12.13.2022 SHOW NOTES:

SCIENCE, THE SCIENTIFIC METHOD, AND THEIR LIMITATIONS

Natural philosophy

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This article is about the philosophical study of nature. For the current in 19th-century German idealism, see Naturphilosophie.

A celestial map from the 17th century, by the Dutch cartographer Frederik de Wit

Natural philosophy or **philosophy of nature** (from Latin *philosophia naturalis*) is the philosophical study of physics, that is, nature and the physical universe. It was dominant before the development of modern science.

From the ancient world (at least since Aristotle) until the 19th century, ***natural philosophy*** was the common term for the study of physics (nature), a broad term that included botany, zoology, anthropology, and chemistry as well as what we now call physics. It was in the 19th century that the concept of science received its modern shape, with different subjects within science emerging, such as astronomy, biology, and physics. Institutions and communities devoted to science were founded.[1] Isaac Newton's book *Philosophiæ Naturalis Principia Mathematica* (1687) (English: *Mathematical Principles of Natural Philosophy*) reflects the use of the term *natural philosophy* in the 17th century. Even in the 19th century, the work that helped define much of modern physics bore the title *Treatise on Natural Philosophy* (1867).

In the German tradition, *Naturphilosophie* (philosophy of nature) persisted into the 18th and 19th centuries as an attempt to achieve a speculative unity of nature and spirit, after rejecting the scholastic tradition and replacing Aristotelian metaphysics, along with those of the dogmatic churchmen, with Kantian rationalism. Some of the greatest names in German philosophy are associated with this movement, including Goethe, Hegel, and Schelling. *Naturphilosophie* was associated with Romanticism and a view that regarded the natural world as a kind of giant organism, as opposed to the philosophical approach of figures such as John Locke and others espousing a more mechanical philosophy of the world, regarding it as being like a machine.[*citation needed*]

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THE GLEANER

Stark truths about Christianity's role in science

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THE EDITOR, Sir:

Dr Patrick White keeps diminishing the role played by Christianity in the development of science. I make reference to his articles published on August 3 and 21, 2015. This sent me to read again Chapter 2 of Professor Rodney Stark's book, For the Glory of God: How Monotheism led to Reformations, Science, Witch-hunts and the end of Slavery. I propose to quote from this chapter with the aim of giving readers alternative viewpoints on the matters raised by Dr White.

Stark argues that *"Christian theology was essential to the rise of science."* He asks some interesting questions: *"Why did real science develop in Europe at this time? Why did it not develop anywhere else?"*

What exactly is Professor Stark referring to when discussing 'science'? He defines 'science' as being not *"merely technology"*. A society does not have science simply because it can *"build sailing ships, smelt iron or eat off porcelain dishes. Science is a method utilised in organised efforts to formulate explanations of nature, always subject to modifications and corrections through systematic observations ... . Science consists of theory and research".*

For Stark, achievements of other civilisations, amazing though they were, *"do not constitute science"* being better described as *"engineering, learning or simply knowledge ... . Until they were linked to testable theories, these observations remained merely facts"*.

Again according to Professor Stark, the rise of science *"was the natural outgrowth of Christian doctrine: Nature exists because it was created by God. To love and honour God, one must fully appreciate the wonders of his handiwork. Moreover,* *because God is perfect, his handiwork functions in accord with immutable principles. By the full use of our God-given powers of reason and observations, we ought to be able to discover these principles".* These critical ideas, according to Professor Stark, were why science arose in Europe and nowhere else.

RISE OF SCIENCE

Stark quotes, *inter alia*, for his thesis an excerpt from a lecture given by Alfred North Whitehead in 1925 at Harvard that science arose in Europe because of *"faith in the possibility of science ... derivative from medieval theology"*. (Alfred North Whitehead co-authored Principia Mathematica, along with philosopher and mathematician Bertrand Russell).

Stark is not saying that Christian theology was by itself sufficient for the development of science. What he, however, maintains is that a particular concept of the Creator was necessary in order for science to develop. Stark also points out that once properly launched, science developed its own momentum.

So my encouragement to readers is that they should go after truth, for it is still the truth which will set us free. A reading of Rodney Stark is a great place to begin.

SHIRLEY RICHARDS

Christianity and the Development of Science: Part 1 – A General Discussion

Christianity and the Development of Science: Part 2 – The Founding Fathers of Science

List of Christians in science and technology

Before the 18th century

- Hildegard of Bingen (1098–1179): also known as Saint Hildegard and Sibyl of the Rhine, was a German Benedictine abbess. She is considered to be the founder of scientific natural history in Germany[2]
- Robert Grosseteste (c.1175–1253): Bishop of Lincoln, he was the central character of the English intellectual movement in the first half of the 13th century and is considered the founder of scientific thought in Oxford. He had a great interest in the natural world and wrote texts on the mathematical sciences of optics, astronomy and geometry. He affirmed that experiments should be used in order to verify a theory, testing its consequences and added greatly to the development of the scientific method.[3]
- Albertus Magnus (c.1193–1280): patron saint of scientists in Catholicism who may have been the first to isolate arsenic. He wrote that: "Natural science does not consist in ratifying what others have said, but in seeking the causes of phenomena." Yet he rejected elements of Aristotelianism that conflicted with Catholicism and drew on his faith as well as Neo-Platonic ideas to "balance" "troubling" Aristotelian elements.[note 1][4]
- Jean Buridan (1300–58): French philosopher and priest. One of his most significant contributions to science was the development of the theory of impetus, that explained the movement of projectiles and objects in free-fall. This theory gave way to the dynamics of Galileo Galilei and for Isaac Newton's famous principle of inertia.
- Nicole Oresme (c.1323–1382): Theologian and bishop of Lisieux, he was one of the early founders and popularizers of modern sciences. One of his many scientific contributions is the discovery of the curvature of light through atmospheric refraction.[5]
- Nicholas of Cusa (1401–1464): Catholic cardinal and theologian who made contributions to the field of mathematics by developing the concepts of the infinitesimal and of relative motion. His philosophical speculations also anticipated Copernicus' heliocentric world-view.[6]
- Otto Brunfels (1488–1534): A theologian and botanist from Mainz, Germany. His *Catalogi virorum illustrium* is considered to be the first book on the history of evangelical sects that had broken away from the Catholic Church.

