (theories), we cannot consider these ideas to be the truth: our constructions are useful to our minds to connect ideas, but other theories, other ways of connecting our observations, could be equally valid.

The philosophies of Hume and Immanuel Kant (1724–1804) overlap in some respects and diverge in others. In many ways, we can see the influence of Kant's Pietist background in his work. Kant attempted to reconcile the extreme viewpoints of empiricism and rationalism that were prevalent during his time. As we have seen, Hume was an empiricist who believed the only source of knowledge was from observable data. Kant acknowledged the importance of empirical data, but also identified a role for reason. Therefore, he also rejected the absolute notions of the rationalists who believe that reason is the only path to knowledge.

Kant maintained the mind actively interprets data, organizes it, and provides understanding. The mind is not passive in this processing. General categories of interpretation are innate within the mind, and Kant referred to this as *a priori* understanding. Some of these categories include space, time, and causality. We don't directly observe these categories, but we know they exist and we can formulate ideas within them. For example, cause and effect for Kant was something innate within the mind, something real. For Hume, cause and effect were based on past observations and experience. These categories allow us to interpret data: they are not, as Hume would argue, revealed by the interpretation of data. For Kant, science is a creative process in which imagination plays a key role in the construction of theories that can lead to deduction of facts.

Kant had a Pietist upbringing in eighteenth-century Germany, which influenced his philosophy of morality and religion. He rejected the argument for God as primary cause, just as Hume did. Religion, he believed, is necessary for morals and ethics, and also to understand and solve practical problems. The purpose of religion is not to solve the theoretical problems that are investigated in the realm of science. Kant believed that ethics and morals should be universally applied, and that they should not be dependent on any particular religious doctrine. God is, in this sense, a postulate that is useful for guiding our laws and determining our morals and ethics. God's will requires us to accept a moral obligation (categorical imperative).

Therefore, according to Kant, the realms of science and religion are very different. Science does not have to invoke design in the explanation of phenomena, while religion does not examine and comment on the natural world, but rather explores and explains morality. Kant's influence reached far into the nineteenth century. We see, in his philosophy, the beginnings of our current attitudes toward science and religion: science is used to understand facts, whereas religion helps us to understand moral issues.

The Rift Emerges

Against the background of the Enlightenment, with its emphasis on rationality and empiricism in science, and of Romanticism, with its renewed emphasis on personal experience in religion, the stage was set for a separation of these disciplines in the nineteenth century. Although there was not a complete separation of science and religion in this period, a rift had developed which was to widen and deepen, and which has led to our present situation. Those who subscribed to natural theology deemphasized the notion of deism and again saw God working in the natural world. Most scientists adopted this view and continued to support the points of contact between science and religion. Many contend that the final blow to the relationship came with Darwin and his ideas regarding evolution (see chapter 8). This also represents the end of Aristotelianism in science, when the last of Aristotle's prevailing notions, teleology, was finally expunged. And thus, today, we have a distinct separation between science and religion. However, as we shall see, there are ways of integrating the two fields, particularly at the boundaries of their limits.

Conclusions

We cannot apply our current world view, on any topic, to people in different times, different places, and different cultures. Our popular understandings of science and religion, notably the distinction we make between them, are very different from those of most of our ancestors. Interactions in the past are varied, and span the continuum from direct conflict to integrated consonance. The remainder of this book will highlight topics, ideas, and people that fall somewhere within this range. We need to understand the complexity of the issues, the diversity of opinions, and the history of the disciplines

to gain a complete picture of where we've been and where we may be headed. For now, we need to be cognizant of the notion that science and religion have had a complex interaction in the past that defies a simple, all-encompassing description. And if we look closely, this also illustrates the situation as it exists today.

Primary Literature

Useful primary sources include Thomas Aquinas's "Five Ways of Knowing God" from *Summa Theologica* (Question 2, Article 3); and the opening chapters of three famous texts: *Metaphysics* by Aristotle, *A Treatise of Human Nature* by Hume, and *Critique of Pure Reason* by Kant.

Questions to Consider

1 What terms would you use to describe the relationship between science and religion historically? Provide an example of each. Do any of these terms apply to their relationship today? Support your answer.
2 In your opinion, why did Aristotle's ideas persist for so long as the basis for much of science? Why were his ideas so important for religion?
3 What was the impact of Augustine's handmaiden formula? Some modern philosophers have used this analogy to describe the application of science to politics, medicine, society, etc. as well as to religion. Can you identify any examples of the handmaiden formula, given this expanded definition, in modern times?
4 Given the relationship between the church and the practice of natural philosophy (science), what affect do you think placing a scientific work on the *Index of Prohibited Books* would have on science? Keep in mind that the first Roman *Index* appeared in the late 1550s.