We gaze up at the same stars, the sky covers us all, the same universe compasses us. What does it matter what practical system we adopt in our search for the truth? Not by one avenue only can we arrive at so tremendous a secret. Symmachus (*c.*345–*c.*402)[1]

CHAPTER 1
Science, religion and myth: making sense of the world

The universe, sense-experience and reality

> For it is owing to their wonder that men both now begin and at first began to philosophize; they wondered originally at the obvious difficulties, then advanced little by little and stated difficulties about great matters, for example, about the phenomena of the moon and those of the sun, and about the stars and about the genesis of the universe. Aristotle[2]

Imagine for a moment that you and a small group of friends were dropped off in some remote area of the country with all your memories and accumulated knowledge erased. Overnight your world would be transformed from one of global information to one of local experiences. Each day would be a survival adventure with every sensory encounter exposing another deep mystery wanting explanation. Like our early ancestors, you would wonder about day and night, the changing phases of the moon, the positions of the shimmering stars, the daily and seasonal movements of animals, the seasons and the mystery of life and death. Superimposed on these regular patterns you may experience a thunderstorm, a tsunami, a torrential flood, a bush fire, an earthquake, a solar eclipse, a sudden injury, sickness or premature death. How might you and your group explain these events, and in what forms might those stories appear?

Our journey begins further down a path of cultural advancement, around 3500 BC. The place is the ancient Near East and the people are the Sumerians and Egyptians. As in our mind game, we shall assume that all the events in space and time were once deep mysteries to these people. We shall further assume that the five basic senses have remained the same over time; for example, a reed growing along the Euphrates or Nile Rivers five thousand years ago would have possessed sensible qualities similar to those of a reed today. The major differences between now and then are how we imagine and reflect upon a reed. The ancient Sumerians or Egyptians believed that as soon as a reed was fashioned into a basket or musical instrument, or used as a writing tool, it appropriated magical powers of divine origin. This mythopoeic way of thinking dominated human thought for

thousands of years until the Greek philosophers used new methods of reasoning and logic to seek alternative explanations involving physical objects and their relations. Mythopoeic belief still exists today in many of the hunter–gatherer cultures of Australasia, Africa, the Americas, the Arctic and the Pacific Rim.

Over the millennia, not only has our thinking about world events changed, but so also has the stratum of our perceptions (apprehension of an idea of sense). For example, in the sixteenth century the telescope extended the human senses far beyond their "normal" physiological limits, as did the microscope in the seventeenth century, which unveiled countless new worlds within worlds never before experienced by human beings. In recent years, with the aid of science and technology, our perceptions have extended from the smallest of subatomic particles that exist for only fractions of a second to the largest of distant galaxies that are billions of years old.

What we perceive as real, therefore, is something actual or experienced as part of developed *knowledge* of objects of sense and not merely an idea.[3] Experience links us to the wider world and the society in which we live; it defines who we are as individuals through community, ownership, self and identity. Thus we are not impartial spectators, but active participants who seek meaning in the things we experience around us. As societies change, human thought patterns change and so do our perceived realities. The most we can know singly or collectively is the sum of our reflections and perceptions cultivated through art, crafts, music, mythology, religion, literature, science, technology, medicine and history. How the external world is experienced by the common chimpanzee, family pet or bird is another question altogether.

Science, religion and myth as "truth-seeking" systems

> Wisdom is the daughter of experience, truth is only the daughter of time.
>
> Leonardo Da Vinci[4]

Like aspects of reality, truth is an extremely elusive concept. Truth can be a verifiable fact such as the earth being roughly spherical, or it can be a feeling such as loving someone, or it can be the belief (or disbelief) in God. Truth can also be a moral judgement that is beyond the reach of verifiability or logical proofs. The moral judgement that murder is a hanging offence is held as a "truth" by some people, but that "truth" may or may not be part of contemporary civil law and ethical standards. In broad terms, truth is the product of knowledge manifest in statements, arguments, practices and beliefs considered to be true. The difficulty is that what you consider true, another may consider wrong or downright offensive. Disagreement or controversy, however, does not mean that the truth is out of human reach, only that there is a lack of consensus about what is considered true.

Since time immemorial human beings have perceived the sun rising in the east, moving across the sky during the day and setting in the west at night. It was not until many thousands of years later that the truth emerged: day and night were produced by the earth rotating about its axis every 24 hours, and the seasons by the earth revolving around the sun once a year. Similarly, for thousands of years heaven was believed to be above the earth and the underworld (or hell) below it. On a flat earth, the concepts "up"

and "down" were relatively straightforward. However, when the earth was found to be spherical these directions became more problematic. "Up" for people living in the northern hemisphere would be "down" for people living on the opposite side of the globe. Belief in a flat earth by the Sumerians, Babylonians, Egyptians and most ancient Greeks – and perpetuated by members of the Flat Earth Society – is now generally considered to be wrong. Reasons for groups such as the Flat Earth Society deviating from the norm relate to an unwillingness to let go of tradition and a refusal to accept new knowledge from science and technology. The moon landing on 20 July 1969 and spectacular pictures of Earth sent back by Apollo 11 astronauts were believed by some to have been a complete fraud sanctioned by the US government.

Whatever the belief, its truth evokes a sense of rightness in a person, cultural group, state or nation. Over the millennia, a rich diversity of worldviews has arisen in part from a different mix of mythopoeic, religious and scientific truths, and each system still profoundly influences Western thinking today.

Myth: early mode of explanation

> [Myth] is not a mere mass of unorganized and confused ideas; it depends upon a definite mode of perception. If myth did not *perceive* the world in a different way it could not judge or interpret it in its specific manner. We must go back to this deeper stratum of perception in order to understand the character of mythical thought.
>
> Ernst Cassirer[5]

Myths: from stories to a way of life

Most of us associate myths with stories,[6] fun, fantasy and fabrications. Western children believe in the myths of Santa Claus, the Easter Bunny, the Tooth Fairy and Little Red Riding Hood. These stories are larger than life in our early years. They only become less significant as we grow older and learn that the world is not make-believe and whimsical but highly ordered and intelligible. As we age, realities change and so do our myths. Myths are also associated with our identity. Some urban myths include America's Wild West, Ground-Hog Day and Halloween, and Australia's Waltzing Matilda and Man from Snowy River, and the list goes on. Each country has its own stories that assist in providing national identity: America, "the land of the free" and "land of opportunity"; Australia, the land of sun-bronzed Aussies, Gallipoli and "mate-ship". Each myth may have some seed of truth but has become stylized over the years to take on "larger than life" status.[7]

Other forms of myth help appropriate and personalize history. As stories of major events such as a flood, fire, drought, sickness or war are passed down from one generation to the next they can enlarge out of proportion and no longer represent objective accounts of history. Historical myths can also be used to incite despotism and hatred against others. A chilling example in the twentieth century was Adolf Hitler's use of the Aryan myths of superiority to inspire the German peoples to sacrifice themselves for the Fatherland. Unfortunately, the myth lives on today in the white supremacy movement and other splinter groups. There are many other examples of myths used by individuals and groups that violate human rights. Indeed, myths

are so intricately woven into the fabric of modern society that it is often difficult to recognize them as such. Nevertheless, despite this difficulty, modern myths are all used in different ways to construct order and meaning in our lives.