In botany his *Herbarum vivae icones* helped earn him acclaim as one of the "fathers of botany".[7]

- William Turner (c.1508–1568): sometimes called the "father of English botany" and was also an ornithologist. He was arrested for preaching in favor of the Reformation. He later became a Dean of Wells Cathedral, but was expelled for nonconformity.[8]
- Ignazio Danti (1536–1586): As bishop of Alatri he convoked a diocesan synod to deal with abuses. He was also a mathematician who wrote on Euclid, an astronomer, and a designer of mechanical devices.[9]
- John Napier (1550–1617): Scottish mathematician, physicist, and astronomer, best known as the discoverer of logarithms and inventor of Napier's bones. He was a fervent Protestant and published *The Plaine Discovery of the Whole Revelation of St. John* (1593), which he considered his most important work. The work occupies a prominent place in Scottish ecclesiastical history.[10]
- Francis Bacon (1561–1626): Considered among the fathers of empiricism and is credited with establishing the inductive method of experimental science via what is called the scientific method today.[11][12]
- Galileo Galilei (1564–1642): Italian astronomer, physicist, engineer, philosopher, and mathematician who played a major role in the scientific revolution during the Renaissance.[13][14]
- Laurentius Gothus (1565–1646): A professor of astronomy and Archbishop of Uppsala. He wrote on astronomy and theology.[15]
- Johannes Kepler (1571–1630): Prominent astronomer of the Scientific Revolution, discovered Kepler's laws of planetary motion.
- Pierre Gassendi (1592–1655): Catholic priest who tried to reconcile Atomism with Christianity. He also published the first work on the Transit of Mercury and corrected the geographical coordinates of the Mediterranean Sea.[16]
- Anton Maria of Rheita (1597–1660): Capuchin astronomer. He dedicated one of his astronomy books to Jesus Christ, a "theo-astronomy" work was dedicated to the Blessed Virgin Mary, and he wondered if beings on other planets were "cursed by original sin like humans are."[17]
- Juan Lobkowitz (1606–1682): Cistercian monk who did work on Combinatorics and published astronomy tables at age 10. He also did works of theology and sermons.[18]
- Seth Ward (1617–1689): Anglican Bishop of Salisbury and Savilian Chair of Astronomy from 1649 to 1661. He wrote *Ismaelis Bullialdi astro-nomiae*

philolaicae fundamenta inquisitio brevis and *Astronomia geometrica.* He also had a theological/philosophical dispute with Thomas Hobbes and as a bishop was severe toward nonconformists.[19]

- Blaise Pascal (1623–1662): Jansenist thinker;[note 2] well known for Pascal's law (physics), Pascal's theorem (math), Pascal's calculator (computing) and Pascal's Wager (theology).[20]
- John Wilkins, FRS (14 February 1614 – 19 November 1672) was an Anglican clergyman, natural philosopher and author, and was one of the founders of the Royal Society. He was Bishop of Chester from 1668 until his death.
- Francesco Redi (1626–1697): Italian physician and Roman Catholic who is remembered as the "father of modern parasitology".
- Robert Boyle (1627–1691): Prominent scientist and theologian who argued that the study of science could improve glorification of God.[21][22] A strong Christian apologist, he is considered one of the most important figures in the history of Chemistry.
- Isaac Barrow (1630–1677): English theologian, scientist, and mathematician. He wrote *Expositions of the Creed, The Lord's Prayer, Decalogue, and Sacraments* and *Lectiones Opticae et Geometricae.*[23]
- Nicolas Steno (1638–1686): Lutheran convert to Catholicism, his beatification in that faith occurred in 1987. As a scientist he is considered a pioneer in both anatomy and geology, but largely abandoned science after his religious conversion.[24]
- Isaac Newton (1643–1727): Prominent scientist during the Scientific Revolution. Physicist, discoverer of gravity.[25]

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science

noun

sci·ence ˈsī-ən(t)s

1a: knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method

b : such knowledge or such a system of knowledge concerned with the physical world and its phenomena : natural science

2a : a department of systematized knowledge as an object of study
the science of theology

b : something (such as a sport or technique) that may be studied or learned like systematized knowledge

have it down to a science

3: a system or method reconciling practical ends with scientific laws
cooking is both a science and an art

4 capitalized : christian science

5: the state of knowing : knowledge as distinguished from ignorance or misunderstanding

scientific method

noun

: principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses

natural science

noun

: any of the sciences (such as physics, chemistry, or biology) that deal with matter, energy, and their interrelations and transformations or with objectively measurable phenomena

Science

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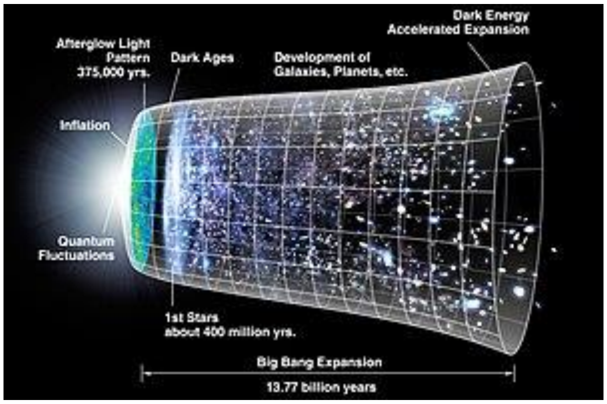
For other uses, see Science (disambiguation).



Chronology of the universe as deduced by the prevailing Big Bang theory, a result from science and obtained knowledge

Science is a systematic endeavor that builds and organizes knowledge in the form of testable explanations and predictions about the universe.[1][2]

Science may be as old as the human species, and some of the earliest archeological evidence for scientific reasoning is tens of thousands of years old. The earliest written records in the history of science come from Ancient Egypt and Mesopotamia in around 3000 to 1200 BCE. Their contributions to mathematics, astronomy, and medicine entered and shaped Greek natural philosophy of classical antiquity, whereby formal attempts were made to provide explanations of events in the physical world based on natural causes.[3][4] After the fall of the Western Roman Empire, knowledge of Greek conceptions of the world deteriorated in Western Europe during the early centuries (400 to 1000 CE) of the Middle Ages, but was preserved in the Muslim world during the Islamic Golden Age[5] and later by the efforts of Byzantine Greek scholars who brought Greek manuscripts from the dying Byzantine Empire to Western Europe in the Renaissance.

The recovery and assimilation of Greek works and Islamic inquiries into Western Europe from the 10th to 13th century revived "natural philosophy",[6][7] which was later transformed by the Scientific Revolution that began in the 16th century[8] as new ideas and discoveries departed from previous Greek conceptions and traditions.[9][10] The scientific method soon played a greater role in knowledge creation and it was not until the 19th century that many of the institutional and professional features of science began to take shape;[11][12] along with the changing of "natural philosophy" to "natural science".[13]

Modern science is typically divided into three major branches:[14] natural sciences (e.g., biology, chemistry, and physics), which study the physical world; the social sciences (e.g., economics, psychology, and sociology), which study individuals and societies;[15][16] and the formal sciences (e.g., logic, mathematics, and theoretical computer science), which study formal systems, governed by axioms and rules.[17][18] There is disagreement whether the formal sciences are science disciplines,[19][20][21] because they do not rely on empirical evidence.[22][20] Applied sciences are disciplines that use scientific knowledge for practical purposes, such as in engineering and medicine.[23][24][25]

New knowledge in science is advanced by research from scientists who are motivated by curiosity about the world and a desire to solve problems.[26][27] Contemporary scientific research is highly collaborative and is usually done by teams in academic and research institutions,[28] government agencies, and companies.[29][30] The practical impact of their work has led to the emergence of science policies that seek to influence the scientific enterprise by prioritizing the ethical and moral development of commercial products, armaments, health care, public infrastructure, and environmental protection.

