Central Figures in the History and Philosophy of Science

edited by

David L. Alles

Western Washington University

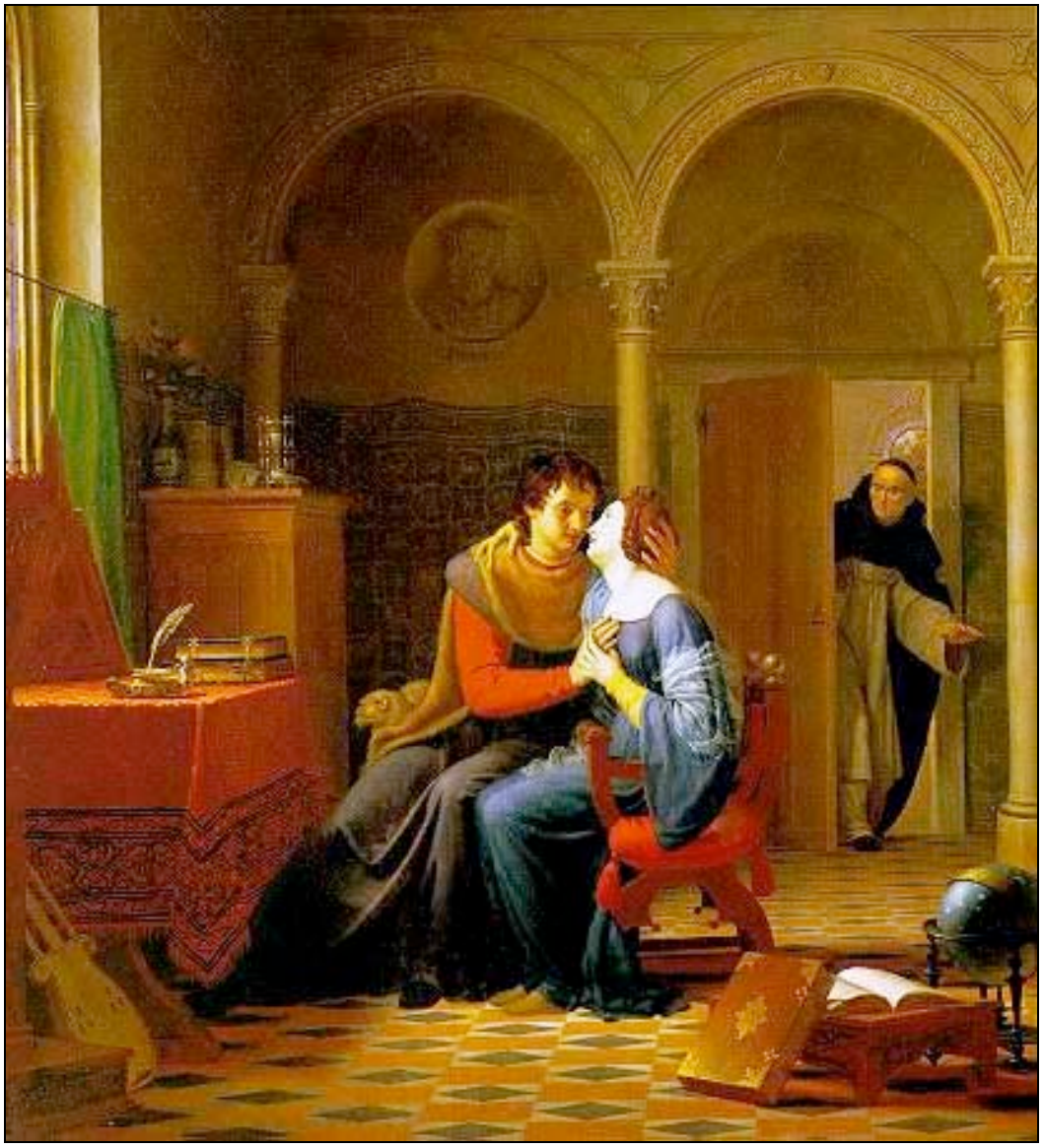
e-mail: alles@biol.wwu.edu

Last updated 2013-2-7

Note: In PDF format most of the images in this web paper can be enlarged for greater detail.