Our journey through time will reveal other functions of myths. In ancient times, they provided our ancestors with a way to explain complex events and relations going on around them. Thus from a modern perspective ancient myths should not be trivialized but should be explored and understood within their cultural contexts.[8] The study of ancient myths is an enormous subject because of the diverse roles they play in society, roles that range from Bronislaw Malinowski's "social charter", Ernst Cassirer's "organ of revelation", Clive Staples Lewis's "fable and fact" and Claude Lévi-Strauss's "mediator between culture and nature" through to Sigmund Freud's "repressed libido".[9] Myth expert Joseph Campbell (1904–1987) proposed four main functions of myth:[10]

- **Metaphysical**: Myths dealing with the wonders of the ever-changing world. In early cultures, they provided a way of explaining a flood, a thunderstorm, life and death, and so on.
- **Social**: Myths helping to give meaning to an established social order in a world of unpredictable outcomes.
- **Cosmogonical and cosmological**: Myths providing a symbolic image of the creation, structure and maintenance of the universe and an explanation of its workings
- **Harmonizing "pedagogical"**: Myths about the human condition and how best to harmonize one's life in the face of personal loss and suffering.

Myths possess authority by presenting themselves

Myth was an intellectual tool used by the ancients to order their everyday experience, including their place in the world. Symbolic linkages helped explain "the way of animal powers", "the way of the seeded earth", "the way of celestial lights" and the "way of man".[11] Every myth possessed authority not by proving itself but by presenting itself as a symbolic narrative, usually involving the deeds of different animals, gods, superhuman beings and heroes. Myths were recounted over and over again, often in dramatic form, from one generation to the next. Over time, variations arose from place to place on the explanation of a thunderstorm, a flood, the creation of the universe, a disease, famine or unexpected death.[12] While the subject matter of myths remained the same over many millennia, the early Greek philosophers, with their new ways of thinking, questioned myth's authority and explanatory power (see Ch. 4). Consequently, in the West many myths slipped down the intellectual scale to become fanciful outdoor allegorical plays and orations.

Animism and anthropomorphism

Since our early ancestors did not write, today's anthropologists have a difficult task in trying to reconstruct the ancient mindset. Around the campfire, the ancients probably told stories of the day's hunt, and other survival experiences, which passed down through the generations. Paleolithic peoples probably saw the world as an extension of themselves in the form of more powerful animal or human spirits. As knowledge

grew, traditions and "binding" relations between humans and supernatural beings[13] were established. The spirits could be praised in the good times and appeased during the bad, not unlike the stories of the hunter–gatherer cultures in parts of the world today.[14] Their "book of knowledge" grew from the traditions of their forefathers supplemented with life experiences.

Over time, as human beings shifted from hunter–gatherer communities to a more settled agricultural existence, anthropologists believe the main story themes changed from being animistic to being more anthropomorphic.[15] In the first river-valley civilizations (Chs 2 and 3), and later in Homeric Greece (Ch. 4), the gods became invisible extensions of human beings but differed by possessing immortality and superhuman powers.

Mythopoeic symbolism as a mode to thinking

Eminent Mesopotamian scholar Henri Frankfort (1897–1954) provides a good example of mythopeic symbolism as a mode of thinking:

> [Modern human beings] would explain, for instance, that certain atmospheric changes broke a drought and brought about rain. The Babylonians observed the same facts but experienced them as the intervention of the gigantic bird Imdugud which came to their rescue. It covered the sky with the black storm clouds of its wings and devoured the Bull of Heaven, whose hot breath had scorched the crops.[16]

Contrast this account with the more objective, physical explanation of the Greek Anaximenes, who lived in Miletus around the middle of the first millennium BC (Ch. 4). Anaximenes claimed that air was the atmosphere in its most evenly distributed state, fire was air's most rarefied state, water was its more condensed state, and earth and rock its most condensed state. Anaximenes wrote:

> The form of air is as follows: when it is most uniform it is invisible to sight [atmospheric air]; but it is made manifest by cold and heat and moisture and motion. [Air] moves continually; for it would not change as much as it does if it were not in motion. As [air] thickens or rarefies it appears as different. For when [air] spreads out into rarer form it becomes fire; winds on the other hand are air as it thickens; air cloud is produced by compression; and water still by more compression; when further thickened it becomes earth and in its thickest form stones.[17]

A more modern scientific explanation of atmospheric changes did not appear until the late-eighteenth and nineteenth centuries. Today, we know that air comprises mostly nitrogen, oxygen, carbon dioxide and water vapour. As an air mass rises from the earth's surface, the lower atmospheric pressure causes it to expand and subsequently cool. If the water vapour cools below a critical temperature, or dew point, the moisture in the air mass condenses into droplets on microscopic atmospheric particles, giving rise to clouds. And when the combination of temperature, humidity and droplet size is just right, rain falls. It has been estimated that about 1400 km^3 of water per day is evaporated from land and ocean surfaces, and returns to the earth as rain.

Despite improvements in our understanding of world phenomena such as cloud formation, rain, thunder and lightning, it is important to stress that the older highly mythologized explanations of the Sumerians, Babylonians, Egyptians and later Homeric societies (and other ancients) provided perfectly "reasonable" ways of ordering experience given the intellectual framework and boundaries from which they built their knowledge. The Near-Eastern and Homeric reality was a world full of gods and divine manifestations, not a world of physical objects, as we believe today.

Religion: cosmic and social order in a moral framework

> [Religion] is the positive human response to experience in thought (myth and theology) and action (cult and worship) . T. Jacobsen[18]

In ancient times, religious practices appear to have grown out of a class of myths that primarily dealt with the "binding" linkages between human beings, spirits and their gods.[19] These mythopoeic linkages told of a creation, maintenance of world order, life and death, happiness and future success. Use of myths in the different religions seems to have provided a wider authority and wholeness in worldview at a time in history when all knowledge was bounded by divine causation.[20]

Genesis, for example, presents a world created by the Hebrew God in six days: a three-layer cake with heaven on top, flat motionless earth in the middle and the dark underworld at the bottom. This description was not unique to the Hebrews but had precedents dating back at least to 3000 BC. The Hebrew version was compiled around 800–900 BC and gave the Hebrew writers a more complete picture with deeper explanatory significance of historical events.[21] Importantly, the association of myth with religion does not mean a worldview is right or wrong, but only that the mythical content requires identification, clarification and interpretation. Truth does not emerge full-blown on the literal surface, but is contained deep within the layers of the ancient mind's literary genre.[22] The story of Adam and Eve, the creation of Adam from clay, the creation of Eve from Adam's rib, and the flood that wiped out humankind are not considered true today in the literal sense but were the ancient Hebrew's attempt to convey meaning about deep mysteries. We shall see the same in ancient Sumer and Egypt in Chapters 2 and 3. The stories reflect an honest, highly imaginative, culturally conditioned consciousness involving mystery, myth and religiosity.

