CHAPTER 1

What's It All About?

Everyone knows what science is, until pressed to provide a definition: then they tend to become much more hazy. Part of the problem is that the meaning of the word itself has changed over the centuries. We may, for example, speak of "Greek science," referring to the science that flourished in ancient Greece and in centers such as Alexandria over the period 600 B.C.E. to 200 C.E., but the science of that era is a very distant cousin of the type of science practiced today. The modern scientific enterprise, complete with scientific societies, journals, specialized laboratories and distinct disciplines, did not really emerge until the sixteenth century onwards.

The word "scientist" was not even invented until the first half of the nineteenth century—by William Whewell (pronounced "Hule"), the polymath clergyman and Master of Trinity College, Cambridge. It seems fitting for the theme of this book that the word scientist was invented by an Anglican vicar! Up until that time practitioners of science were known as natural philosophers. In 1851 Charles Babbage complained that "Science in England is not a profession: its cultivators are scarcely recognized even as a class." It was not until the latter half of the nineteenth century that scientists emerged as a distinct professional community.

If pressed to provide a definition for contemporary science we might try: "Science is a body of organized knowledge that describes the properties and interactions of the material components of the universe." The "organized knowledge" part of the definition draws attention to the fact that scientific knowledge is not generated by a bunch of maverick individuals scattered round the world, but by an international community working within the parameters of strict criteria for what is acceptable as science. It also points to the way in which scientific advances build on the existing framework of scientific knowledge: the wheel is not re-invented at every stage. Indeed, the brilliant individual who pushes science into new realms does so in a manner that explains the existing knowledge base in a way that doesn't negate it, but rather is superior to

existing explanations. The "material components" aspect of the definition reminds us that the scope of science is limited. There are many kinds of questions that science is ill-equipped to answer.

Of course, no single definition is sufficient to do justice to such a complex phenomenon, and although the borders between science and non-science may shift a little and be somewhat fuzzy, it is usually clear as to what counts as science and what does not.

This book is focused primarily on the interactions between science and Christianity, but irrespective of whether we ourselves have any religious faith, the impact of science on our daily lives is generally via technology. Technology involves the implementation of results from both the physical sciences, leading to faster computers, cell phones, microwave ovens and the like, and the biological sciences, making feasible the genetic modification of crops, non-invasive medical procedures and new drugs to combat disease. Scientific advances underpin technological innovation, but the driving force behind technological developments is often economic, political or military rather than curiosity-driven basic science.

Huge ethical and moral questions continue to face society in the use of technology. For example, is it or is it not right to ban some technology, such as nuclear power plants, simply because they carry enormous risks in the event of an accident? Technology always comes at a price, and can be divisive between those who can afford it and those who cannot. Should we continue, for instance, to pour more and more money into increasing the technological sophistication of medical care for relatively few people in the richer countries, when the same funds applied in "low-tech" ways to medical needs in poorer countries could have benefits for a far larger number of people? Does Christianity have anything distinctive to say about the use of finite resources on technology?

These days it is often possible, at huge cost, to keep people alive using modern medicines and medical appliances, long after the time when they would otherwise have died from natural causes. How do we balance concepts of the sanctity of life against respect for the dignity of individuals and the knowledge of the perspective of eternity in making decisions about keeping people alive on life-support machines? Such issues are ones where Christian faith brings particular insights to the debate.

Some characteristics of science

The aim of science is to establish *generalizations* about the behavior of the material world. Science is not so much interested in the particular football that was kicked to win the Super Bowl, but in such things