Introduction

To understand the nature of science it's necessary to have an acquaintance with the historical and philosophical context that gave rise to the scientific enterprise. What follows is a selection of portraits and biographic sketches of some of the major figures in that history. Hopefully they provide a human face to this story to help us understand the underlying cultural and philosophical changes that have given us science as we know it today.



Abelard (1079-1142) and Heloise (1101-1164)

Pierre Abelard the perfector of nominalism, the basis of modern empiricism, was arguably the first modern thinker. His tendency to disputation is perhaps best demonstrated by his book *Sic et Non* (For and Against), a list of 158 philosophical and theological questions about which there were divided opinions. This dialectical method of intellectual reflection was to become an important feature of western education and distinguishes it sharply from other world cultures such as Islam and the Confucian world. Abelard's mistake was to leave the questions open for discussion and so he was repeatedly charged with heresy. For a long period all his works were included in the Catholic Index of Forbidden Books.

The scholastic tradition or scholasticism was the system of theological and philosophical teaching predominant in the Middle Ages, based chiefly upon the authority of the Catholic Church. Abelard was the first significant figure to challenge that tradition. Until the time of Abelard a statement by an accepted authority had sufficed for proof. Abelard showed that these authorities were contradictory. Though he claimed that his attack on authority aimed only at finding the truth, the Church did not approve. When he said, "By doubting we come to enquiry; by enquiring we perceive the truth," Rome heard the voice of a revolutionary.

Abelard laid down four basic rules for argument and investigation:

> "Use systematic doubt and question everything.
>
> Learn the difference between statements of rational proof and those merely of persuasion.
>
> Be precise in the use of words, and expect precision from others.
>
> Watch for error, even in Holy Scripture."

Statements like these were quite extraordinary in the twelfth century. Objectivity, detachment and unprejudiced, unemotional ratiocination were rare to the medieval mind, steeped as it was in mystery and dogma.

Abelard is perhaps as famous today for his love affair with Heloise and its disastrous consequences, which resulted in her giving birth to a son (called Astrolabe), to Abelard's castration by Heloise's angry relatives, and to both their retreats to monastic life. Heloise, Abelard's junior by 22 years, was one of the most literate women of her time, and an able administrator: as a result her monastic career was notably successful. Abelard, a intellectual jouster throughout his life was notably less happy as a monk. He incurred the displeasure and enmity of abbots, bishops, his own monks, and a number of Church councils. The last months of his life were spent under the protection of Peter the Venerable of Cluny, where he died. The tomb of Abelard and Heloise can be visited in the Pére Lachaise cemetery in Paris.