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ETYMOLOGY OF THE WORD:

science (n.)

mid-14c., "state or fact of knowing; what is known, knowledge (of something) acquired by study; information;" also "assurance of knowledge, certitude, certainty," from Old French science "knowledge, learning, application; corpus of human knowledge" (12c.), from Latin scientia "knowledge, a knowing; expertness," from sciens (genitive scientis) "intelligent, skilled," present participle of scire "to know."

The original notion in the Latin verb probably is "to separate one thing from another, to distinguish," or else "to incise." This is related to scindere "to cut, divide" (from PIE root *skei- "to cut, split;" source also of Greek skhizein "to split, rend, cleave," Gothic skaidan, Old English sceadan "to divide, separate").

OED writes that the oldest English sense of the word now is restricted to theology and philosophy. From late 14c. in English as "book-learning," also "a particular branch of knowledge or of learning, systematized knowledge regarding a particular group of objects;" also "skillfulness, cleverness; craftiness." From c. 1400 as "experiential knowledge;" also "a skill resulting from training, handicraft; a trade."

From late 14c. in the more specific sense of "collective human knowledge," especially that gained by systematic observation, experiment, and reasoning. The modern (restricted) sense of "body of regular or methodical observations or propositions concerning a particular subject or speculation" is attested by 1725; in 17c.-18c. this commonly was philosophy.

The sense of "non-arts studies" is attested from 1670s. The distinction is commonly understood as between theoretical truth (Greek epistemē) and methods for effecting practical results (tekhnē), but science sometimes is used for practical applications and art for applications of skill.

The predominant modern use, "natural and physical science," generally restricted to study of the phenomena of the material universe and its laws, is by mid-19c.

The men who founded modern science had two merits which are not necessarily found together: Immense patience in observation, and great boldness in framing hypotheses. The second of these merits had belonged to the earliest Greek philosophers; the first existed, to a considerable degree, in the later astronomers of antiquity. But no one among the ancients, except perhaps Aristarchus, possessed both merits, and no one in the Middle Ages possessed either. [Bertrand Russell, "A History of Western Philosophy," 1945]

Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural. [Stephen Jay Gould, introduction to "The Mismeasure of Man," 1981]

SOCIETY FOR CLASSICAL LEARNING

Science, Non-Science, and Nonsense: Toward the Legitimate Science Classroom

Posted on October 1, 2015 by Paul Drake

Recent years have witnessed no shortage of controversy regarding the nature and proper content of primary and secondary school curricula. The science classroom has offered no exception. Indeed, ever since the famed Scopes "Monkey" Trial of 1925, parents and teachers, politicians and lawyers, scientists and clergy, journalists and pundits, have weighed in with sundry suggestions, proposals and mandates regarding the teaching of science.1 The results, contend some observers, suggest less progress in legitimate learning, than in production of lame legislation and loony litigation. In many cases, once the shouting subsides, terms of dispute can be stated rather simply: Such-and-such a topic, whatever interest it may hold for some, does not belong in the science classroom because the topic in question is not science; and only science belongs in the science classroom. A recent example of this kind of public kerfuffle was the 2005 Kitzmiller v. Dover trial in Harrisburg, Pennsylvania Federal District Court, in which the public school teaching of "Intelligent Design" theory was found to be an unconstitutional violation of the first amendment's establishment clause. My concern is not to consider the merits or flaws with Intelligent Design or any other contested theory or ideology, be it from the left or the right. Instead, this essay considers a premise upon which much curricular debate rests and it suggests something about the educational implications that follow from a recognition that this premise is, in fact, false.

In 1976 the English philosopher Alan Chalmers came out with a very nice little book under the title What is this Thing Called Science? He concluded the volume ironically by criticizing his own title: "[T]he question that constitutes the title of this book is a misleading and presumptuous one," he wrote. "It presumes that there is a single category science, and implies that various areas of knowledge, physics, biology, history, sociology and so on, either come under that category or do not. I do not know how such a general characterization of science can be established or defended."2 About the same time, other philosophers of science reached similar conclusions. The distinguished philosopher of science, Larry Laudan, for example, observed that ever since Plato, "philosophers have sought to identify those epistemic features which mark off science from other sorts of belief and activity. Nonetheless, it seems pretty clear that philosophy has largely failed to deliver the relevant goods. . . . [I]t is probably fair to say that there is no demarcation line between science and non- science, or between science and pseudo-science, which would win assent from a majority of philosophers. Nor is there one which should win acceptance from philosophers or anyone else . . .”3 Philosophers of science have persisted in this thesis to the present day. How did they reach such a conclusion? And what are the implications for the science classroom? First, the story of the failed attempts to distinguish science from everything else is long and complicated.4 Further, scholarly “awareness of the contingency and fluidity of the boundaries between the sciences and the humanities,” continues to generate conversation.5 Although the scope of this essay does not permit a complete retelling of the narrative, it opens with a review of the tale’s general themes before consideration of the educational implications.

The tale begins with ancient attempts to distinguish knowledge (episteme), on the one hand, from mere opinion (doxa), on the other. Here Aristotle led the way in his Posterior Analytics by distinguishing knowledge (or science) from opinion according to the principle that knowledge furnishes apodictic certainty. 6 Another ancient demarcation criterion was sometimes advanced upon the distinction between techne (the skill of one able at an art or craft or “know-how”) and scientia (demonstrative understanding or “know-why”). One may be a capable auto repairman, for example, without possessing genuine understanding of the chemical and thermodynamic principles of the internal combustion engine. Hence we distinguish between the craftsman and the scientist by virtue of the scientist’s comprehension of first principles. Thus there emerged in the ancient world two candidates for demarcation: one grounded upon the separation between apodictic certainty of science and fallible opinion of extra-scientific issues; the other distinguished between understanding and mere know-how.7

By the end of the seventeenth century, however, scientists had come to disregard the distinction between understanding and know-how as a viable demarcation line. Newton, for example, is famous for rejecting attempts to understand the cause of gravity or to answer why-questions about it. Instead, he remained content to describe mathematically how gravitation functioned (whatever it was).8 The result was that scientists came to regard the distinction between science and non-science as the distinction between infallible knowledge and fallible opinion.