Attempts to define religion

Most early civilizations had no words for religion as we have today. Religion's etymology[23] comes from the Latin *religio*, meaning "a mutual binding obligation" or "oath" and emphasizes a relationship between human beings and their god(s).[24] Greater interest in the meaning of religion (and myth) did not occur until the nineteenth century, when history and anthropology became disciplines in their own right. Anthropologist Edward B. Tylor (1832–1917) defined religion as "the belief in spiritual beings".[25] James Frazer (1854–1941) believed religion was "a propitiation or conciliation of powers superior to man which are believed to direct and control the course of nature and of human life".[26] Myth expert Joseph Campbell argued that

religion was a way of "bringing inner experience into the outer life of the people themselves".[27] And philosopher and mathematician Alfred North Whitehead (1861–1947) wrote that religion was "what an individual does with his own solitariness".[28]

In the early twentieth century, French sociologist Émile Durkheim (1858–1917) added a social dimension by defining religion as "a system of beliefs and rituals with reference to the sacred which binds people together into social groups".[29] The purpose of a "binding" ritual, he argued, was to reaffirm an individual's social identity, shared values and way of life among a group, community or nation. Durkheim's emphasis on religion's social function was a turning point. We shall see that over the past 5000 years, the social "binding" of human beings to gods in the West has changed dramatically from a nationalistic duty within a "corporate" structure to a more voluntary one based on choice. Today, Western beliefs in god(s) range from radical fundamentalism to atheism.[30]

Religion as a vital and pervasive feature of human life

> Religion, then, can be defined as a system of beliefs and practices by means of which a group of people struggles with the ultimate problems of human life. It expresses their refusal to capitulate life to death. To give up in the face of frustration, to allow hostility to tear apart their human aspirations. J. M. Yinger[31]

A truly remarkable fact is that no society has been discovered without some form of religiosity, meaning a belief in spirits, supernatural powers or gods.[32] Human burial sites in the Middle East as early as 90 000 to 120 000 years ago,[33] and in Europe around 40 000 years ago, imply heightened ritual and death awareness. The ritual interment of the dead may[34] have been part of a wider symbolic enactment of the separation of life and death.[35] The discovery of small carved figurines of a Mother Goddess of fertility[36] (birth and regeneration) from Minoan Crete to China, and the appearance of spectacular cave art[37] in parts of Europe, the Americas and Australasia adds to the hypothesis of a new "cultural" awareness and heightened religiosity.[38]

Baring and Cashford have further suggested that the new awareness followed two main myth themes:[39] a wider search for meaning beyond everyday experience such as linking life and death to a higher power, the Mother Goddess; and the symbolic representation of local hunting experiences in cave art that could be talked about, reflected upon and worshipped. In part, Baring and Cashford base their claims on the Mother Goddess, heavenly bodies, the sun, moon or the stars not widely depicted in Paleolithic cave art; and animals not symbolized as carved figurines.[40] Although controversial, the idea does appear to have support in the Bradshaw rock paintings scattered over about 50 000 km^2 of the rugged Kimberley region of northern Western Australia. The Bradshaw rock art represents animals and hunting scenes dated to around 20 000 years ago although they may extend as far back as 60 000 years.

Given the solitude of human beings living in small groups, it is not hard to imagine the changes that took place when the Paleolithic lifestyle slowly transformed from pack hunting to living in small temporary villages, then to larger agricultural settlements and finally grand civilizations. Religiosity must have also changed, presumably, from simple myth-based belief and ritual systems involving shaman-like individuals[41]

to a more complex hierarchical system of people management with a hierarchy of gods.[42] Archaeologist Colin Renfrew writes on this possibility: "This notion of a hierarchy of divinities is one which comes more easily to a society which is itself hierarchically structured, for instance to a state society. It is difficult to imagine such a feature in an egalitarian society organised at the band level."[43] Chapters 2 and 3 will show this close binding between human activities on earth and divine activities in heaven. With the invention of writing, codified rules gradually replaced memory in all aspects of urban life, including myth-based rituals and religious practices.

Another dramatic turning point in religious thinking occurred in the Middle East, India and China between 800 BC and 500 BC. This extraordinary fertile period gave rise to today's major world religions. In Israel, the Hebrew prophets taught a monotheistic faith from which Judaism, Christianity and Islam developed. In India, the teachings of Buddha (*c.*563–483 BC) gave rise to Buddhism,[44] and in China, the teachings of Confucius (*c.*551–*c.*479 BC) founded an ethical system that grew into Confucianism.[45] At around the same time, another extraordinary revolution had began in Ionian Greece among the ancient Presocratic philosophers (600–400 BC). This period of heightened abstraction is called the "Axial Age" and the major worldviews that exist today were shaped at that time.[46]

Multi-dimensional features of religion

Religion is a multi-dimensional activity comprising at least six major components: spiritual, experiential, mythical, social, ritual and doctrinal. Each will be discussed briefly below to help put our story in its proper context.

1. The spiritual dimension and ultimate reality

All religions have an ultimate reality. It may be an eternal source, truth or principle that governs the universe, an impersonal transcendent God who created everything or a more personal God who must be kept separate from his creations.[47] Aspects of Hindu Vedanta, Buddhist Mahayana and Taoism have an impersonal ultimate reality, which is the creator principle and eternal truth of the universe.[48] The Tao, for example, is the eternal and unchanging source in which originate and return all the manifestations of the universe. All the gods, human beings, plants, animals and insects, everything in the universe, including the universe itself, came from the Tao.[49] Confucianism, albeit a more secular doctrine of worldly social-mindedness, has as its ultimate reality the moral law that is omnipresent, hidden from the senses and eternal.[50]

The ultimate reality in the monotheistic traditions of Christianity, Judaism and Islam is a personal God. The God of the Old Testament is different from any god of the Hindu pantheon, ranging from the oldest supreme Varuna to Brahman of the Upanishads. The concept of divinity is also different because the God of the Jews, Christians and Muslims created the world only once, not many times, as described in the ancient Hindu literature. However, it would be wrong to think that the God of the Old Testament is similar for Jews, Christians and Muslims, as differences of interpretation have occurred over the centuries.

The Christian God, for example, involves the notion of Christ as *logos*, who affects the entire meaning of the creation and world order. Similarly, the Muslim God, Allah, is placed into the Islamic context with special meanings and acts of symbolism, but

without the Christian Trinity.[51] Notwithstanding many similarities among the world religions, we have to recognize that each operates within its own set of boundaries and historical truths.

2. The experiential dimension

The experiential dimension is the foundation of the origin and development of all religious traditions. It may involve an enlightened interaction with the super-sensory world or with some divine manifestation in the sensory world. The experience and its truth may be realized through revelation, prophecy, doctrine, dreams, trances, songs, orations, oracles or waking visions.

Buddhism grew from Buddha's enlightenment in the sixth century BC as he sat in meditation beneath the Bo-Tree. Judaism developed from the Mosaic doctrine and the inaugural visions of the prophets (*c.*550 BC). Christianity developed from a small breakaway Jewish sect who believed that Jesus by his resurrection had brought about the beginnings of final salvation.[52] The message spread to the Gentile world via St Paul after he had a conversation with the resurrected Christ on the road to Damascus. And Islam was finalized after a series of revelations from the Arabian Prophet Muhammad (AD *c.*570) and God's angel, Gabriel. As a general conclusion most, if not all, religions and their developed philosophies are based on the experience of some "enlightened" person or persons. The problem for historians is sorting out the relationship between the religious experience, its mythical content and the facts of history.