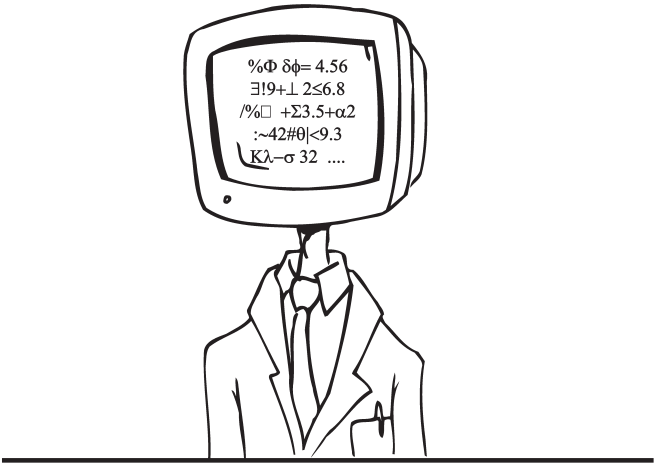
as the general properties of the materials used in making footballs, or in the aerodynamic interactions that explain the flight of oval-shaped balls through the air. Science is not interested in the single stone that killed Goliath, but in the general properties of stones. Science generally ignores historical particularity but takes a special interest in reproducible events that provide an opportunity for the analysis of cause and effect. When "singularities" occur in science, unique events without precedent such as the Big Bang, then science tends to flounder in explaining their origins. Science is much better at tackling events that occur more than once, preferably in a reproducible manner, so that the causes of the events can be investigated.

Science depends heavily on *quantification* to establish its generalizations about the properties of the material world. Theories that can be established or tested within a mathematical framework are viewed favourably. Data are frequently processed using statistical methods to establish significance. Possible sources of bias are considered and quantified wherever feasible.

Science is best at addressing phenomena that can be *taken apart* and analyzed in their component parts in order to explain the phenomenon in question. This is the approach of the car mechanic—if you want to find out how the engine works, then take it apart. Such an approach is more formally called "methodological reductionism." Whether this approach can lead to other types of reductionism is a question we shall consider further in later sections.

Science is also good at answering questions that are answerable by *empirical investigation,* that is by investigation that depends on carrying out experiments. This does not mean that everything that counts as scientific knowledge is based directly on experimental results. Some disciplines, such as the study of quantum mechanics in theoretical physics, work with theoretical models that are far removed from the everyday world, and indeed may produce counter-intuitive predictions. Yet the veracity of the theories is based ultimately on whether they provide good and fruitful explanations of phenomena that we can observe, be those in a multimillion-pound particle accelerator or in our everyday lives. Other scientific disciplines, such as geology, are more historical in their perspective, reconstructing historical events from data collected many millions of years after the events. But geology, like other sciences, uses present-day experiments, analogues or theoretical models to deduce the conditions that would have given rise to particular types of rocks, or environmental conditions, in the past. As with other sciences, it is a fundamental tenet of geology that the way in which matter behaves is consistent and predictable: one particular

Scientific language is often very specialized



way in which this is often expressed in geological research is that "the present is the key to the past."

Scientific knowledge is often couched in a *highly specialized language*, which unfortunately may make it rather impenetrable to the nonspecialist. But the language is used for good reasons, so that ideas can be expressed concisely and in a way that can be understood unambiguously by scientists anywhere in the world. Sometimes the language is couched in mathematical formulae. When the Royal Society was founded in the seventeenth century it soon made it one of its important goals to establish a scientific language that contributed to this process of scientific communication. Often terms are borrowed from everyday speech and used in science with quite different meanings, which can lead to much confusion unless their technical meaning is understood properly. Terms such as "black hole," "selfish gene," "protein denaturation," "altruistic" and so forth litter the scientific literature, but their true meanings cannot be guessed without understanding something of the scientific discipline and context in which they are used.

A final characteristic of science is that the theories or models of how the universe works, developed by scientists, are always *provisional,* in the sense that better explanations often lie just around the corner. Even such an influential and successful body of work as Newton's laws of motion was shown by Einstein to be based on conceptually incorrect ideas. The point is not that Newton's laws were wrong, because they

still provide a perfectly adequate and effective description of how things work in circumstances relevant to many of our daily activities, such as driving cars or playing snooker, or even for getting a man to the moon. But in more extreme cases, such as explaining black holes, Einstein's general theory of relativity is required. The theories are simply descriptions of how the world behaves, and their utility is judged on the range of phenomena and circumstances over which they provide useful results and predictions. The so-called laws of nature do not control how things happen in the world. In the Christian worldview God controls the world. In this view the scientific "laws" and theories provide elegant descriptions of how God acts consistently in the world. Powerful they may be, in a descriptive and predictive sense. Often they are even beautiful in the eyes of the (scientific) beholder. Yet even the most successful scientific theories remain only incomplete descriptions of how things behave.