Such a view of the scientific enterprise could not withstand the overwhelming theme of the history of science, namely that scientific theories are not infallible. They are fallible, subject to correction and open to revision. If they were not, then the history of science would be in the odd position of declaring every revised or replaced scientific theory unscientific. This would render the history of science the history of non-science. The clear implication was that scientific belief, because it is not infallible, ultimately is a species of opinion.9

Still philosophers remained convinced that even if scientific belief is only a kind of opinion, it must be a special kind of opinion that is ultimately distinct from superstition. To demonstrate this, philosophers knew that they had to craft that distinction upon some other criterion than the alleged "certainty" of scientific knowledge. Surely, they believed, science could be set off from everything else, if not by virtue of the certainty it offered, then, perhaps, because it followed a distinct methodology, something they called the scientific method. Consider this view as expressed by the great English statistician Karl Pearson in his late- nineteenth-century work The Grammar of Science: "The scientific method is the sole path by which we can attain to knowledge. The very word 'knowledge' indeed only applies to the products of the scientific method in the field. Other methods . . . may lead to fantasy as that of the poet or metaphysician, to belief or superstition, but never to knowledge."10 Strong words these are. It seemed perhaps that this thing called the scientific method would emerge as the decisive tool by which man could definitively set science apart from everything else and acknowledge it as the single source of knowledge. This would require, however, a rigorous and universally held explication of science's unique method. On this line of thinking any activity that was recognized as scientific would presumably employ the same method as every other ostensibly scientific activity.

This is where the rub came. Philosophers simply could not agree on just what that scientific method was. Was science an activity that restricted its theories to observable entities? Was it an activity that exclusively employed inductive reasoning? Was it an activity unique in its capacity for making predictions? Consensus could not be reached.11 "Absent agreement on what 'the scientific method' amounted to, demarcationists were scarcely in a position to argue persuasively that what individuated science was its method." Moreover, philosophical conceptions of scientific method often suffered from ambiguity or they substantially departed from the methods actually employed by practicing scientists.12 The outcome of this situation, as Larry Laudan eloquently stated was "more than a little ironic":

At precisely that juncture when science was beginning to have a decisive impact on the lives and institutions of Western man, at precisely that time when 'scientism' (i.e., the belief that science and science alone has the answers to all our answerable questions) was gaining ground, in exactly that quarter-century when scientists were doing battle in earnest with all manner of 'pseudo-scientists' (e.g. homeopathic physicians, spiritualists, phrenologists, biblical geologists), scientists and philosophers found themselves empty- handed. Except at the rhetorical level, there was no longer any consensus about what separated science from anything else.13

Not surprisingly then, the twentieth century saw the emergence of a new set of demarcationist strategies. The best early case of this new set of strategies emerged during the 1920s and 1930s through the efforts of the so- called Vienna Circle of philosophers to forge a semantic conception of the scientific enterprise, sometimes called "logical positivism." Science could be distinguished from non-science, logical positivists argued, because only the statements of science were meaningful. Meaningful statements were those that could, at least in principle, be verified. Hence the hope for setting apart science from non-science was placed upon this "verifiability criterion of meaning" which can be briefly stated as follows: a proposition is meaningful, and therefore scientific, if and only if the proposition is empirically verifiable.14 Accordingly, a statement such as "God created the world and saw that it was good" is neither true nor false, but simply meaningless because it is not possible, even in principle, to say how such a proposition could be empirically verified. On the other hand the statement "Water freezes at 0° C" is empirically verifiable, and therefore meaningful, and thus scientific. Unfortunately for the logical positivist program, however, their own verifiability criterion of meaning could not pass its own test and was rendered meaningless; for to what possible empirical test could this criterion of meaning be subjected? How could anyone, then, presume to demarcate science from non-science by appealing to a meaningless principle? Or as another critic put it, "To say that only factual statements have validity is to be not only dogmatic but self-contradictory, since the statement itself is not factual."15 The abject failure of logical positivism to demarcate science from non-science ran even deeper than this. While it certainly ruled out some "undesirable" metaphysics from the ranks of science, it failed to exclude other patent nonsense that happened to meet its criterion of meaning. For example, the proposition "The earth is flat," while clearly absurd, happens to be empirically verifiable in principle (even though the evidence mitigates against it); and therefore it is a meaningful statement that cannot be deemed "unscientific" according to the logical positivist demarcation criterion.16

Following the implosion of logical positivism, philosophers proposed that the search for a qualitative standard by which to isolate the scientific enterprise should be abandoned in favor of a quantitative benchmark. Maybe "scientific status is a matter of degree rather than kind."17 What sort of things might we consider here? Candidates include the degree to which a science is "well- tested." For example, one might contend that the theories of terrestrial mechanics are more testable (and thus more scientific) than those of astrology. Perhaps instead, one might appeal to a pragmatic scale. The more scientific an activity, it might be argued, the more useful and reliable will be its products. Some have advanced the notion that science is comparatively progressive and cumulative in its knowledge. Unlike religion, for example, science can claim a rate of "cognitive progress" by which it is set apart from non-scientific activities that accrue knowledge only very slowly, if at all. Still others suggest that a scientific activity will result in more predictions of unanticipated outcomes than a non-scientific activity. It turns out, however, that every such quantitative benchmark – testability, pragmatic benefits, cognitive progress, predictive capacity and others – demonstrably fails as a viable demarcation criterion.18 Although the scope of this essay does not permit exploration of how each one does fail, philosophical attempts to justify the quantitative approaches all reach the same conclusion: regardless of the criterion applied, each ends up including within the domain of "science" much that is intuitively and generally regarded as "extra- scientific," and conversely each ends up excluding as "extra-scientific" much that is widely regarded as "scientific."

What, then, are we to do? Are we to conclude that there is no such thing as science? Or at least, if there is, that we have no way of telling it apart from anything else? I do not think such despair is in order. Do we have to retreat to some sociological definition and say, "Science is just whatever scientists do"? This would be of little help, of course, because it would merely recast the question to ask who the scientists are.19 Or perhaps we fall back on a tacit intuitive answer: "Science is like obscenity. Although we cannot define it, we know it when we see it." None of these ultimately satisfy. Consequently, at least in the context of education, we are driven to the only sane conclusion. We must stop asking whether or not an issue, belief, subject, or activity is "scientific." Instead we must ask whether or not it is legitimate to discuss an issue, belief, subject or activity (regardless of its alleged “scientific” status) within a classroom that is ostensibly devoted to such topics as physics, chemistry, biology or geology.

Legitimacy and the Contemporary Situation

The issue of scientific legitimacy is distinct from the demarcation problem. As we have seen, the demarcation problem is a theoretical problem without solution. The question of legitimacy is a practical problem with a tangible solution that must be worked out through a collective effort linking the arena of public discourse to the philosopher’s tower, and the scientist’s bench. Although the legitimacy question is not without solution, its solution may change over time. As the philosopher of science Del Ratzsch has put it, “The nature and boundaries of scientific legitimacy were neither found carved in stone somewhere, developed purely a priori, nor just always known innately by humans. Rather, conceptions of . . . scientific legitimacy that we currently take to be correct have histories and have developed along with science.”20 Unlike the demarcation problem, the issue of legitimacy cannot not be solved. The question is whether it will be solved actively (and responsibly) or passively (and irresponsibly). It simply is the case that all manner of subjects are treated by scientists while they are speaking as scientists. Quibbling about whether or not we can classify the subjects about which they speak as “science” has proved an exercise in futility. Rather, our need is to determine whether or not any topic, even if it seems “extra-scientific” by whatever demarcation criterion adopted, may be a legitimate focus for study and discussion by science students.