Web References

http://www.newadvent.org/cathen/01036b.htm

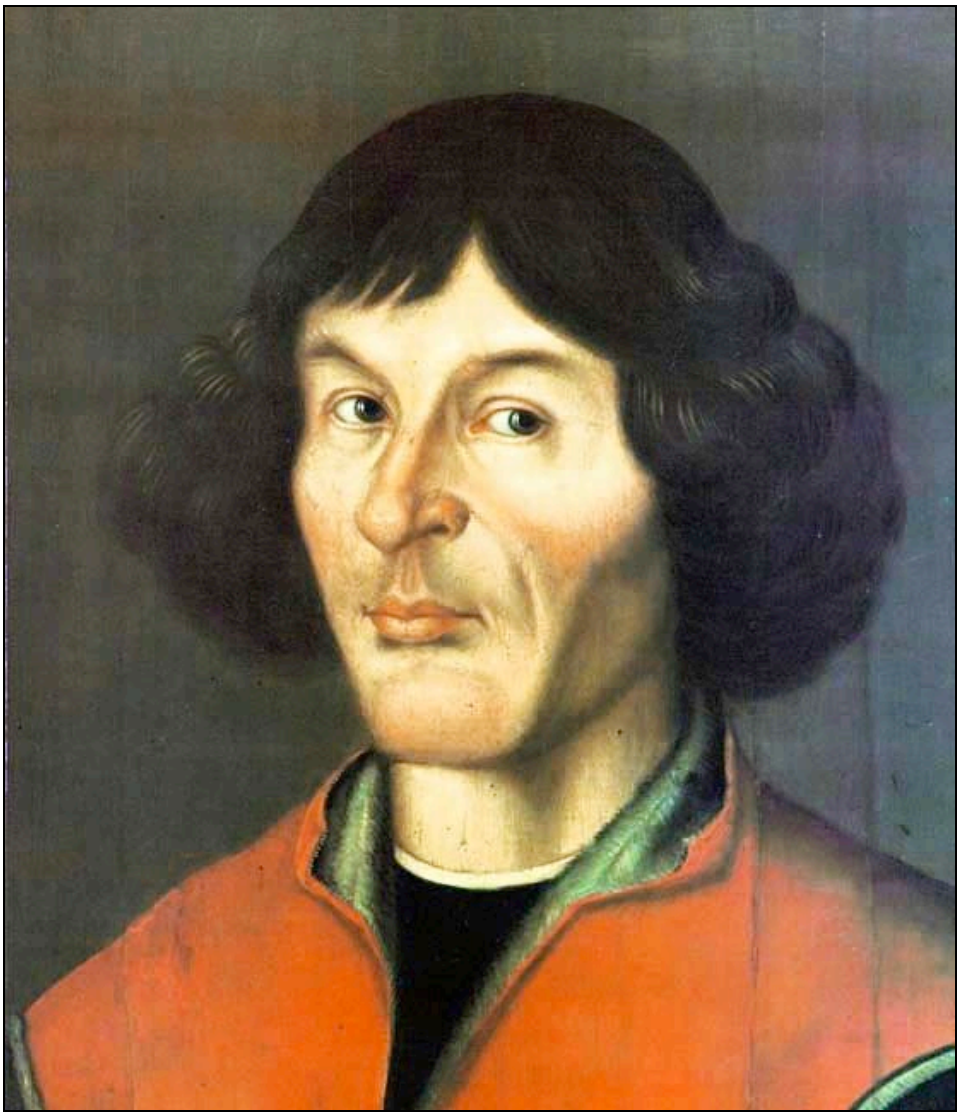
http://www.historyguide.org/ancient/abelard_b.html

Pietro Pomponazzi (1462–1525)

Pomponazzi aroused great interest in the intellectual circles of his day when he questioned St. Thomas Aquinas's interpretation of Aristotle. In his *De immortalitate animae* (1516), Pomponazzi argued that evidence suggests that the soul is mortal; its immortality, therefore, must be accepted as an article of faith. His naturalist position is developed in *De incantationibus* (*Of Incantations*) published in 1520, in which he stressed the evolution of man and of nature.

> "It is possible to justify any experience by natural causes and natural causes only. There is no reason that could ever compel us to make any perception depend on demonic powers. There is no point in introducing supernatural agents. It is ridiculous as well as frivolous to abandon the evidence of natural reason and to search for things that are neither probable nor rational."—Pomponazzi from his book *Of Incantations* 1520

Web Reference
http://www.newadvent.org/cathen/12227a.htm



Nicolas Copernicus (1473-1543)

Born on Feb. 19, 1473, in Thorn (Torun), Poland, Nicolas Copernicus was destined to become, through the publication of his heliocentric theory 70 years later, one of the seminal figures in the history of scientific thought. The son of a prosperous merchant, he was raised after his father's death by a maternal uncle, who enabled him to enter the University of Krakow, then famous for its mathematics, philosophy, and astronomy curriculum. This experience stimulated the young Copernicus to study further liberal arts at Bologna (1496-1501), medicine at Padua, and law at the University of Ferrara, from which he emerged in 1503 with the doctorate in canon law. Shortly afterward he returned to Poland and eventually settled permanently at the cathedral in Frauenberg (Frombork), less than 100 miles from his birthplace. Through his uncle's influence he had been elected a canon of the church even before his journey to Italy. Copernicus not only faithfully

performed his ecclesiastical duties, but also practiced medicine, wrote a treatise on monetary reform, and turned his attention to a subject in which he had long been interested—astronomy.