What is counted as scientific knowledge is guarded jealously by the scientific community itself, and the main gateway for acceptance into this body of knowledge is by publication in peer-reviewed journals. Can you imagine bank managers, accountants, lawyers or head teachers accepting that others in their profession should control what they publish? But that is in fact what scientists do—and their papers submitted to journals are not infrequently refereed by their direct competitors! Scientific prestige is even measured by "impact factors" which measure the number of times that a particular paper has been cited by other scientists when they write their own papers. Not infrequently a whole new field of study can be started by a single seminal paper. Arguably the now vast research field of molecular genetics began with the publication in the scientific journal *Nature* of James Watson and Francis Crick's two-page paper on the structure of DNA in 1953.[1]

DNA

A defining paper that changed the history of biology:

J.D. Watson and F.H.C. Crick (1953)
A structure for Deoxyribose Nucleic Acid
Nature, vol. 71, pp. 737-738

One reason why the veracity of scientific knowledge is so carefully guarded by its practitioners is because their future work depends on its validity. Scientific research is constantly building on what has already been published. If that core of

shared information has a weak foundation, then the whole superstructure will be shaky and much time and effort may be lost in demonstrating the point and in establishing a firmer basis. This explains also why cases of scientific fraud are investigated and publicized with such dismay within the scientific community. As well as the moral deceit involved in cases of scientific fraud, there is also the loss of time, money and energy as other scientists attempt to repeat or to build on the fraudulent results, but without success.[2] Science is about truth-telling. If scientists were to stop telling the truth about their data, then the scientific enterprise would collapse.

Science is far from being a mere cataloguing of isolated facts, but requires creative panache and bold hypotheses to make progress. Scientific data are "theory laden," which means that they are often collected with the aim of developing or disproving a particular hypothesis. Scientists are passionate about their commitments to theories, a point well illustrated by the vigorous debates that occur at scientific conferences. The public perception of scientists as being rather cold fish in white coats, without any feelings or commitments is far from reality, as anyone who has spent any time in a research laboratory will know.

What does science exclude?

A problem from which some scientists suffer is that they become so enthusiastic about their science that they fall into the trap of claiming that scientific knowledge is the *only* valid type of human knowledge. This philosophy is known as *positivism.* As a formal school of philosophy, positivism is more or less dead, but the idea lives on in a popular version of the same idea known as "scientism."[3] The idea in scientism is that scientific descriptions of events are the only type of descriptions that really matter—all the rest is merely opinion. Such an idea is clearly not inherent in science itself but has been added on to science by those who wish to utilize the status of science for their own personal ideological purposes.

Demonstrating the weakness of scientism is quite easy. Take your favorite daily newspaper, read through all the news items, comment columns, latest film reviews and so forth, and then at the end ask yourself the question, "How does scientific knowledge contribute to an understanding of the particular items that I have just read?" The answer in most cases will be clear: "not a lot." Scientific knowledge is simply irrelevant to most daily human activities, which is what our newspapers are

there to describe, but it is silly to pretend that these human activities are any the less important or interesting simply because science does not have much to say about them. There is an arrogance about scientism that is irritating to the non-scientist and is equally embarrassing to the scientific colleagues of those few (but vocal) scientists who insist on making scientistic claims in public.

More formally, what kinds of human knowledge are excluded from scientific investigation? Certainly aesthetics is excluded. No amount of scientific knowledge can confirm or deny the claim that someone is observing beauty in a sunset, in a range of mountain peaks, in a painting, or in a piece of poetry. You could of course plant electrodes in the head of the person as they had aesthetic experiences and made aesthetic judgments, but the data you would collect would not be the same as the aesthetic judgments themselves. And only a knave or a fool would claim that there was no reasonable basis for assessing creativity, because otherwise all reviewers of books, novels, films, ballet, the theater and so on would simply be wasting their time.