This is so important because scientific and so- called “non-scientific” issues are interminably intermingled in both theory and practice. Scientists past and present repeatedly have incorporated into their ostensibly “scientific” discourse pronouncements about purpose, ethics, the deity, worldviews, meaning, duty, morality, chance, design, mind, metaphysics, ontology, teleology, good, evil, and so on. The question is not whether such practice is scientific. The question is whether it is legitimate to do so. Before exploring that question, permit me to recite a few examples to acquaint us with the kind of utterances I have in mind.

Ernst Mayr, perhaps the twentieth-century’s greatest biologist, argued in his book, This is Biology: The Science of the Living World, that contemporary moral and political issues are properly matters for biological discourse. He asserted that “an understanding of evolution can give us a worldview that serves as the basis for a sound ethical system that can maintain a healthy human society . . ."21 Worldview? Ethical system? Healthy society? This is hardly the stuff of old-fashioned pure and simple biology. Such topics have traditionally been the purview of priests, ethicists, and policy experts. But Mayr contends they are matters for the student of biology. Perhaps they are. At least they cannot be ruled out according to any received criterion of demarcation.

Now consider for a moment conclusions of several biologists who offer pronouncements that they believe to follow directly as conclusions from their biological science:

Ernst Haeckel (1877): "The cell consists of matter called protoplasm, composed chiefly of carbon, with an admixture of hydrogen, nitrogen and sulphur. These component parts, properly united, produce the soul and body of the animated world, and suitably nursed become man. With this single argument the mystery of the universe is explained, the Deity annulled and a new era of infinite knowledge ushered in."22

Douglas Futumya (1983): "Some shrink from the conclusion that the human species was not designed, has no purpose, and is the product of mere material mechanisms – but this seems to be the message of evolution."23 Michael Behe (1996): "The result of these cumulative efforts to investigate the cell . . . is a loud, clear, piercing cry of 'design!' The result is so unambiguous and so significant that it must be ranked as one of the greatest achievements in the history of science. The discovery rivals those of Newton and Einstein, Lavoisier and Schrödinger, Pasteur, and Darwin. The observation of the intelligent design of life is as momentous as the observation that the earth goes around the sun or that disease is caused by bacteria or that radiation is emitted in quanta."24

Francis Crick (1988): "Biologists must constantly keep in mind that what they see was not designed, but rather evolved."25

Michael J. Denton (1998): ". . . the unique fitness of the laws of nature for life is entirely consistent with the older teleological religious concept of the cosmos as a specially designed whole, with life and mankind as its primary goal and purpose. . . the emerging picture provide[s] powerful and self-evident support for the traditional anthropocentric teleological view of the cosmos."26

George Gaylord Simpson (1949): "Man is the result of a purposeless and natural process that did not have him in mind. He was not planned. He is a state of matter, a form of life, a sort of animal, and a species of the Order Primates, akin nearly or remotely to all of life and indeed to all that is material."27

Of course there are many more such quotations. Richard Dawkins proclaims that "Darwin made it possible to be an intellectually fulfilled atheist" while another biologist insists that "the universe is a purposeful creation."28 We could go on and on ping-ponging back and forth quotations attesting to the scientific evidence or lack thereof for meaning, purpose, design, values, et cetera.

Let my intent be clear. I am not concerned here to argue, as some do, that the preceding quotations are dastardly intrusions of scientists into the domain of metaphysical and religious discourse, although they might be just that. Rather since rigid demarcation fails, we should openly acknowledge the fact that the various disciplines, while distinct, are not wholly separable from one another. This means we must learn to navigate those borderlands where scientific discourse overlaps most often with other human concerns. The question becomes one of legitimacy. Is it or is it not legitimate to include in science classrooms discussions of contested issues and ideas that scientists believe, nonetheless, to follow directly from their scientific practice?

There are, of course, those who answer in the negative. Yet, to my knowledge, those who do, rest their opposition to discussions of such things as good and evil, meaning and purpose, design and beauty, etc. upon the nonsensical presumption that science and non-science can be competently demarcated from one another. As already noted, such questions about meaning and purpose whether they ought to or not, do in fact have a place in science because scientists have given them a place, repeatedly talking about purpose, issuing ethical imperatives, and offering normative claims in the name of science.29 Further, scientists do, in fact have scientific methods for addressing the idea of "purpose." Forensic scientists, detectives, lawyers, insurance fraud investigators, U.S.- government funded SETI researchers, and others all rely on sophisticated scientific methods for detecting purposeful activity. This is not the place to tease out the various conceptions of purpose. That topic could easily command yet another essay. Still it should be easy enough to see that it is one thing to determine whether a given event was the product of intention or purpose. It is another thing to identify the intention or purpose behind the event as benign, beneficent, malevolent, natural, supernatural, etc.

So we return to the question: Is it legitimate to include in science classrooms discussions of issues and ideas that scientists believe to follow directly from their scientific practice, even if some of these issues lurk on the borderlands shared with presumably "extra-scientific" concepts like purpose, meaning, beauty, and design? Permit the proposal of a tentative answer that defends the inclusion of such issues on a carefully limited basis, while avoiding the pitfalls of an "anything goes" free-for-all in the classroom.

Legitimacy and Liberal Education

The great Samuel Johnson rightly noted,

> Prudence and justice are virtues, and excellences, of all times and all places; we are perpetually moralists, but we are geometricians only by chance. Our intercourse with intellectual nature is necessary; our speculations upon matter are voluntary, and at leisure. Physiological learning is of such rare emergence, that one man may know another half his life without being able to estimate his skill in hydrostaticks or astronomy; but his moral and prudential character immediately appears.30

I submit that the chief end of education is to furnish and discipline students' minds and to equip them for human flourishing and constructive participation in civil society. If I am right, and if Samuel Johnson was correct about the perennial need for virtue, if he was correct about the secondary need for technical specialization, and if he was correct when he also asserted that "whether we provide for action or conversation, whether we wish to be useful or pleasing, the first requisite is . . . knowledge of right and wrong," then I submit that all teachers, of whatever subject matter (even biology, physics, astronomy, or hydrostatics), need to understand these things and be committed to them. Otherwise their primary educational duty cannot be fulfilled.31

I am not suggesting that the science classroom abandon the periodic table for the ten commandments, that learning acid-base titration techniques be replaced by speeches on moral philosophy, or that Mosaic cosmogony replace study of natural selection. I am suggesting that limiting the science classroom to such activities as studying the periodic table, learning titration techniques, or understanding a natural process like descent with modification, while necessary, cannot be sufficient, even for science education. I am suggesting that to realize the primary pedagogical aim of preparing students for virtuous and constructive participation in civil society, we must not retreat exclusively into the comfortable disciplinary hinterlands of specialization and technique, as if science can be hermetically sealed from other issues. It rarely can. Instead teachers must lead students into the sometimes risky no-man's land where science overlaps with religion, with ethical and metaphysical theory, with public policy, and with epistemology. For it is there that some of the most important educational work can and must happen. To retreat from it through fear of transgressing a dubitable demarcation line between science and non-science is not just a technical philosophical mistake, but a potentially dangerous omission.