3. The mythical dimension

Every religion contains some form of myth. Myths are recorded in the ancient literature as if they actually occurred in history. The Passover, for example, re-enacts the exodus of the children of Israel from bondage in Egypt back to the Promised Land. The historical event may be true, partly true or fabricated, but nonetheless is appropriated through myth, ritual and service. The story provides a framework for understanding the individual and personal journey through life. Catholic baptism is another example. Although Jesus appears not to have taught baptism, Paul taught that it symbolized a believer's union with Christ in his death, burial and resurrection. The believer finds solace and validation of personal rites of passages in the historical and cultural myths of the community in which he or she lives.

4. The social dimension

The social dimension of religion helps to support and validate an individual's place within a particular group sharing a common belief system. Religion imposes order on an ever-changing, often perilous, world and helps to provide deeper meaning to the human condition in the grander scheme of things. Davis and Moore give a penetrating account of the social function of religion:

> The reason why religion is necessary is apparently to be found in the fact that human society achieves its unity primarily through the possession by its members of certain ultimate values and ends in common. Although these values and ends are subjective, they influence behaviour, and their integration enables this society to operate as a system …

> In an extremely advanced society built on scientific technology, the priesthood tends to lose status, because sacred tradition and supernaturalism drop into the background … [but no] society has become so completely secularized as to liquidate entirely the belief in transcendental ends and supernatural entities. Even in a secularized society some system must exist for the integration of ultimate values, for their ritualistic expression, and for the emotional adjustments required by disappointment, death and disaster.[53]

5. The ritual and service dimension

Ritual and prescribed service are essential features of religion. They involve a myriad of devotional activities including worship (prayer), ritual, sacrifices and offerings.[54] In the earliest civilizations services were performed at selected communal sites, such as on a mound, in a cave or on a mountaintop. Ancient Mesopotamians built ziggurats,[55] Egypt had the pyramids[56] and China had a mythical peak in the Thai Shan cult.[57] Ancient India had its golden mansion of the god Varuna at the sky's zenith. Homeric Greece had Mount Olympus near Athens and Israel had Mount Sinai, where God revealed the Covenant to Moses.[58] In the Old Testament, the prophet Isaiah wrote of a time when "the mountain of the house of the Lord shall be established as the highest of mountains".[59] In Muslim history, the Arabian prophet Mohammed had a mountain cave for devotional purposes where he heard a voice saying to him: "Mohammed, you are God's messenger."

A recurring theme in ancient times is a preoccupation with "high places" providing privileged access to heaven and the divine. In early Mesopotamia, one of the highest rooms in the towering ziggurats was a dark bedchamber frequented by the priestess, who became the bride of the gods.[60] This "mythical" marriage each year renewed the fertility of the soil and the strength of the king's arms.[61] Such rituals illustrate the strong ties between early human beings and their gods upon which life and death depended.

6. The doctrinal dimension

Doctrine underpins the narratives of all world religions. The Hindus have their sacred scriptures of Vedic (*c.*1000 BC), writings of Upanishads (800–400 BC) and philosophy of Buddha (*c.*500 BC). The Chinese have the Analects of Confucius, teachings of Lao Tse (founder of Taoism) and variations of Buddhism. Similarly, Judaism, Christianity and Islam have their books of religion, with their own individual style, inner dynamic and historical meaning.

The narrative and doctrinal dimensions contain many stories and moral laws that bind a people to their gods. In Judaism it is not only the Ten Commandments, but also over 600 rules imposed on the Jewish community by God. The books of Christianity and Islam are also heavily codified revelations with answers to profound existential questions. The central ethic for Christian faith is love founded in the life, death and resurrection of Jesus Christ.

However, within any doctrine there is not always agreement on the nature of a religious truth. In Chapter 6, we discuss the Christian doctrine of Trinity and the heated debates that ensued among religious scholars. History is full of examples where consensus could not be reached and religious sects have formed and split off from the mainstream. According to the *World Christian Encyclopedia*, there are around 35 000 denominations

of Christianity, each differing on some fundamental interpretation of central dogma or past events.[62] The "single truth" of a sacred text may have many interpretations.

Religion defined

Taking account of its multi-dimensional structure, religion may be defined as a social response to a world of predictable and unpredictable outcomes involving an "enlightened" spiritual leader, human beings and their god(s). Religion is a way of ensuring a meaningful, happy and purposeful life and a possible means to the afterlife. It provides consolation for personal and community tragedy, often through prayer, divine revelation, stories, imagery and moral teachings. All major religions have been culturally conditioned. Most of us are born into at least one system of codified beliefs and service, which we continually grapple with, modify or reject throughout our lives as part of an ongoing and personal search for deeper meaning and purpose.

World religions today

> The belief in God has often been advanced as not only the greatest, but the most complete of all the distinctions between man and lower animals … I am aware that the assumed instinctive belief in God has been used by many persons as an argument for His existence … The idea of a universal and beneficent Creator does not seem to arise in the mind of man, until he has been elevated by long-continued culture.
>
> Charles Darwin[63]

Today about 35 per cent of the world's population is Christian, 22 per cent is Muslim, 15 per cent is Hindu, 6 per cent is Buddhist, 1 per cent is Confucian, 0.3 per cent is Jewish, 0.1 per cent is Baha'i and a fraction of a per cent of the world's population holds primal religions.[64] Older religions include those defunct in early Mesopotamia, Egypt and Greece, and those still existing in Australasia, Africa, the Americas, the Arctic and the Pacific Rim. With the exception of Judaism, the popularity of the world religions has steadily increased over the past 20 years. About 20 per cent of the world population is non-religious (agnostic, secular humanist and atheist) (Fig. 1.1).

Science: seeking relationships among physical objects

> Nam et ipsa scientia potestas est
> [Knowledge itself is power]
>
> Francis Bacon[65]

The universe is ordered and explainable

Natural science provides a very different way of making sense of the world. Natural science began in ancient Greece with the Presocratic philosophers of the sixth century BC. As will be discussed in Chapter 4, this group single-handedly invented a physical cosmos and a new system of reasoning, logic and validity to explain the wondrous workings of the world. Their fundamental tenet was that the physical universe was ordered and explainable: there was no longer any need for hundreds of gods to carry out specific duties or have complex interactions with human beings. After many stops and starts over the next

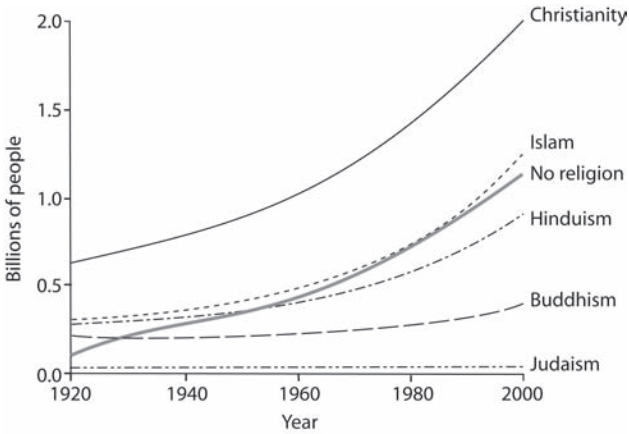

Figure 1.1 Comparative growth of world religions (1920–2000). The data show a steep rise in the popularity of the major world faiths, with the exception of Judaism. The rise reflects both population expansion and increased recruitment. Non-belief has increased steeply over the past 40 years. (Adapted version of Ch. 19, Figure 1, by John Taylor in McManners (1990: 634), by permission of Oxford University Press.)

two millennia, natural science grew in the seventeenth century to become the most powerful problem-solving and knowledge-seeking system ever invented.

