I. THE NATURE OF GREEK SCIENCE

1.1 *On science and scientists*

The essential difference between science and related forms of intellectual activity is very difficult to define exactly. A dictionary definition of science is an accurate reflection of what *some* people understand by the term 'science', and then only in the period and place in which the dictionary was written. Most people live their lives and use their language without reference to a dictionary. Even sticking to the dictionary definition, what the word 'science' has meant to different people has varied over time and cultures, and its meaning continues to change.[1] As such, the term itself can be a source of anachronism in the study of science in ancient times. For we naturally tend to find in ancient authors just those sorts of things which we recognize as science in our own times, and to ignore those things which are incomprehensible or just plain wrong – to *our* way of thinking. And we naturally tend to organize what we find into categories which reflect *our* way of dividing up the world into subjects and disciplines. Thus things that the ancients linked together, we tear apart and treat separately. In particular, some we include in the category of science, others we exclude.

In this process, Crombie has emphasized that the circumscription of subject matter – what is regarded *as* science, and what count as valid questions, pieces of evidence, types of argument and answer – is the key to opening doors to new knowledge and understanding; but that at the same time it *closes* other doors. For example, modern astronomers are expected not to engage in astrology, but that door remained open for their predecessors, from ancient Greece to enlightenment Britain, who were socially and intellectually free to study both subjects

[1] According to Crombie 1994 there are, and historically have been, six and only six distinct styles of scientific thinking. A scientific style is a way of thinking about the world that aims 'to advance knowledge by the identification of answerable questions and soluble problems, to devise methods of finding possible answers and solutions, and at the same time to determine what counted among these as acceptable' (p. ix). Each style focused its inquiries upon certain regular natural phenomena, decided what sort of question would be considered valid, and determined what sort of answers would be acceptable. 'A style thus opened certain routes of inquiry and closed others' (vol. 1, p. xi). The Greek style of scientific thinking, the earliest European style and a style which has continued to the present day, he calls Postulation, and discusses at length in volume 1.

simultaneously. The ancients put astrology on a par with astronomy, as two sides of the same coin.[2] Changing views of the meaning of 'science' closed this door in due course, and classical scholarship felt its influence. So, until very recently, modern scholars have highlighted the ancients' achievements in ancient astronomy, and done their best to ignore (if not positively conceal, excuse, or try to explain away) what they regarded as an embarrassing lapse of rationality.[3]

Modern intellectual traffic between the 'science' end of ancient activities and the 'superstition' end of the same, even when both were conducted by the same ancient person, tends to be one-way. Astronomy-historians, for example, can produce works focused tightly on ancient theories of the cosmos. They may extend this to include closely related matters, such as the business of actually observing heavenly phenomena, but it is not considered necessary for an intellectually sound treatment of ancient astronomy. Astrology-historians need to explain ancient astronomical theories before they can start on the real subject of their interest, which is astrological theories. And alchemy-historians need to know ancient astrology (and therefore ancient astronomy) in order to deal with their subject of interest.[4] But a historian of astronomy considers alchemy well outside the remit of his study.

For the purpose of this book, I too have divided the subject matter into modern categories, in spite of what I have said above, for three pragmatic reasons. First, because the original ancient categories are too large to serve as analytical tools. For the Greeks, all serious intellectual pursuits could be classified under the heading *philosophia*. The Greek term usually translated as 'science', *episteme*, covered cooking, amongst other things;[5] with due respect to the modern category of domestic science, that will not do for our purposes. Natural history, or more precisely, inquiry into *phusis*, nature, was the nearest phrase to the modern term 'science', but if we use this category, then we cannot sort the material, because almost everything falls into the one category, and the only obvious tool left to apply to break the mass up into manageable

[2] Astrology was also closely linked with medicine, chemistry (under the ancient label *phusis*, physics), botany, and anthropology. For the first, see Scarborough 1991 esp. pp. 154–63.

[3] E.g. Cohen and Drabkin 1948, pp. viii–ix: 'No one can well deny that a good deal of what may be called "pseudo-science", such as astrology and the like, can be found in the writings of such sober Greek scientists as Aristotle and Ptolemy. But it is well to remember that the intrusion of the occult can be found in modern writings such as Kepler's or Newton's and in the contributions to the early volumes of the transactions of the Royal Society down to the works of Lodge, Carrel and Eddington in our own day.'

[4] See e.g. Keyser 1990a.