By May 1514, Copernicus had written and discreetly circulated in manuscript his *Commentariolus*, the first outline of those arguments eventually substantiated in *De revolutionibus orbium coelestium* (On the Revolutions of the Heavenly Spheres, 1543). This classic work challenged the geocentric cosmology that had been dogmatically accepted since the time of Aristotle. In direct opposition to Aristotle and to the 2d-century astronomer Ptolemy, who enunciated the details of the geocentric system based on the celestial phenomena, Copernicus proposed that a rotating Earth revolving with the other planets about a stationary central Sun could account in a simpler way for the same observed phenomena of the daily rotation of the heavens, the annual movement of the Sun through the ecliptic, and the periodic retrograde motion of the planets.

The new theory that Copernicus espoused in *De revolutionibus* exhibits a peculiar mixture of both radical and conservative elements. In the midst of his radical reordering of the structure of the universe, Copernicus still adhered to the ancient Aristotelian doctrines of solid celestial spheres and perfect circular motion of heavenly bodies, and he held essentially intact the entire Aristotelian physics of motion. Moreover, with significant innovations, he clung to the Ptolemaic representation of planetary motion by means of complicated combinations of circles called epicycles. Although Copernicus realized that his theory implied an enormous increase in the size of the universe, he declined to pronounce it infinite.

These aspects of the Copernican treatise do not mitigate the novelty or the impact of the final theory, or the author's firm conviction that his system was an accurate representation of physical reality. Rather, they indicate the scope of the work that lay ahead and that was effectively addressed in the next century when Kepler determined the ellipticity of planetary orbits, Galileo formulated his new concept of motion, and Newton espoused his theory of universal gravitation.

The enunciation of the heliocentric theory by Copernicus marked the beginning of the scientific revolution, and of a new view of a greatly enlarged universe. It was a shift away from the comfortable anthropocentrism of the ancient and medieval world. A scientific theory that reflected so profoundly on humanity was not welcomed by the church, and it was only after the publication (1540) of *Narratio prima* (A First Account), by an enthusiastic supporter named Rheticus, that the aged Copernicus agreed to commit to print the theory already outlined in 1514. An undocumented, but often repeated, story holds that Copernicus received a printed copy of his treatise on his deathbed. He died on May 24, 1543.

Web Reference http://www.phy.hr/~dpaar/fizicari/xcopern.html

Giambattista della Porta (1535-1615)

Giambattista della Porta (also known as Giovanni Battista Della Porta or John Baptist Porta) was a polymath who dabbled in nearly everything. *Magiae Naturalis*, his first book, is also his best known work and the basis of his reputation. The first edition, which consisted of four books, appeared in 1558; an expanded edition of twenty books was first published in 1589.

Magiae Naturalis is an extraordinary hodge-podge of material representing that unique combination of curiosity and credulity common in the late Renaissance. But combined with the author's insatiable desire for the marvelous and apparently miraculous is a serious attempt to define and describe natural magic and some refined application of both mathematical and experimental techniques in science.

From Della Porta's book published in English as *Natural Magick* in 1658:

Chapter II "What is the Nature of Magick"

"There are two sorts of Magick; the one is infamous, and unhappy, because it has to do with foul Spirits, and consists of incantations and wicked curiosity; and this is called Sorcery; an art which all learned and good men detest; neither is it able to yield an truth of reason or nature, but stands merely upon fancies and imaginations, such as vanish presently away, and leave nothing behind them; as Jamblicus writes in his book concerning the mysteries of the Egyptians.

The other Magick is natural; which all excellent wise men do admit and embrace, and worship with great applause; neither is there any thing more highly esteemed, or better thought of, by men of learning. The most noble Philosophers that ever were, Pythagorus, Empedocles, Democritus, and Plato, forsook their own countries, and lived abroad as exiles and banished men, rather than as strangers; and all to search out and to attain this knowledge; and when they came home again, this was the Science which they professed, and this they esteemed a profound mystery. They that have been most skillful in dark and hidden points of learning, do call this knowledge the very highest point, and the perfection's of Natural Sciences; inasmuch that if they could find out or devise amongst all Natural Sciences, any one thing more excellent or more wonderful then another, that they would still call by the name of Magick.