The word "science" comes from Latin *scientia* (to learn or to know) and entered the English language in the Middle Ages around 1340 as a French import equated with learning and knowledge.[66] The word "scientist" is more recent and was coined in 1833 by English scientist and philosopher William Whewell (1794–1866) to describe a person who was "a cultivator of science", by making an analogy with the word "artist".[67] Modern natural science can be defined as the sociohistoric process of understanding the physical universe and our place in it.[68] The system is built on scientific facts interwoven into conceptual schemes as they relate to perceptible, verifiable (or falsifiable) sense-experience. It is self-correcting and, for the most part, self-perpetuating, with no absolutes; science begins with a question and ends with a question.[69]

Growth of Western science

> [Individuals who break through by inventing a new paradigm are] almost always … either very young or very new to the field whose paradigm they change … These are the [people] who, being little committed by prior practice to the traditional rules of normal science, are particularly likely to see that those rules no longer define a playable game and to conceive another set that can replace them. T. S. Kuhn[70]

For most of its history, Western science has passed through six main stages. The first stage was a pre-scientific stage (3500–650 BC), when knowledge was generally sought for some practical good of a social collective. It was followed by an originative stage (in Greece, 650–30 BC), when Greek philosophers sought to understand the workings of the world largely for advancing knowledge itself using new methods of interrogation. The second stage was at odds with the older Near Eastern and contemporary Homeric religions with their hundreds of gods, although the concept of the divine was not dismissed altogether (Ch. 4). At the third stage, a "desenile" stage (AD 300–1200), natural philosophy was avoided in the West because it distracted the mind from

contemplation of God and scriptural writings. This was typical of the early Roman and Western Latin Christendom periods until the Islamic "revival" of philosophy in the ninth century.

The fourth stage was a "revival" stage (1200–1450) during the "great age of literary translation" and "institutionalization of reason" in the universities. Studying nature was endorsed by a number of highly influential theologian-philosophers as a genuine road to understanding God's creation. The fifth stage was a more techno-mathematical "experimental" stage (1450–1850) involving free-thinkers of the likes of Copernicus, Kepler, Galileo, Newton and many others who viewed the workings of the world more mechanistically. The sixth stage of Western science was a "maturation" phase (1850–), when it increasingly combined with technology to become an enormous social, intellectual and economic benefit. The homes we live in, the water we drink, the clothes we wear, the medicines with which we heal the sick and prolong life, transport, communications, space exploration, computers and the Internet are all products and refinements of modern science and technology.[71] The informational revolution of the twenty-first century promises to accelerate discovery in all areas; it will solve many deep mysteries about ourselves and generate many more that we haven't yet contemplated. Indeed, the twenty-first century appears to be the beginning of a new seventh "translational" stage of science, where the spectacular diversity of life is increasingly recognized to involve surprisingly fewer changes to a primitive genetic master plan than previously thought. Understanding the unifying principles underpinning life's grand design will, I believe, translate into new approaches to repair damaged or diseased organs including nerves, further delay the ageing process, lead to the first "cookbook" creation of life from raw materials, and continue to unveil the deep mysteries of life, the universe and its composition (see Chs 9, 10 and 11).

Five major features of modern science

- **Science's function is to help understand the physical universe and our place in it**. It does so by extending, ordering and bringing sensory experience into a logical system of thought and assembly.[72] The facts of science (observations and measurements) are not only the raw materials of scientific enquiry, but the proof of its results.
- **Science seeks knowledge by objectifying natural phenomena from the smallest of particles to the largest of distant galaxies**. Science breaks the event or entity of interest into pieces and describes it operationally by linking concepts and formulating conceptual schemes and natural laws. The conceptual schemes and laws are verified (or falsified) by observation, experiment and measurement. Scientific reductionism does not do away with the thing being explained as asserted by some critics of science.
- **Science is a never-ending cycle of questions and answers with no absolutes**. Authority in science is self-corrective because the scientific process generates many more new questions than answers. Conceptual schemes and laws are only as valid as the assumptions and methods used to derive them. Over time the truths may be subtly modified or completely abandoned. One of the most misunderstood features of science is that it does not answer "first causes", such as

the "cause" of gravity or questions about God's existence. However, there is no limit to science's ability to solve problems within its reach.

- **There is no "one" method of science**. Science is a process that is built on a connected series of logical and practical operations involving an idea, a test or experiment and some kind of measurement. The scientific process is characterized by rules of logic and methods of experiment and measurement.
- **Basic or curiosity-driven science is full of surprises**. Scientific discovery and innovation underwrite human quality of life in profound ways. Many people and politicians fail to realize that most scientific, medical and technological discoveries are mere "accidents" of the process, with their benefits not realized until many years or decades later. Basic or curiosity-driven science[73] is a proven economic, practical and social success that has paid for itself over and over again. X-rays, the transistor, clinical imaging modalities, penicillin, computers, lasers, optical fibres, nanotechnology, DNA fingerprinting and bionic implants are just a few examples of the "accidental" spin-offs of basic research. The development of the World Wide Web in 1990 was yet another "surprise" in a long chain of invention involving basic science. CERN computer scientist Tim Berners-Lee wanted to improve communications between physicists in universities and research institutions around the world. Today the Web drives the largest informational revolution ever in history; and it would not have been possible without the invention of the transistor in 1948 and basic research into the quantum mechanical properties of crystalline solids decades earlier. Supporting basic research is our lifeline to the future because the future is invented, not predicted. There is a wonderful story from the early nineteenth century, when a cynical member of the British government asked Faraday about the relevance of his ongoing work converting electrical energy to a force. Faraday's terse but farsighted reply was: "One day, Sir, you may tax it."

The language of science

Concepts

Concepts are abstract terms used every day to generalize categories or groups of particular objects and their parts, events or operations. According to philosopher Rudolf Carnap (1891–1970), the concepts of modern science fall into three broad groups: classificatory, comparative and quantitative.[74]

Classificatory concepts place an object in a given class. For example, cloud, lightning, rain, animal, plant, gene, head, hot, cold, dry, wet and species are all classificatory concepts. The second type of concept, the comparative concept, differs from a classificatory concept by being more descriptive, and gives more information about the object studied. Instead of classifying an object as hot or cold, dry or wet, comparative concepts would describe objects as hotter or colder, drier or wetter. Comparative concepts play an important role in science because they are more effective in describing sense-experience.