[5] See Owens 1991.

chunks is the chronological one, loosely applied.[6] As W. Knorr pointed out in a mathematical context,[7] 'to explain certain aspects of modern geometry, it may become advisable, even necessary, to import notions from more recent fields, like algebra. This raises the possibility of anachronism, as is present in all analogical forms of exegesis. That risk becomes acceptable if the alternative is the learner's incomprehension.' I have taken that risk by using modern categories. A second reason why I have divided the subject matter into modern categories is that most of the existing modern literature focuses on one or another category, and since this is a survey, it seems sensible to organize it on the same principles. The third reason is that a brief survey of a vast field is not the place to try to develop a new taxonomy of ancient science. However, within each category it is my intention to include material which sits uncomfortably within it, simply in order to make clear the limitations of these categories.

A separate and serious problem with 'science' as a category is that the abstract nature of scientific ideas seems to encourage an abstraction in the study of its history. Often the ideas are presented in splendid isolation from the social, political, religious, and economic context of their formation.[8] (This problem is not confined to ancient history.) For example, when one reads the word 'school' applied to e.g. Aristotle's Lyceum, one imagines a building, at the very least. Yet there was no private building until after Aristotle's death;[9] his 'colleagues' and 'students' met him and each other in a sacred public wood outside Athens' city walls, where *ho boulomenos*[10] could worship Apollo Lukeios, or go for a stroll, or collect firewood, or hunt rabbits, or whatever.[11] Meanwhile ancient studies carried out by people now more or less anonymous in circumstances not fitting with modern notions of research can be overlooked. For example, Mithridates' immunity to all known

[6] This is a problem with French's otherwise excellent *Ancient Natural History*, which is sometimes frustrating, but rewards well the diligent reader.

[7] Knorr 1991 p. 122 n. 11.

[8] Needham suggested that this abstract approach arose because 'the social background of Hellenistic science and technology can be taken for granted because it is quite familiar to us from our schooldays onwards', 1962 §26 p. xxvi. This familiarity might have been true for some 30 years ago, but it is sadly untrue today, and a generation of scholars who allegedly took social knowledge for granted, and thus neglected to draw out its significance, seems to have led to scholarship which does not recognize its significance at all, typified in e.g. Barnes 1979.

[9] There was a publicly owned gymnasium there from at least the late fifth century, for public use.

[10] Any Athenian citizen who wished.

[11] See Lynch 1972. The same general point is true of Plato's Academy; see Cherniss 1945.

venoms and poisons[12] was the result of a long programme of research and development by toxicologists who worked in his service,[13] combined with empirical trials on death-row prisoners in the pursuit of antidotes. Pompey (at least) was interested in this scientific project: he ordered a Latin translation of Mithridates' written results (Pliny *NH* 25.7). These results, like those obtained by the human vivisectionists of the Hellenistic period, were incorporated into the ancient scientific knowledge base, and can now be studied in comfortable abstraction from the context of their creation. Medical ethics is not new incidentally, and, as with vegetarianism, the arguments have not changed much since antiquity.

One of the major features of Greek science is that most of its practitioners were autodidacts. Even those who studied under a philosophical giant seem, with very few exceptions, not to have been content to follow a path laid down by a predecessor. They wished to carve out their own path, citing predecessors' views when it suited them, and ignoring them likewise. They did not so much stand on their predecessors' shoulders as knock them down, step over them, and go elsewhere.[14] In this respect, the nature of the scientific endeavour today is quite different from that in antiquity. A big and related difference, with many profound corollaries, is the individualism of ancient science. Though we (and the ancients) occasionally talk of philosophical 'schools' or medical 'sects', these terms more often refer

[12] This prevented him from committing suicide by mouth after his capture by the Romans, and caused him to fall on his sword instead.

[13] We have one name, Krateuas. Very little is known about him, other than that he was known as a rootcutter, he lived at Mithridates' court, and he wrote a lost, illustrated, work on plants, which may have been the basis for later herbals such as that by Dioskorides; see Wellmann 1897, with Riddle's discussion 1985 pp. 180–217. Attalus III of Pergamum was also (and a generation earlier) interested in and very knowledgeable about toxic substances and antidotes, which he tested on condemned criminals (Galen, *Antidotes*, 1.1 (14.2 K)), and on 'friends' according to the hostile tradition in Justin's *Epitome of Trogus' History of Philip* 36.4.3.