Others have named it the practical part of natural Philosophy, which produces her effects by the mutual and fit application of one natural thing unto another. But I think Magick is nothing else but the survey of the whole course of Nature. For, while we consider heavens, the stars, the elements, how they are moved, and how they are changed, by this means we find out the hidden secrets of living creatures, of plants, of metals, and of their generation and corruption; so that this whole Science seems merely to depend upon the view of Nature, as later we will see more at large. This art, I say, is full of much Virtue."

Web Reference
http://www-groups.dcs.st-and.ac.uk/%7Ehistory/Biographies/Porta.html

Giordano Bruno (1548-1600)

"Who so itcheth to Philosophy must set to work
by putting all things to the doubt."—Bruno

By the year 1582, it's easy to get an impression of the reputation which Bruno had created in the minds of the church authorities of southern Europe. He had written of an infinite universe which had left no room for the greater infinite conception of God. For he could not conceive that God and nature could be separate and distinct entities as taught by the Catholic Church. But after 14 years of wandering about Europe, Bruno turned his steps toward Italy and home in spite of the danger.

Inevitably, charges of heresy were made against him. He was imprisoned by the Inquisition for eight years as his trial dragged on. When he was finally sentenced as a heretic for his beliefs, Bruno answered the sentence of death by fire with the words: "Perhaps you, my judges, pronounce this sentence against me with greater fear than I receive it."

On February 17, 1600, he was taken to the Piazza Campo dei Fiori in Rome, tied naked to an iron stake, and burned alive by the Catholic Church.

Web References

http://en.wikipedia.org/wiki/Giordano_Bruno

http://www.infidels.org/library/historical/john_kessler/giordano_bruno.html

Francis Bacon (1561-1626)

"If the enjoyment of happiness is a great good,
the power of imparting it to others is greater."—Bacon

Bacon's real claim to fame is: not that he, as the lord chancellor, in 1621, was removed from office for accepting a litigant's bribe; nor, that he was the real writer of the Shakespearean plays (one of the controversies in English literature, the "Baconian controversy"); but rather Francis Bacon is known as a philosopher, one of the first order. Bacon delineated the principles of the inductive method,

which constituted a breakthrough in the approach to science. Bacon argued that the only knowledge of importance to man was empirically rooted in the natural world; and that a clear system of scientific inquiry would assure man's mastery over the world.

He was the originator of the expression, "Knowledge is power." He was quite taken up by the "materialist" theories and the resultant discoveries of both Copernicus and Galileo. Bacon, along with Galileo are known in the literature as "the great anti-Aristotelians who created the 'modern scientific' view of Nature."

Francis Bacon was born in London. He entered Trinity College, Cambridge, at the age of twelve. He studied law and became a barrister in 1582; two years later he took a seat in the House of Commons. With the accession of James I and thereafter, a number of honors were bestowed on Bacon: he was knighted in 1603, made Solicitor General in 1604, Attorney General in 1613, and Lord Chancellor in 1618.

Bacon, not having come from a rich family, and always pressed for money: accepted, and this is one of the great surprises of history, a litigant's bribe. This was in 1621; so, just four months after he was raised to the peerage, Bacon was evicted from office. ("I do plainly and ingenuously confess that I am guilty of corruption, and do renounce all defense.") Francis Bacon went into retirement and died in 1626.

Web Reference
http://en.wikipedia.org/wiki/Francis_Bacon

Galileo Galilei (1564-1642)

"I do not feel obliged to believe that the same God who has endowed us with sense, reason, and intellect has intended us to forgo their use."—Galilei

Galileo (Galilei), astronomer, mathematician, and physicist was another of those great anti-Aristotelian scientists of the age, such as Johann Kepler (1571-1630) who also published laws of planetary motion. These great men came to their great discoveries because of their scientific view of nature.

They were a new breed of philosophers, natural philosophers, or scientists as we call them today. They did not dwell long on the useless question: Why do things happen? They asked: "How do things happen?