The third kind of concept is the quantitative concept. It is an outgrowth of the classificatory and comparative concept, and relies on some kind of measurement of quantity. The following example shows the progression of ideas from a classificatory to a quantitative concept:

classificatory	→	comparative	→	quantitative concepts
e.g. hot, cold	→	hotter, colder	→	temperature and heat

Importantly, quantitative concepts are usually defined in terms of a set of operations that lead to their measurement.[75] Temperature, for example, did not have a precise meaning until Gabriel Fahrenheit (1686–1736) and Anders Celsius (1701–1744) introduced a defined scale on a thermometer. Likewise, heat did not have a precise meaning until James Prescott Joule (1818–1889) accurately measured the unit quantity of heat, or calorie, in a calorimeter. One calorie is defined as the heat required to raise the temperature of 1 gram of water 1 °C, from 14.5 °C to 15.5 °C. However, quantification through standardization did not begin with science, but with technology dating back to the Sumerians and Egyptians (see Chs 2 and 3).

Conceptual schemes

The great value of a concept is how it relates to other concepts. Concepts can be likened to letters of the alphabet and conceptual schemes help narrate the scientific stories. An example of a conceptual scheme is Newton's law of gravitation. The law relates the quantitative concepts of force, mass and distance. It is expressed mathematically:

$$F = G\frac{m_1 m_2}{d^2}$$

where F is the mutual force of gravitational attraction in newtons (N), m_1 and m_2 are the masses of two bodies in kilograms (kg) separated by distance d in metres (m). The constant G is the gravitational constant, equal to 6.672×10^{-11} N m^2 kg^{-2}.

Newton's law, expressed in words, states that any two bodies attract each other with a gravitational force directly proportional to the product of their masses and inversely proportional to the square of the distance between them at their centres. If the Earth had half its present mass, the gravitational force between the Earth and the moon would be half because, all else being equal, force is proportional to mass. Similarly, if the Earth's mass remained the same but the distance between the Earth and the moon doubled, the gravitational force would become a quarter of today's value. What Newton further demonstrated was that gravity is not just a property of the solar system but a universal property of matter. The law of gravitation helps explain how the universe is stuck together, and why there is a high tide when there is a full moon. It describes the trajectory of the planets around the sun and how satellites orbit around the Earth.

Another different type of conceptual scheme is one formulated against large sets of independent criteria. The best example is Darwin's theory of natural selection and human descent. Natural selection is not something we can readily see or measure directly, but is inferred from different kinds of observations and measurements.[76] Darwin knew only too well that he could not "directly" observe the origin of a new species, much less evolutionary trends.[77] He went about his search not by formulating and testing a hypothesis through some repeatable experiment and measurement or mathematical model, but by comparing large sets of independent geological, embryo-

logical, morphological and anatomical data.[78] He reasoned that if all the sources pointed to the same result (and disproved all others), his theory should be received.[79] Darwin wrote to his botanist friend Joseph Hooker in 1861: "The doctrine must sink or swim according as it groups and explains phenomena. It really is curious how few judge this way, which is clearly the right way."[80] Darwin's approach is similar to how a modern historian judges and weaves past events into history or how a Greek philosophy scholar pieces together early Greek thought from the extant fragments and commentaries from ancient texts.

Power of prediction

The clarity, rigidity and elegance of a conceptual scheme or theory is often expressed in a mathematical formula (e.g. Newton's law of gravitation) or a non-mathematical statement (e.g. Darwin's theory of natural selection and human descent).[81] In general, a scientific theory is valuable in three ways: first, in its universality to describe and explain what has been carefully observed; secondly, in its ability to endure criticism as new knowledge is found; and thirdly, in its ability to predict what has not been observed, but is still within the bounds of known physical laws. Prediction is an extremely powerful aspect of scientific enquiry because it extends beyond what is known, or at least beyond what is supported by scientific facts. Here are four brief examples of how scientists have used a theory for prediction.

- **The bending of light rays around large gravitating bodies.** Albert Einstein's special theory of relativity, published in 1911,[82] predicted that light rays approaching the sun (or any gravitating body) would be deflected near the surface. He based his theory on the assumption that light has energy, and energy has mass.[83] On 29 May 1919, English astronomer Arthur S. Eddington (1882–1944), while on an astronomical expedition to the island Principe in equatorial Africa to observe a 6–8-minute total solar eclipse, confirmed Einstein's prediction. He calculated that the deflection of light caused by the gravitational field of the sun was on average 1.64 seconds of arc (as opposed to Einstein's calculated 1.75 seconds of arc).[84] The agreement between theory and measurement gave Einstein's principle of mass–energy equivalence, with respect to the speed of light, scientific verifiability.[85]
- **The expansion of the universe.** An equally ingenious prediction from Einstein, but this time from his 1916 theory of general relativity and field equations, was that the universe was not "standing still" but expanding in all directions.[86] This most remarkable mathematical prediction, which incidentally Einstein originally thought preposterous, gained support in 1929 with the observations of astronomers Edwin Hubble (1889–1953) and Milton Humason (1891–1972) (see Ch. 9).
- **The existence of black holes.** Einstein's theory of general relativity also predicted the idea of black holes: regions of space-time that not even light can escape because gravity is so strong.[87] For a long time many physicists were highly sceptical and thought the existence of black holes was pushing relativity theory too far. Today black holes are considered to be real phenomena created out of the collapse of stars. As the star becomes smaller and smaller, the gravitational field at the surface becomes stronger and stronger to a point where nothing escapes, not even light.[88] Black holes are detected by the things they swallow up,

such as neighbouring stars or whole galaxies. More recently, they have been seen to emit faint x-rays and are believed to be located in the centres of galaxies, including our own Milky Way.

- **The theory of cosmic wormholes.** The fourth example of the predictive power of a scientific theory is cosmic wormholes. Cosmic wormholes may provide rapid interstellar transport without exceeding the speed of light. They represent severe distortions in the fabric of space in the universe caused by extremely powerful gravitational fields such as black holes. Some theoretical physicists hypothesize that by moving the mouth of a wormhole and collapsing it, the system could potentially turn into a time machine that would permit human beings to visit the past.[89] While the wormhole theory has no experimental support, its formulation, according to theoretical physicists, still lies within the bounds of existing physical laws.[90] Such "thought experiments" may seem totally contrived and fanciful, but they are extremely powerful in challenging scientists to think beyond the present and forage the path of future discovery. The key point is that while science must operate within the province of human experience it must also be encouraged to extend beyond it.

Another recent example of the predictive power of science comes from the analysis of the six universal physical constants. Astronomer Royal Martin Rees discusses the consequences of making the constants slightly higher or lower.[91] Rees explains that if the constant describing the amount of energy produced in the stars were 10 per cent higher there would be no hydrogen left in space, and if it were 10 per cent lower there would be no heavy elements. If the force of gravity were 10 per cent higher the planets would spiral into the sun, and if it were weaker they would spiral out into space. If any of these cases actually existed, life on earth would have been impossible. Importantly, Rees's examination is not metaphysics but solid science within the realm of current physical theory, and one day may bear fruit with new discoveries.

A self-correction process with no absolutes

That Western science is a dynamic, self-correcting process with no absolutes is one of the most difficult aspects of science to convey to the non-scientific layperson. The statement *with no absolutes* simply means that science's conceptual schemes and laws are valid only in relation to the methods and assumptions used to derive them.[92] In general, a conceptual scheme in science, unlike the observations, is not a perceived action but an inferred one formulated from the experimental data at hand.