In short, I propose a vision of education that begins with a particular view of mankind and ends with a corresponding understanding of liberal education. Both biologists and theologians acknowledge our identity as homo sapiens. The Latin homo means "mankind or man." The word sapiens, from the Latin sapientia, means "wisdom" and "discernment." To be truly human thus requires the cultivation of wisdom and discernment, that is the cultivation of what the ancients called the cardinal virtues – Prudence, Justice, Fortitude, and Temperance. Cardinal here is from the Latin cardo, meaning "hinge." In short, the realization of all other human goods and of our full flourishing hinges or turns upon the acquisition of these virtues, especially wisdom.32

There is another view of mankind. We might call it homo sciens, from the Latin scientia from which we get the word science. Homo sciens knows lots of stuff. The stuff he knows begins with the assumption that man is, like everything else he sees, a material thing. To be fully human, on this view, is to stockpile material things, to amass knowledge of material things, and to acquire expertise in the techniques of manipulating material things. In the end, this view of mankind underwrites the cynical conclusion of the twentieth-century American journalist H. L. Mencken who declared that human beings are no more than "an endless series of miserable and ridiculous bags of rapidly disintegrating amino acids."33

What is man? Any view of education must begin with a working answer to this question. Homo sciens can do things. He knows stuff. He is the master of means. Homo sapiens knows what to do and why to do it. He understands ends. The story of the modern era has been the story of the waning of homo sapiens and the waxing of homo sciens.34 As we have acquired the tools to do more and more, we have lost the wisdom needed to tell us what ought to and ought not to be done. The way to restore a salutary balance between these two visions of man is to foster an integrated view of education, a view that sees education as more than merely imparting information and techniques. We need a view that explores the disciplinary borderlands and is suspicious of the alleged sufficiency of narrow specialization. Richard Weaver put it so well when he noted, "Specialization of any kind is illiberal in a freeman. A man willing to bury himself in the details of some small endeavor has been considered lost . . . specialization develops only part of a man; a man partially developed is deformed."35

In her insightful discussion of Evolution as a Religion, the philosopher Mary Midgley remarked upon the popular ideal of scientists as objective inquirers: Scientists ought to be so impartial that they either do not have anything so unprofessional as a world-picture at all, or,

if they have one, do not let it affect their work. But this is a mistaken ideal. An enquirer with no such general map would only be an obsessive . . . Merely to pile up information indiscriminately is an idiot's task. Good scientists do not approximate to that ideal at all. They tend to have a very strong guiding imaginative system. Their world-picture is usually a positive and distinctive one, with its own special drama.36

My present concern is to recommend that scientists and science teachers embrace a sufficiently large world-picture to help foster what John Henry Newman called, in his classic treatment of liberal education The Idea of a University, a "philosophical habit of mind." Newman described this educational ideal:

An assemblage of learned men, zealous for their own sciences, and rivals of each other, are brought, by familiar intercourse and for the sake of intellectual peace, to adjust together the claims and relations of their respective subjects of investigation. They learn to respect, to consult, to aid each other. Thus is created a pure and clear atmosphere of thought, which the student also breathes . . . He apprehends the great outlines of knowledge, the principles on which it rests, the scale of its parts, its lights and its shades, its great points and its little, as he otherwise cannot apprehend them. Hence it is that his education is called "Liberal." A habit of mind is formed which lasts through life, of which the attributes are, freedom, equitableness, calmness, moderation, and wisdom; or what . . . I ventured to call a philosophical habit.37

This ideal can only be achieved when science does not presume to be the only kind of knowledge, when moral categories and virtues are not just things we teach students about in comparative religion classes, but things we teach students to embrace in every class. Students cannot embrace things they do not know. Both science students and humanities students must study issues at the borders between the sciences and the humanities; for to comprehend a subject requires knowledge of its relations to other subjects. Fostering this relational perspective is the duty of all teachers.38

One practical avenue toward achieving this perspective comes from admitting that scientific knowledge is not the only valid form of knowledge, that one can have genuine knowledge of such things as duty and virtue. "We have to allow there is another kind of knowledge besides the explicit, exact and testable kind . . . Traditional skills, intuitions, scientific systems, poetic and religious insights and the understanding of moral values are all fed from the same root." This is what the philosopher and physical chemist Michael Polanyi called "tacit knowing."39 We could profit from considering his perspective.

Finally, and even more practically, our science classrooms would do well to include discussion of select issues that surface in public discourse with which our students must eventually wrestle and reckon. Perhaps the best and diciest contemporary example, which I mentioned at the opening of my remarks, has emerged in the case of "intelligent design" theory (ID). One of ID's most vigorous critics is the political philosopher Larry Arnhart. Despite his conviction that intelligent design is wrong, he puts forth a recommendation for teaching ID in the science classroom:

Allowing our public school students to study and debate creationist criticisms of Darwinism in their biology classes would promote a better understanding of scientific argumentation and of the moral and political implications of science. If students were allowed to study some readings from the intelligent design theorists along with Darwin's writings and some contemporary defenses of Darwin, they could better judge the evidence and arguments . . .

Science education in the public schools often consists of mindless memorization of scientific formulas so that students have no understanding of how one goes about weighing evidence and arguments for and against scientific ideas. Moreover, students rarely see the emotional excitement associated with scientific controversies that have moral, political, and religious implications. A lively classroom debate over Darwinism would be a great improvement, and it might actually prepare students to become citizens capable of judging scientific disputes that have deep consequences for human life.40

Both politicians and philosophers appear to concede the merit in Arnhart's proposal. The explanatory statement accompanying the 2002 Elementary and Secondary Education Authorization Act included the following language: "A quality science education should prepare students to distinguish the data and testable theories of science from religious or philosophical claims that are made in the name of science. Where topics are taught that may generate controversy (such as biological evolution), the curriculum should help students to understand the full range of scientific views that exist, why such topics may generate controversy, and how scientific discoveries can profoundly affect society."41 Philosopher of science Del Ratzsch takes head on the tendency of most scientists to exclude the notion of supernatural design from the discussion table:

[A]ttempts to support blanket, normative prohibitions on even considering supernatural design in science seem without exception to fail for various reasons. Attempts to justify such prohibitions on pragmatic grounds seem to do little better. The intuition that science cannot deal with the supernatural, so must systematically ignore it, seems a bit like advising swimmers in the Amazon that since they cannot see pirhanas from the bank nor survive a pirhana attack once in the water, they should plunge right in, pretending that there are none. Perhaps better advice might be to work on learning some pirhana recognition techniques.42

We live in one world, not separate scientific and religious worlds, but one world. Consequently, the differing perspectives from which the sciences and humanities view our one world must be accommodated by the minds of individual human students in which these different perspectives are fostered.