Galileo was an Italian. At the age of 19 he discovered the principle of isochronism that each oscillation of a pendulum takes the same time despite changes in amplitude. Soon thereafter he became known for his ideas on hydrostatic balance; and, further, his treatise on the center of gravity of falling bodies. He found experimentally that bodies do not fall with velocities proportional to their weights, a conclusion received with hostility because it contradicted the accepted teaching of Aristotle. Galileo discovered that the path of a projectile is a parabola, and he is credited with anticipating Isaac Newton's laws of motion. In 1609, Galileo constructed the first astronomical telescope, which he used to discover the four largest satellites of Jupiter and the stellar composition of the Milky Way, and in 1632, he published his *Dialogue Concerning the Two Chief World Systems*, a work that upheld the Copernican system rather than the Ptolematic system and marked a turning point in scientific and philosophical thought.

In 1633, Galileo was brought before the Inquisition in Rome, he was made to renounce all his beliefs and writings supporting the Copernican theory. In spite of recanting, Galileo was condemned to house arrest by the Catholic Church where he remained under arrest until his death in 1642. His books were placed on the Index of Prohibited Books and remained there until 1835. Finally, in 1992, the Catholic Church formally apologized for its treatment of Galileo.

Web References

http://es.rice.edu/ES/humsoc/Galileo/

http://www.newadvent.org/cathen/06342b.htm

Johannes Kepler (1571-1630)

Johannes Kepler was born December 27, 1571, in Weil der Stadt, Württemburg, in the Holy Roman Empire. He was a sickly child and his parents were poor. But his evident intelligence earned him a scholarship to the University of Tübingen to study for the Lutheran ministry. There he was introduced to and delighted in the ideas of Copernicus. In 1596, while a mathematics teacher in Graz, he wrote the first outspoken defense of the Copernican system, the *Mysterium Cosmographicum*.

Kepler was forced to leave his teaching post at Graz due to the counter Reformation because he was Lutheran and moved to Prague to work with the renowned Danish astronomer, Tycho Brahe. He inherited Tycho's post as Imperial Mathematician when Tycho died in 1601. Using the precise data that Tycho had collected, Kepler discovered that the orbit of Mars was an ellipse. In 1609, he published *Astronomia Nova*, delineating his discoveries, which are now called Kepler's first two laws of planetary motion. And what is just as important about this work, it is the first published account where in a scientist documents how he has coped with the multitude of imperfect data to forge a theory of surpassing accuracy, a fundamental law of nature. Today we call this the scientific method.

In spite of more forced relocations, Kepler published the seven-volume *Epitome Astronomiae* in 1621. This was his most influential work and discussed all of heliocentric astronomy in a systematic way. He then went on to complete the *Rudolphine Tables* that Tycho had started long ago. These included calculations using logarithms, which he developed, and provided perpetual tables for calculating planetary positions for any past or future date. Kepler used the tables to predict a pair of transits by Mercury and Venus of the Sun, although he did not live to witness the events.

Johannes Kepler died in Regensburg in 1630, while on a journey from his home in Sagan to collect a debt. His grave was demolished within two years because of the Thirty Years War. Frail of body, but robust in mind and spirit, Kepler was scrupulously honest to the data.

Web References

http://www-groups.dcs.st-and.ac.uk/%7Ehistory/Biographies/Kepler.html

http://es.rice.edu/ES/humsoc/Galileo/People/kepler.html

René Descartes (1596-1650)

"If you would be a real seeker after truth, it is necessary that at least once in your life you doubt, as far as possible, all things."—Descartes

René Descartes is one of the most important Western philosophers of the last five centuries. During his lifetime, he was famous as an original physicist, physiologist and mathematician. But it is as a highly original philosopher that he is most frequently read today. He attempted to restart philosophy in a fresh direction.

For example, his philosophy refused to accept the Aristotelian and Scholastic traditions that had dominated philosophical thought throughout the Medieval period. In their place he attempted to fully integrate philosophy with the "new" sciences and change the relationship between philosophy and theology. Such new directions for philosophy made Descartes a revolutionary figure.