[14] This observation was made first by the Greeks themselves. Diodorus Siculus 2.29.6: 'a few [Greeks] here and there really strive for the higher studies and continue in the pursuit of them as a profit-making business, and these are always trying to make innovations in connection with the most important doctrines instead of following in the path of their predecessors. The result of this is that the barbarians, by sticking to the same things always, keep a firm hold on every detail, while the Greeks, on the other hand, aiming at the profit to be made out of the business, keep founding new schools and, wrangling with each other over the most important matters of speculation, bring it about that their pupils hold conflicting views, and that their minds, vacillating throughout their lives and unable to believe anything at all with firm conviction, simply wander in confusion. It is at any rate true that, if a man were to examine carefully the most famous schools of the philosophers, he would find them differing from one another to the uttermost degree and maintaining opposite opinions regarding the most fundamental tenets' (trans. Oldfather). There are examples from the medical field and discussion of this point in Lloyd 1995 and Hankinson 1995.

to like-minded individuals, who might be widely dispersed over time and space, than to organizations of intellectual co-workers and colleagues. Someone who never set foot in the Academy might be called a Platonist, because the label reflected his philosophical inclinations and not his membership of some club, society, or association.

Moreover, it is a large and usually overlooked *assumption* that the authors of ancient scientific texts were 'professional' philosophers or doctors or teachers or people otherwise engaged most of their time in thinking or writing about their subject. The same point can be made for other producers of literary works, e.g. dramatists.[15] It seems to me probable that a significant number of these people undertook their studies in their (relatively ample) leisure time. As late as the last century, the men who founded ancient history and kindred subjects founded them in their spare time: for example, George Grote was a banker, MP and a few other things simultaneously, Thomas Heath was a civil servant, and James Gow was a lawyer; they were not salaried academics.

For much of Western history there is an assumption that writers belong to an educated elite. But this assumption is highly presumptuous for ancient Greece. A fair number of the Greek authors were, we can safely assume, born to farm,[16] whilst others were taught craft skills by their fathers. Sokrates' father was a stonemason; Aristotle's a healer; Theophrastos' a laundryman; Ktesibios' a barber. Apollonios of Perga was called a carpenter;[17] several creators of panaceas mentioned by

[15] Aiskhulos famously wanted recorded on his gravestone not that he wrote this or that tragedy, but that he fought at Marathon. As a hoplite, it is a safe assumption that he was a farmer, as were more than 90% of the population. Thoukudides wrote history when forced into exile after active (but unsuccessful, hence exile) service as general in the Peloponnesian war; Xenophon was a professional soldier, again largely because he was exiled and thus prevented from engaging in farming and politics; Cicero was a professional politician first, and author of diverse subjects second; Plutarch was a politician, priest at Delphi and much else besides; the list could be as long as the authors about whom we have biographical information. Why then should we suppose that those who wrote what we call 'scientific treatises', about whom we usually have little if any reliable biographical information, were fundamentally different, a class apart from authors of all other types of literary work? For example, later Greeks knew so little about Euclid that they confused the Euclid of *Elements* with another philosopher called Euclid who came from Megara. See also Authier 1995 on Plutarch as creator of the (false) archetypical image of the scientist, and its perseverance in the face of any and all evidence to the contrary.

[16] Nutton assumes the same of 'most doctors resident in a small town' and points out that 'doctors were regularly encouraged to grow their own simples' [simple drugs], 1985b quotes from p. 140. All those Greek scientists who played a part in the politics of their local poleis (e.g. Arkhytas, Empedokles, Eudoxos, Hippias, Philolaos) may confidently be assumed to have owned farms. Polubios (3.59.3–5) thought that many Greeks of the Hellenistic and Roman periods pursued an intellectual life because political domination by Macedon, the successor states, and then Rome, 'relieved' them of the ambition to pursue a life in war and politics when not managing their farms. Polubios himself was a case in point.