Scientific knowledge also excludes ethical and moral knowledge. Science can analyse the reasons for the latest famine in a particular country, but it cannot tell you whether you personally ought to give up your expensive summer holiday and volunteer to help the aid agencies as they distribute food. When people make ethical decisions they are appealing to forms of argument and knowledge that lie outside the purview of scientific journals. The "naturalistic fallacy" is the attempt to derive an "ought" from an "is"; that is, to try to derive judgments about what ought to be the case from descriptions of what is actually the case. Scientific descriptions are good at giving an account of what is the case, but they will never tell you what *ought* to be the case, which is what ethical decisions are all about.

Scientific knowledge also excludes all forms of personal knowledge and experience. If you submit to a scientific journal your description of an encounter with a famous scientist, the editor is unlikely to count it as a contribution to scientific knowledge (more likely it will go straight into the trash), even though the experience may have been life-changing for you personally to such an extent that it led you into a career in science. Likewise, if I am asked the question "Do you know John?," and if in fact I do know him, then I would be lying to deny it. But the kind of personal knowledge implied in that answer is of a different kind from scientific knowledge that I may obtain *about* John by measuring his blood pressure, putting electrodes in his brain or measuring the levels of certain chemicals in his urine. However important scientific assessments may be of human individuals in different contexts, they will

never be the same as knowing-the-person. Knowing-the-person does not invalidate scientific knowledge in any way, nor is it contradictory to scientific knowledge—it is simply a different type of "knowing." For most people it is actually the kind of knowledge that makes life worth living.

Another whole sphere of human enquiry that science is poorly equipped to address is the domain of metaphysics. Metaphysics encompasses all the big philosophical questions of life, such as "Why am I here?," "Does life have a meaning?," "Is there a God?" and so on. Of course, those who hold to the philosophy of scientism will try to pretend that such questions are unanswerable precisely for the reason that they cannot be tackled by the methods of science and, therefore (they say), we can never find an answer. There are several problems with such a position. For a start, scientism itself is a metaphysical conviction that is beyond science, although parasitic upon it. It is perfectly possible to do good science without adopting the metaphysical position described by scientism. Furthermore, such a position smacks of intellectual laziness, since humans throughout history have continued to insist on asking metaphysical types of question, and just because science cannot answer them does not mean to say that they are unanswerable.

A somewhat different point was underlined by one of the twentieth century's great philosophers of science, Karl Popper, during a broadcast talk, when he insisted that:

> Everybody has some philosophy; you, and I, and everybody. Whether or not we know it, we all take a great number of things for granted. These uncritical assumptions are often of a philosophical character. Sometimes they are true; but more often these philosophies of ours are mistaken.[4]

All human beings are committed philosophers in the sense that they hold prior metaphysical assumptions that shape their actions and behavior in the world. So it is an exercise in academic arm-waving to suggest that there exists some non-metaphysically based high ground from which lofty (and mythical) vantage point one could then survey the metaphysical beliefs of lesser mortals. In practice everyone behaves within the framework provided by their metaphysical convictions, even though they may not be very good at articulating what those are. There is no such animal as an uncommitted human being. Those who hold to the metaphysics of scientism are already committed to living as if the great metaphysical questions of life had already been answered, despite their denial of such a possibility. Living as if life has no ultimate meaning implies a prior assumption that life in fact has no ultimate meaning, so the protestation that such metaphysical questions cannot be an-

swered fails to convince. People are demonstrating that they believe such questions are answerable all the time by the way they live their lives, scientists no less than anyone else. Everyone has to live a life, everyone has to construct a personal biography, and this involves making a wide range of decisions on a daily basis that lie well beyond science, not least ethical decisions. Once we accept that we are all in the same boat and that no one in practice lives their life as if scientific knowledge was the only valid form of knowing, then the dialogue between science and faith can really begin.