The two most widely known of Descartes' philosophical ideas are those of a method of hyperbolic doubt, and the argument that, though he may doubt, he cannot doubt that he exists. The first of these comprises a key aspect of Descartes' philosophical method. As noted above, he refused to accept the authority of previous philosophers, but he also refused to accept the obviousness of his own senses. In the search for a foundation for philosophy, whatever could be doubted must be rejected. He resolves to trust only that which is clearly and distinctly seen to be beyond any doubt. In this manner, Descartes peels away the layers of beliefs and opinions that clouded his view of the truth. But, very little remains, only the simple fact of doubting itself, and the inescapable inference that something exists doubting, namely Descartes himself.

His next task was to reconstruct our knowledge piece by piece, such that at no stage is the possibility of doubt allowed to creep back in. In this manner, Descartes proves that he himself must have the basic characteristic of thinking, and that this thinking thing (mind) is quite distinct from his body; the existence of a God; the existence and nature of the external world; and so on. What is important in this for Descartes is, first, that he is showing that knowledge is genuinely possible (and thus that skeptics must be mistaken), and, second, that, more particularly, a mathematically based scientific knowledge of the material world is possible.

Descartes' work was influential, although his studies in physics and the other natural sciences much less so than his mathematical and philosophical work. Throughout the 17th and 18th Centuries, Descartes' philosophical ghost was always present: Locke, Hume, Leibniz and even Kant felt compelled to philosophically engage (often negatively, of course) with this philosophical giant. For these reasons, Descartes is often called the 'father' of modern philosophy.

Web References

http://en.wikipedia.org/wiki/René_Descartes

http://www.iep.utm.edu/d/descarte.htm

Benedict de Spinoza (1632-1677)

Spinoza is one of the most important philosophers, and certainly one of the most radical, of the early modern period. His philosophy combines a commitment to Cartesian metaphysical and epistemological principles with elements from ancient Stoicism and medieval Jewish rationalism. His extremely naturalistic views on God, the world, human beings and knowledge serve to ground a moral philosophy centered on the control of the passions leading to virtue and happiness.

They also lay the foundations for a strongly democratic political thought and a deep critique of the pretensions of Scripture and sectarian religion. Of all the philosophers of the seventeenth-century, perhaps none have more relevance today than Spinoza.