[17] By Saïd al-Andalusi in the *Book of Categories of Nations*, 1991 p. 26. The association is not

Galen are labelled tradesmen (or worse) of one sort or another;[18] and Archimedes was apparently at Hieron's beck and call.[19] Demetrios of Phaleron governed Athens before organizing the Library at Alexandria;[20] a number of Greek intellectuals appeared on the Roman scene first as civic officials, ambassadors for their poleis;[21] Frontinus was consul and governor of Britain (amongst other things), whose interest in hydraulic engineering arose from his (important political) appointment by Nerva to the office of overseer of the water supply to the city of Rome;[22] and Pliny was Commander of the Fleet at Misenum when he died, famously observing Vesuvius from too close quarters. If this point is not convincing, consider, as the implied alternative, the plausibility of an ancient Greek boy (still less a Roman) telling his father that he wanted to be a professional philosopher when he grew up.[23]

accidental: the geometer's tools are the carpenter's tools – compass and set square or gnomon. Hahn (1995, p. 126 n. 25) drew attention to 'a kind of applied geometry with technological innovation' which characterizes the real or attributed achievements of Thales, Anaximander, Rhoikos, Theodoros, Khersiphron, and Metagenes. Although only the first two are generally thought of as presocratic *philosophers* (the other four being labelled architect/engineers) I believe that the kind of employment specialization these labels imply is inappropriate for the period.

[18] Namely, Celer the centurion, Diogas the trainer, Euskhemos the eunuch, Flavius the boxer, Orion the groom (which indicates an overlap between human and veterinary medicine), and Philoxenos the schoolmaster, all cited by Nutton in his hugely entertaining, as well as very informative, article on 'The drug trade in antiquity', 1985b, p. 145.

[19] Cicero, nearest in time of those remarking on his origins, described Archimedes as 'a humble little man', *Tusc.Disp.* 5.23, which can hardly refer to his personality as revealed in his surviving works, and therefore ought to be read as a reference to his socio-economic status. Silius Italicus thought likewise, calling Archimedes destitute (*nudus*), *Punica* 14.343. This, however, did not fit at all with Plutarch's image of the scientist induced only by Roman soldiers besieging the city to tear himself away from contemplation of abstract mathematics and get his hands dirty in an occasional bit of mechanical engineering, so Plutarch *Marcellus* 14.5 says he was a relative (unspecified) and friend of Hieron.

[20] Aristeas, *Epistle* 10, 29–30. He too was 'not well-born' according to Diog. Laert. 5.75.

[21] e.g. Poseidonios of Apameia and famously Karneades, who so irritated Cato (Plut. *Cato* 22–3). Similarly the historian Polubios, who went to Rome as a political hostage for the good behaviour of his home community, the Achaian League, after they lost the battle of Pudna.

[22] His treatise on the *Aqueducts* was completed under Trajan. Before that he had written military treatises for Domitian, and a work on surveying.

[23] Absence of evidence is not evidence of absence, and the primary sources (prior to the C2 A.D.) are notoriously uninterested in biography and autobiography, so we must be content with probabilities. Greek scientists did not leave memoirs – even Galen did not leave a memoir as such. On his many autobiographical comments scattered through his works, it is essential to understand the context, for which see Nutton 1972, to whose points we should add one more, concerning forgeries. 'Forgers' might not simply be in the business of trying to make sales of their own works by passing them off as Galen's; they might rather be medical opponents in the business of trying to discredit him, as Anaximenes of Lampsakos 'forged' one of his rivals, the historian Theopompos, to damage him (Pausanias 6.18.2). There are of course secondary sources written in antiquity, by men like Diogenes Laertius (*Lives of the Famous Philosophers*), Philostratos (*Lives of the Sophists*) and Eunapios (*Lives of the Philosophers*), but they are all late (C3–4 A.D.) and generally unreliable – they are mentioned frequently in modern scholarship because we are beggars for biographical information and have no other choice. On the hypothetical Greek boy, my feeling is that the

The abstraction of ancient science from the people and the context of its creation misses the most important question in any historical study, which is not *what* happened, but *why* did it happen? And even the 'what' question is going to be inadequately handled if it is uncontextualized. Lloyd has long argued that it is precisely the socio-political context which explains why Greek science emerged in the first place,[24] and this contextualizing approach needs to be extended to all aspects of ancient science, not just its beginnings.[25]