For example, although Newton's law of gravitation has gained wide consensus, it is not an "absolute" law. The law was formulated when Newton applied the laws of motion to two spherical bodies placed in an abstract or idealized system that had been isolated from all other influences. One of the fundamental assumptions he made was that gravitational force acted instantaneously across empty space between two bodies, whether they be the Earth and the moon or the Earth and distant planets. By combining the law of gravitation with his fundamental laws of motion, he was able to prove mathematically that the path of a planet orbiting around the sun was an ellipse.

Newton's physical law holds generally true for all celestial bodies in the solar system (and wider universe), but exceptions to the rule do exist. It does not accurately describe orbits of artificial satellites around Earth. For that we must appeal to classical

Newtonian mechanics, which takes into account the deviation of the Earth's non-spherical shape, density and atmospheric drag.[93] Similarly, Newton's law does not accurately describe the precession of the orbit of the planet Mercury around the sun and physicists must incorporate Einstein's relativistic mechanics. Put simply, Newton's law of gravitation represents *a generalization or an over-simplification* of what actually occurs in nature. It is the best Newton could do with the information and methods he had available. Today, Newton's concepts of absolute time, space and mass have all been replaced by Einstein's four-dimensional space-time continuum (see Ch. 9).

The important point is that science can only postulate functional dependencies or relations, not absolutes. A fundamental error made by many non-scientists writing about science is to imply the existence of absolute laws.[94] A "cause" in twentieth- and twenty-first-century science is generally a statistical change in an independent variable, while an "effect" is a statistical change in a dependent variable. Physicist Ernst Mach (1838–1916) clearly understood this difference when he wrote:

> There is no cause nor effect in nature; nature has but an individual existence; nature simply is. Recurrences of like cases in which A is always connected with B, exist but in the abstraction which we perform for the purpose of mentally reproducing the facts. Cause and effect, therefore are things of thought, having an economical office. It cannot be said why they arise.[95]

Nineteenth-century causality and/or determinacy, in the strictest meaning of cause-and-effect, have no place in today's science because science never reaches finality; each problem begins and ends with a question. Thus the very essence of science does not lie in its permanence, but in its development toward greater learning and understanding.

Is mathematics an exception to the rule?

If there are no absolutes in science, what about the rules and laws in mathematics? In one sense, the rules and laws in mathematics are absolute. However, mathematics of its own accord gives no account of reality; it is a symbolic language, a tool of formal logic *par excellence* used by theoretical and experimental scientists to order, explore and predict interrelationships. Alongside the spoken word, art, writing and music, mathematics is one of the purest forms of language abstraction invented by human beings. Mathematics is not concerned with a description of phenomena *per se* but with a specific language of relations among concepts.[96] In other words, mathematics does indeed provide science with "certain" answers,[97] but the discipline of mathematics by itself is not a science.

What is a scientific truth?

If we say that there are no absolutes in science, what, then, is a scientific truth or proof? This question is at the very heart of understanding the scientific process. Today a scientific "truth" is defined as that relation derived by careful observation and some form of verifiable experimentation, usually involving measurement.[98] The "truths" (or relations) are those observational theory-laden statements as part of the "method" that have been scrutinized and agreed upon by the scientific community. As knowledge advances, the "truths" undergo continual refinement; they may be subtly changed or completely abandoned.

Understanding science through its methodology

> Generally, researchers don't shoot directly for a grand goal. Unless they are geniuses (or cranks) they focus on bite-sized problems that seem timely and tractable. That is the methodology that pays off for most of us. M. Rees[99]

The nature of a scientific truth is best understood through its methodology. For many decades textbooks have often talked about "one" method in science. However, I know of no professional scientist who would subscribe to "one" method. Scientists simply do not carry out their business in this way. Instead, scientists use curiosity, intuition and common sense and a whole arsenal of strategies to interrogate natural phenomena. These operations are broadly summarized in Figure 1.2.

After forming an idea or hypothesis,[100] scientists perform a preliminary test or experiment (usually with institutional infrastructure support). If the hypothesis fails the first test, the initial idea and founding assumptions are re-evaluated. Having preliminary data at hand, a scientist usually seeks external funding to continue the research. The funding process is peer-driven and assesses the novelty of the idea, and the methodology and competency of the scientists. If successful, the idea can be more fully tested using an appropriate sample size and statistical test. When a tentative hypothesis is affirmed by a scientist and later by others, it may be general enough to become a theory.

However, most hypotheses turn out to be wrong, which is why Popper argued for falsification and not verification as the driving force of science.[101] That is, no finite number of positive tests can prove a scientific hypothesis, but one negative case can prove it false. While I understand Popper's idea of falsification driving science[102] on a broad scale, and as a criterion for separating science from pseudoscience, it does not drive science daily. In practice, what drives science is the fun, and excited anticipation that your experiment "will work" and "will lead" to a new discovery or interpretation. Popper's falsification can really do no better (or no worse) at driving science than verification. As Jacob Bronowski (1908–1974) pointed out, both falsification and verification offer evidence for or against a conceptual scheme, and no more.[103]

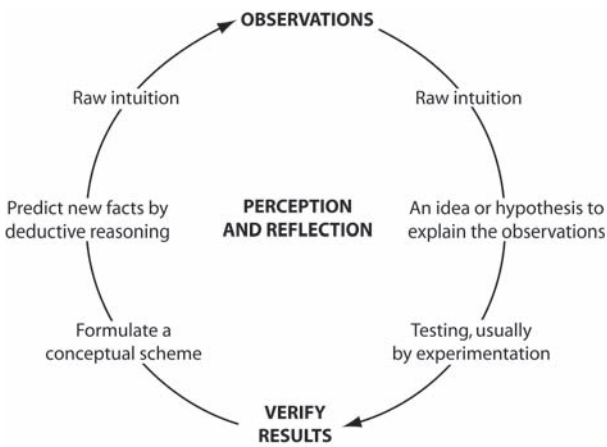

Figure 1.2 Simplified scheme showing the process of scientific discovery. There is no one scientific method, only a number of operations and criteria that must be adhered to before an enquiry can be called scientific.

Science, religion and myth: similarities and differences

> It is not to be expected that there should be agreement about the definition of anything until there is agreement about the thing itself. J. S. Mill[104]

We have now reached an important stage of our analysis. As a general conclusion, science, religion and myth are different dimensions of the human experience in response to the unknown. All three attempt to demystify the world in different ways: myth and religion use more prescriptive methods with metaphysical or transcendental origins, whereas science is more descriptive, operating exclusively in the physical domain, which may or may not be bounded by the divine. Each system involves an outward expression of thought, language and practice with truth packaged in symbolic or conceptual form. Notwithstanding pathological deranged mind-states, the symbolic representations are not patchwork illusions, but a meaning-seeking and purpose-driven correspondence between the external world, experience and language. If there is no correspondence, each system as we know it would cease to exist.