Consider these remarks from a Canadian newspaper by Michael Ruse, an internationally respected and widely-published philosopher of biology who has written extensively on evolutionary biology: "Evolution is promoted by its practitioners as more than mere science. Evolution is promulgated as an ideology, a secular religion – a full-fledged alternative to Christianity, with meaning and morality. . . . Evolution is a religion. This was true of evolution in the beginning, and it is true of evolution still today."43 Now, Dr. Ruse may have gone over the top. He may be as far off the mark as one can get. He may, on the other hand, be right on target. This is not the issue. The issue is that students who may read his words in the newspaper at breakfast before school should be able to ask their science teachers to help them sort these things out. Science teachers should be eager to devote class time to doing so. But they cannot do it correctly unless they are permitted to do so and properly equipped for the task. Our schools will better serve their primary educational mission of furnishing and disciplining minds if they welcome, indeed encourage, opportunities to consider contested issues in the science classroom. Sometimes valuable pedagogical lessons lurk in the disciplinary borderlands. And there is no questioning the fact that divisive public policy issues are often thorny to the degree they are interdisciplinary. Acknowledging this in the science classroom is one way to prepare students for wise participation in contemporary civil society.

Falsifiability: How to Distinguish Between Science and Nonscience

By Sean Carroll ***Previously published in December 2014***

In a world where scientific theories often sound bizarre and counter to everyday intuition, and where a wide variety of nonsense aspires to be recognized as "scientific," it's important to be able to separate science from non-science—what philosophers call "the demarcation problem." Karl Popper famously suggested the criterion of "falsifiability"—a theory is scientific if it makes clear predictions that can be unambiguously falsified.

It's a well-meaning idea, but far from the complete story. Popper was concerned with theories such as Freudian psychoanalysis and Marxist economics, which he considered non-scientific. No matter what actually happens to people or societies, Popper claimed, theories like these will always be able to tell a story in which the data are compatible with the theoretical framework. He contrasted this with Einstein's relativity, which made specific quantitative predictions ahead of time. (One prediction of general relativity was that the universe should be expanding or contracting, leading Einstein to modify the theory because he thought the universe was actually static. So even in this example the falsifiability criterion is not as unambiguous as it seems.)

Modern physics stretches into realms far removed from everyday experience, and sometimes the connection to experiment becomes tenuous at best. String theory and other approaches to quantum gravity involve phenomena that are likely to manifest themselves only at energies enormously higher than anything we have access to here on Earth. The cosmological multiverse and the many-worlds interpretation of quantum mechanics posit other realms that are impossible for us to access directly. Some scientists, leaning on Popper, have suggested that these theories are non-scientific because they are not falsifiable.

The truth is the opposite. Whether or not we can observe them directly, the entities involved in these theories are either real or they are not. Refusing to contemplate their possible existence on the grounds of some a priori principle, even though they might play a crucial role in how the world works, is as non-scientific as it gets.

The falsifiability criterion gestures toward something true and important about science, but it is a blunt instrument in a situation that calls for subtlety and precision. It is better to emphasize two more central features of good scientific theories: they are definite, and they are empirical. By "definite" we simply mean that they say something clear and unambiguous about how reality functions. String theory says that, in certain regions of parameter space, ordinary particles behave as loops or segments of one-dimensional strings. The relevant parameter space might be inaccessible to us, but it is part of the theory that cannot be avoided. In the cosmological multiverse, regions unlike our own are unambiguously there, even if we can't reach them. This is what distinguishes these theories from the approaches Popper was trying to classify as non-scientific. (Popper himself understood that theories should be falsifiable "in principle," but that modifier is often forgotten in contemporary discussions.)

It's the "empirical" criterion that requires some care. At face value it might be mistaken for "makes falsifiable predictions." But in the real world, the interplay between theory and experiment isn't so cut and dried. A scientific theory is ultimately judged by its ability to account for the data—but the steps along the way to that accounting can be quite indirect.

Consider the multiverse. It is often invoked as a potential solution to some of the fine-tuning problems of contemporary cosmology. For example, we believe there is a small but nonzero vacuum energy inherent in empty space itself. This is the leading theory to explain the observed acceleration of the universe, for which the 2011 Nobel Prize was awarded. The problem for theorists is not that vacuum energy is hard to explain; it's that the predicted value is enormously larger than what we observe.

If the universe we see around us is the only one there is, the vacuum energy is a unique constant of nature, and we are faced with the problem of explaining it. If, on the other hand, we live in a multiverse, the vacuum energy could be completely different in different regions, and an explanation suggests itself immediately: in regions where the vacuum energy is much larger, conditions are inhospitable to the existence of life. There is therefore a selection effect, and we should predict a small value of the vacuum energy. Indeed, using this precise reasoning, Steven Weinberg did predict the value of the vacuum energy, long before the acceleration of the universe was discovered.

We can't (as far as we know) observe other parts of the multiverse directly. But their existence has a dramatic effect on how we account for the data in the part of the multiverse we do observe. It's in that sense that the success or failure of the idea is ultimately empirical: its virtue is not that it's a neat idea or fulfills some nebulous principle of reasoning, it's that it helps us account for the data. Even if we will never visit those other universes.

Science is not merely armchair theorizing; it's about explaining the world we see, developing models that fit the data. But fitting models to data is a complex and multifaceted process, involving a give-and-take between theory and experiment, as well as the gradual development of theoretical understanding in its own right. In complicated situations, fortune-cookie-sized mottos like "theories should be falsifiable" are no substitute for careful thinking about how science works. Fortunately, science marches on, largely heedless of amateur philosophizing. If string theory and multiverse theories help us understand the world, they will grow in acceptance. If they prove ultimately too nebulous, or better theories come along, they will be discarded. The process might be messy, but nature is the ultimate guide.

This article originally appeared on edge.org and is written by Sean Carroll, Theoretical Physicist, Caltech; Author of The Particle at the End of the Universe *and* From Eternity to Here: The Quest for the Ultimate Theory of Time

Further reading suggestion: http://theundisciplined.com/2014/11/16/natural-philosophy-falsifiability-and-pseudo-science/

CREATION MOMENTS

WHAT IS CARBON-14-DATING AND HOW RELIABLE IS IT?