Contextualization will not just benefit historians of science. 'To study what passes for science in a society is to go to the centre of the values of that society', as Lloyd has pointed out forcefully.[26] The ancient historian with little or no interest in ancient science can learn a great deal about 'ordinary' history from the scientific texts produced in any particular place and time. They contain a large amount of incidental information concerning everyday life and ideas at the time the texts were written. Nutton (1972 p. 50) described Galen's *Prognosis* as 'the finest contemporary account of society in Rome during the reign of Marcus Aurelius'. Consider a selection of 'scientific' texts from just one century (the fourth B.C.), and from one place (Athens): in Theophrastos' treatise *On Fire*, one discovers that there were entertainers eating fire and performing the fire-walk; from his *Metaphysics* that puppies were kept in quail cages to produce small dogs; from his *On Stones* that coal was mined and used as fuel; and from the Aristotelian *Problems* that sponge divers were using diving bells. None of this is obvious from the dramatists, historians, orators, novelists, large pile of inscribed stones, and other sources typically used by ancient historians. The primary sources for any period consist not just of the well-known and well-ploughed texts: there are a lot of grossly underutilized 'scientific' texts too, which cast a different and sometimes brilliant light on ancient society.

more 'elite' the father considered himself and his family to be, the more opposed he would have been to this idea.

[24] Much of what he has written since 1979; see e.g. Lloyd 1992. See further below §2.

[25] For examples illustrating the importance of this type of approach for reaching a fuller and deeper understanding of the scientific context of such texts, see e.g. Klein 1968 on mathematics (*arithmos* means a number of *things*, not just an abstract quantity); Osborne 1987 on the importance of the literary context in which fragments of the presocratics appear in later authors; Solmsen 1975 on presocratic and Socratic ways of thinking evidenced in history and drama (and other forms of non-philosophical/scientific literature); Rihll and Tucker 1999 on the socio-economic context of theories of matter; Cosens 1998 on the importance of practicals in Galen's treatises; and Shapiro 1994 on seventeenth-century scientists' adoption of practising artists' ideas on colour mixing (this has much interesting material on ancient theories of colour).

[26] Introductory essay to the reprint of his Inaugural Lecture (1985), in 1989, p. 353.

This incidental information is also important to the historian of science, for the society in which the science was created shapes the science itself, and neither can be properly understood in isolation from the other. This will be a theme throughout this book.

1.2 *On the methods and assumptions of Greek science*

Geoffrey Lloyd, more than any other modern scholar, has highlighted the *variety* of theories, ideas, and opinions which co-existed in ancient Greece, and their interdependence. We moderns may, quite naturally, alight on one or two which seems to be 'on the right track' or to be 'predecessors' of modern theories or methods, but the ancients did not know which way natural history or medicine or philosophy or technology would develop after them; they did not know which theories were 'right' – or at any rate 'less wrong' (as judged by today's beliefs and standards); and they did not know which theories would 'fit' into a modern concise history of a particular discipline. They did not, in short and of course, have hindsight.

As a result, ancient society as a whole did not give the kind of precedence *we* might give to one theory or sect over another: Hippocratics over herbalists, for example. If we write histories which focus only on those theories which complement or are consistent with modern theories (as was usual for previous generations of scholars), and ignore those ancient theories which can be so inconsistent with modern thinking that it is almost embarrassing to discuss them (akin to drawing attention to a friend's *faux pas*), then our histories will give a very distorted view of ancient science and ancient society.

Ancient theories developed in competition with one another. The agonistic nature of Greek culture penetrates their science too. Developing as a response to a pre-existing theory, modified in response to new theories or new arguments or new evidence, shaped by those debates rather than by a systematic and 'objective' programme of research into some type of natural phenomenon, the various theories should not be seen as free-standing intellectual systems developed in an intellectual vacuum. Their content and form is shaped partly by the content and form of other, pre-existing and contemporaneous, theories and ideas. To quote Lloyd (1989, pp. 431–2), '[the Greeks] created, they invented, their own distinctive and divergent ideas, often in direct and explicit confrontation with their rivals. The concept of nature was forged in controversy, notably as the underpinning to the claims made by new

styles of wisdom in their attempts to outbid more traditional kinds.' No area of ancient scientific work was free from such dispute, not even Euclidean geometry.[27]

Lloyd is also responsible for advancing the idea that the Greek 'scientific' spirit grew out of the socio-political environment, where decisions were made by debate not by fiat, in non-monarchical systems of government, where an idea was tested by reasoning and not accepted as given. This idea[28] has been picked up widely by historians of Greek science, and has much to commend it as an explanatory factor for the extraordinary emergence of 'scientific thinking'. It does not dovetail neatly with the standard view on socio-political development in the Greek poleis,[29] but in my opinion,[30] it is the standard view which needs serious revision rather than Lloyd's hypothesis.