Myth and religion: prescriptive roads to truth

Mythopoeic and religious truths largely deal with deep personal reflection involving emotional, moral and cosmic qualities. Spirituality appears to be a common denominator that can be expressed in many forms, ranging from a reflective act involving animal and human-like spirits to a deeply binding personal relationship with hundreds of gods or one god exclusively (Fig. 1.3). The truths are usually prescribed by an authority within a social collective and involve opposing passions such as love and hate, fear and hope, life and death, good and evil. The authority may be a spiritually enlightened person such as a priest, prophet, shaman, witch, sorcerer, medicine man, seer, magician or diviner, using revelation, oracular utterances, song, spirit possessions, incarnations, dreams, trances, hypnosis, divinations, magic, visions or prayers. From the study of early cultures, religion appears to have developed from piety of worship with myth as a major mode of explanation through symbolic imagery and linkages. Historically, religion arose within a moral and cosmic framework and provided the believer with a promise and prospect beyond the reach of everyday affairs, including the possibility of afterlife.

Science: descriptive road to truth

Western science is very different; it deals with physical objects without necessarily invoking mythopoeic or divine causation (Fig. 1.3). Those scientists who are highly religious carry on their work without separation and self-contradiction; however, how the world of physical objects relates to the supernatural and vice versa remains problematic. This will become clearer in later chapters as we distinguish between the "objects" of myth and religion and the "objects" of science. The practice of science involves a more "impersonalized" belief system than either myth or religion because its operations can be repeated and verified (or falsified) by others.[105] The term "impersonalized" does not mean that science is free of "subjectivity"; it means that its procedures, experiments and results can be independently checked and re-checked by independent parties. Disagreements and controversy in science are just as lively as in

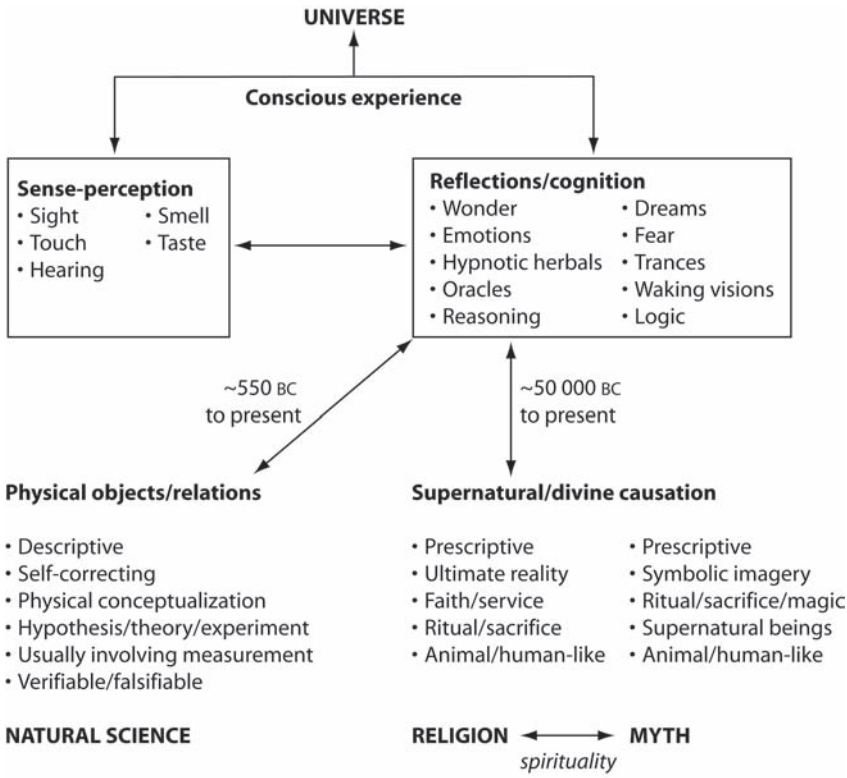

Figure 1.3 Schematic showing the possible conceptual developments leading to science, religion and myth. Each cognitive system responds to questions about the mysteries of the universe and our place in it. Natural science is a Greek invention and deals with conceptual relations among physical objects. Historically, religion and myth deal with knowing based on personal and/or societal feelings and beliefs derived from sensory and super-sensory inputs. Myth and religion are linked via spirituality, which may range from a reflective act involving animal or human-like spirits to deeply binding personal relationships with hundreds of gods or one God exclusively.

religion and may range from emotional outbursts to healthy criticism involving methodologies, analysis or interpretation of data, which all help drive the process.

One of the biggest misconceptions today is to equate religious faith with a scientist's attitude to a hypothesis, theory or law.[106] For the believer, despite periodic moments of doubt, God is absolute and unwavering, whereas a scientist's attitude to a hypothesis, theory or law is most definitely not. Authority in science is always being challenged by new ideas, criticism and revision. No scientific idea is free from criticism, and those scientists who think they are absolutely correct are in the minority. Nineteenth-century physiologist Claude Bernard (1813–78) put the issue into its proper perspective when he wrote: "Men who have excessive faith in their theories or ideas are not only ill prepared for making discoveries; they also make very poor observations."[107]

When subject matter collides

Many of the conflicts that arise between science and religion occur when the mythical components of religion enter the domain of science. If the results from science repeatedly oppose religious dogma, then the dogma becomes untenable from a scientific perspective. One of the most famous conflicts in the history of science was between Galileo and the Church in the seventeenth century. On 31 October 1992, an official statement was made by Pope John Paul II on the Church's position[108] on science and religion:

> From the Galileo affair, we can learn a lesson that remains valid in relation to similar situations that occur today and that may occur in the future … There exists two realms of knowledge, one that has its source in revelation and one that reason can discover by its own power. To the latter belong especially the experimental sciences and philosophy. The distinction between the two realms of knowledge ought not to be understood as opposition. The two realms are not altogether foreign to each other; they have points of contact. The methodologies proper to each make it possible to bring out different aspects of reality.[109]

Conflict and confusion may also arise when science and scientists enter the realm of religion and talk about the existence of God. Those scientists who continue to associate God either directly or metaphorically with the scientific process are committing a fatal error in judgement. Science deals with relations among physical objects, not super-sensory phenomena. As discussed earlier in this chapter, all we can ask of science is to postulate functional interrelationships, not "first causes". Nor can science answer questions on moral issues. Science has often been charged with undermining morality and ethics but science does no such thing; human beings do.[110] Today the scientific enterprise has to meet strict ethical standards that are overseen by internal institutional and external national and international regulatory bodies. A significant ongoing controversy surrounds stem cell research and its ethical and deep religious implications, including the cloning of animals and human beings.

Having completed the general introduction to our story, we shall now enter the extraordinary world of the Sumerians and Egyptians, explore the roles myth and religion have played in framing their worldviews, and ask why natural science was not part of their innovation and discovery. Unfortunately, we can only touch on the equally fascinating Indian and Chinese traditions with their parallel discovereies, intersections and contributions to Western thought; to do otherwise would be an entirely new undertaking. Our story will concentrate on the contributions of Near Eastern, Greek, Christian, Islamic and Renaissance thought. Western traditions only became distinctive after the West experienced renewed stimulus from a number of literary revivals of classical antiquity between the twelfth and sixteenth centuries. This is true for the rise of modern science and the expansion of western Christianity, even if today a high proportion of their practitioners are not from the West.