Anything that was once alive or that was produced by a living thing can be dated by using the radiocarbon method of dating. This method, which received widespread attention in connection with the Dead Sea Scrolls, relies on the fact that all living things take in carbon, some of which is very slightly radioactive. But just how reliable is this method?

To hear some people tell it, scientists have nearly absolute confidence in the dating methods they use. When their dating methods say that something lived 30,000 years ago, they sound certain. And on the basis of these methods, many scientists announce that the Bible's record of history is not accurate. But that's not really how it is when scientists are working in their labs.

To understand how the C-14 clock works and what processes are involved, let us consider the egg-timer. By tipping the glass when the egg starts cooking, one learns when three minutes are up and the boiling should be stopped. One assumes that there is enough sand in the timer so that it takes three minutes for it to move from the top of the glass to the bottom of the glass. One also assumes that all the sand is in the bottom of the glass when one turns it over.

How does a scientist date a rock or a bone? He must look for something in the bone which disappears over time, as the sand disappeared from the top chamber of the egg timer. The disappearance must take place at a known and measurable rate. If the scientist can find out how much of this material was in the bone when the animal died, and if he knows how fast it disappears, and if he can measure the amount still left in the bone, he has something like a natural hourglass. Carbon-14 is used as just such a substance.

Carbon is one of the most important atoms in the living system. Carbon is present in proteins, fats and carbohydrates – the three basic foods. Carbon is found in all of our cells, including bone cells.

Carbon atoms such as we have in the living body are two kinds. Most of the carbon atoms are of the C-12 type. C-12 does not disappear, because it is stable. A very small part of the carbon in our body is radioactive C-14, which does change to a nitrogen atom. C-14, thus, disappears, like sand running through the hourglass.

The beta rays given off when C-14 changes to C-12 can be counted with a counting machine such as the Geiger counter. If many counts per minute (beta rays), are measured, high radioactivity and, therefore, much C-14 is present. If there are fewer counts per minute, there is not much C-14 in the bone.

If all bones have about the same amount of C-14 at the moment of their death, then the scientist can use the C-14 test as something like an hourglass.

Since carbon comes from the air, does the amount of carbon-14 in the air remain constant? Much of the carbon in the air is C-12, but a small amount of it is C-14. The plant, animal and human will each have about the same ratio of C-14 to C-12 as does the air. The next question is: Where did the air get its C-14?

C-14 enters the air by the action of cosmic radiation. Cosmic rays enter our Earth's atmosphere from outer space. When cosmic rays enter the atmosphere, they cause "scatter radiation," which consists of little particles called neutrons. A moving neutron is a high-energy particle which performs an interesting task. A nitrogen atom hit by one of these neutrons changes into a C-14 atom and ejects a protein. If a moving neutron enters a nitrogen nucleus, a proton comes flying out, and the nitrogen atom is changed to an atom of C-14. Thus, C-14 forms from nitrogen in our atmosphere.

The constancy of C-14 in our atmosphere depends on the cosmic rays coming into the atmosphere at the same rate. But the cosmic ray bombardment changes moment by moment, day by day and week by week. Such activity as sun spots or solar storms will affect the cosmic radiation. Some of the scientists who date by C-14 claim these are only small fluctuations and would have no overall effect.

But if there can be small fluctuations in the amount of the C-14 produced in the atmosphere day by day, then there could have been greater fluctuations in Earth's history. Let's take a look at the early Earth.

What might such changes in the atmosphere mean for dating studies? Let's consider the Flood and use what is called the "canopy theory." There is some evidence for a canopy surrounding the Earth before the Flood. The canopy would probably not stop all the cosmic rays themselves, but a good deal of the scatter radiation would be reduced. It would act as a shield. Thus, there would be a few neutrons and fewer C-14 atoms formed. Most of the carbon before the Flood would then be C-12.

Suppose the scientist doing the dating did not know about the Flood. He would give his bone a "date" of 15,000 to 30,000 years because of the very low C-14. He would do so because he believed all bones contained the present amount of C-14 when they died. He would give this bone a false date because of a false assumption. If the ratio of C-14 to C-12 was much less in the past for any reason, then false dates would be given to such fossils.

In recent years, many scientists have adopted a policy of refusing to trust radiocarbon dates which have not been tested by a second method. In 1966, scientists found, among some fragments of mammoth and bison bone in the Yukon Territory of Canada, a sharpened hide scraper made of caribou bone. This was clear evidence of man's activity, so they wanted to find out how old the bone scraper was. Radiocarbon dating told them it was 25,000 to 30,000 years old, placing it 20,000 years before man arrived in North America. Twenty years later, using a nuclear accelerator, another scientist tested the bones using a different method, and dated the bones not at 25,000 or 30,000 years old, but at only 2,000 years old!

Professor Robert Whitelaw was a leading creationist expert on carbon dating. The method itself was invented in the 1950s by W.F. Libby, a committed evolutionist. Dr. Whitelaw began studying carbon dating results in the 1960s and reviewed over 30,000 carbon-dating results. Dr. Whitelaw pointed out that Libby knew, from his own research, that carbon-14 dating proved that the Earth was only a few thousand years old. But Libby rejected this result as being contrary to his religion. When carbon-dating information is adjusted to fit Libby's own data, carbon-14 dating demonstrates that there was a world-wide cataclysm which destroyed all life at just about the time given in the Bible for the great Flood. Carbon-14 also shows that all living things appeared at about the same time.

When God's Word tells us about day and dates, we can trust His Word to be accurate. The Bible is not only a higher authority than any of man's schemes, it has always proven to be unerringly accurate, even when it speaks about history and science.

Stanford Encyclopedia of Philosophy

Metaphysics

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It is not easy to say what metaphysics is. Ancient and Medieval philosophers might have said that metaphysics was, like chemistry or astrology, to be defined by its subject-matter: metaphysics was the "science" that studied "being as such" or "the first causes of things" or "things that do not change". It is no longer possible to define metaphysics that way, for two reasons. First, a philosopher who denied the existence of those things that had once been seen as constituting the subject-matter of metaphysics—first causes or unchanging things—would now be considered to be making thereby a metaphysical assertion. Second, there are many philosophical problems that are now considered to be metaphysical problems (or at least partly metaphysical problems) that are in no way related to first causes or unchanging things—the problem of free will, for example, or the problem of the mental and the physical.

The first three sections of this entry examine a broad selection of problems considered to be metaphysical and discuss ways in which the purview of metaphysics has expanded over time. We shall see that the central problems of metaphysics were significantly more unified in the Ancient and Medieval eras. Which raises a question—is there any common feature that unites the problems of contemporary metaphysics? The final two sections discuss some recent theories of the nature and methodology of metaphysics. We will also consider arguments that metaphysics, however defined, is an impossible enterprise.

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