I think that another factor in the Greeks' unusual independence of mind is their slaveholding. Freedom, in all its aspects, was a highly cherished possession amongst the free, and acute awareness that it could be lost made it all the more precious. Hence their passion for autonomy. Autonomy does not sit well with the notion of a higher authority of any kind, political or intellectual. The atomists (beginning with Leukippos and Demokritos) pushed this to the extreme in side-lining even the authority of the gods, by thinking up a wholly materialistic, deterministic cosmos which had no place for gods at all. The independence theme

[27] For example, Zeno of Sidon launched what he thought was a damaging attack on Euclid's axiomatic method. Poseidonios (amongst others) argued the toss with him; see Proclus, *On Euclid's Elements Book* 1, especially 199–200, 214–18.

[28] Which originated with the French scholars Gernet, Vernant, and Detienne, who argued for an association between rationality and the polis, but which has been developed by Lloyd.

[29] This envisages an 'aristocratic' stage in the (crucial) archaic period, with a very gradual assumption of responsibility by the *demos* (the people), and presumes that what debates were held in this period were dominated by a few 'great and good' whilst the *demos* stood around and said or did little or nothing. This is hardly compatible with the general atmosphere of argument and debate presumed by Lloyd. He has been criticized for this reason in Hurwit 1985. The details needed to try to dovetail social and intellectual histories are also unexplicated at the moment: since the intellectual revolution started in Ionia, does Lloyd suppose that the Ionian poleis were more 'democratic' earlier than the mainland poleis? Is there any correlation between constitutional type and philosophers' home towns? Although Athens is the most famous and most well-known ancient democracy, her only homegrown critical thinkers of great stature were Sokrates and Plato. Many people from other poleis found this polis a congenial place to live and think critically – at least some of the time (Anaxagoras and Aristotle, amongst others, both felt compelled by fear to skip the country at a certain point in their residencies). Which conjunction leads to the question: is there a connection between being a *metic* rather than a citizen, and being a free thinker? Metics, by definition, were excluded from the political environment, so if there is a connection here, it would considerably complicate Lloyd's hypothesis. It would however tally with Polubios' view on political and intellectual life (see n. 16 above).

[30] I speak not as an historian of science but as an 'ordinary' ancient historian who cut her professional teeth on Greek political and constitutional history, especially in the archaic period.

continues even in Roman times: Seneca, for example, comments with reference to various leaders of and ideas within Stoicism, 'we are not ruled by a king. Each is his own man' (*Epistle* 33.9).

All ancient theories on nature were part and parcel of theories on god, the good, and much else besides. The ancient emphasis on the good, the perfect, the form, or similar notions might be compared with the modern hankering after the god of quantification: in both cases there is a tendency to try to import into everything something highly valued in the society which produces it. For some Greeks, such as the elderly Sokrates, what really mattered was how one lived one's life, and all other matters were subordinated to ethics. Most of us moderns have been brought to believe that what really matters is measurement and accountability (in many senses of the word, but especially the literal one), and all other matters are subordinated to number, even intrinsically incommensurable things such as the artistic element in a performance of ice-skating. For us, numbers seem to lend an aura of objectivity, solidity, and reliability which mere opinion lacks. But if you allocate a number to a weightless opinion, then you can amass opinions, and get a supposedly objective number; thus the world is quantified. For the ancients, the virtues (especially goodness and justice) seem to have had a role similar to our numbers, providing an idealized scale against which all real things could be measured, a conceptual rock in a real sea of shifting sand, a familiar comfort-blanket in a world in flux.

Ancient atomism had no place for deities and argued for atheism. Competing theories required gods somewhere, e.g. creator (Plato) or unmoved mover (Aristotle), but otherwise tried to keep them out of explanations for natural phenomena. Atomists argued for chaos and randomness as the fundamental principle at work in nature, others (teleologists) argued for purpose and direction, and still others (sceptics) argued for a suspension of judgement on the grounds that the senses are unreliable and, despite everybody's best efforts, nobody really knows what is or why.[31]

What they all assume, except the sceptics who assume only that they can know nothing, is that natural phenomena occur in regular, ordered ways which are susceptible to analysis. Patterns can be recognized, studied, and explained by reasoning, preferably working from observation of particulars to first principles and then from those first principles

[31] See Sharples 1996 for a discussion of the main schools in Hellenistic times, arranged around their answers to various types of question rather than a traditional historical narrative or description of each school's philosophical tenets.