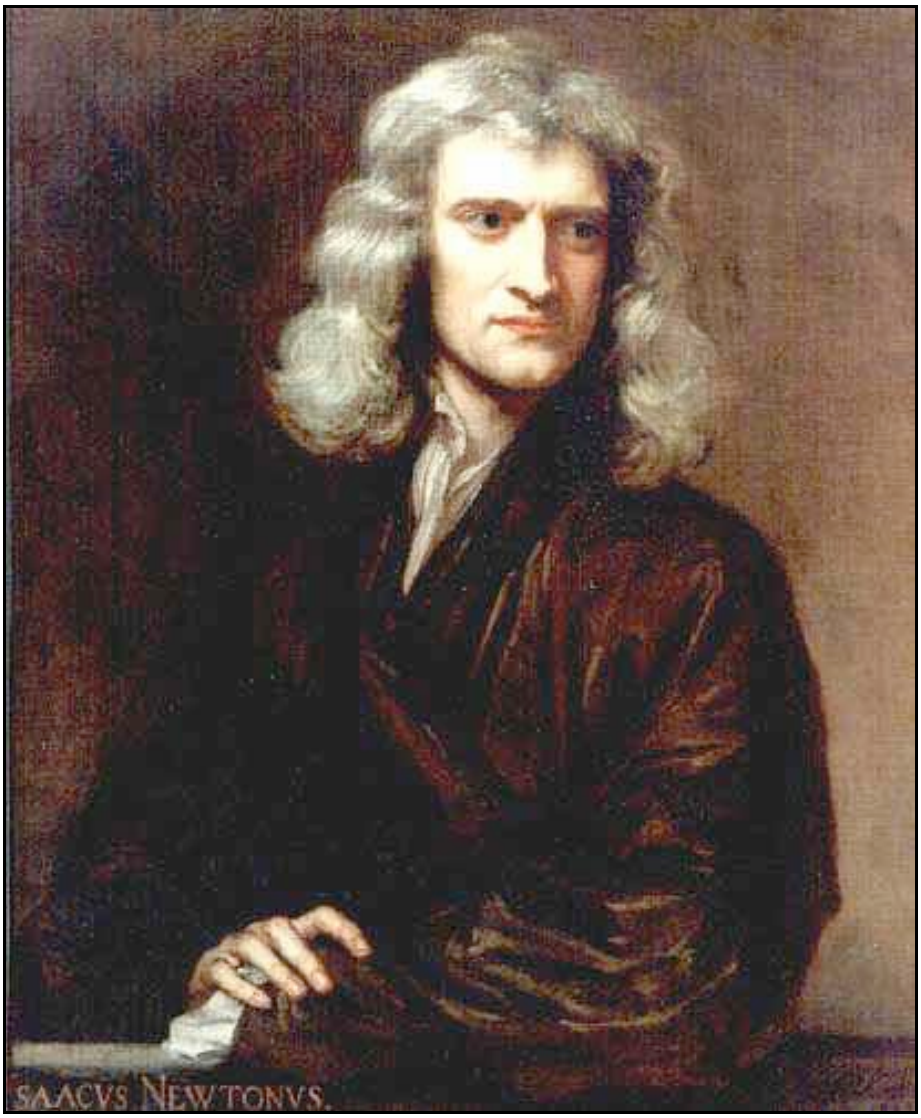
Benedict de Spinoza, also known as Baruch de Spinoza, was among the most important of the post-Cartesian philosophers who flourished in the second half of the 17th century. He made significant contributions in virtually every area of philosophy, and his writings reveal the influence of such divergent sources as Machiavelli, Hobbes, Descartes, and a variety of heterodox religious thinkers of his day. For this reason he is difficult to categorize, though he is usually counted, along with Descartes and Leibniz, as one of the three major Rationalists of the Age of Reason who laid the groundwork for the Enlightenment in the 18th-century.

Among philosophers, Spinoza is best known for his *Ethics*, a monumental work that presents an ethical vision unfolding out of a monistic metaphysics in which God and Nature are one. God is no longer the transcendent creator of the universe who rules it via providence, but Nature itself, understood as an infinite, necessary, and fully deterministic system of which humans are a part. The implications of this proposition are startling. Most obviously, the proposition marks a break with the substance pluralism advocated by the majority of philosophers in the west. Even Descartes, from whom Spinoza learned much in the area of metaphysics, posited a plurality of mental and physical substances, the most famous of which is the mind/body duality. More importantly, the proposition signals a rejection of classical theism, the idea that God is the creator of the universe who remains ontologically distinct from it and governs it according to his sovereign will. Because of this and other provocative positions he advocated, Spinoza has remained a controversial figure. But for many, he is seen as the harbinger of enlightened modernity. Spinoza's work has influenced a wide range of thinkers from Gottfried Leibniz and Immanuel Kant, to Albert Einstein.

Web References

http://en.wikipedia.org/wiki/Baruch_Spinoza

http://www.iep.utm.edu/s/spinoza.htm



Sir Isaac Newton (1642-1727)

> "I do not know what I seem to the world, but to myself I appear to have been like a boy playing upon the seashore and diverting myself by now and then finding a smoother pebble or prettier shell than ordinary, while the great ocean of truth lay before me all undiscovered."—Newton

Newton, mathematician and physicist, was one of the foremost scientific intellects of all time. Born at Woolsthorpe, near Grantham in Lincolnshire, where he attended school, he entered Cambridge University in 1661; he was elected a Fellow of Trinity College in 1667, and Lucasian Professor of Mathematics in 1669. He remained at the university, lecturing in most years, until 1696.

Of these Cambridge years, in which Newton was at the height of his creative power, he singled out 1665-1666 (spent largely in Lincolnshire because of plague in Cambridge) as "the prime of my age for invention". During two to three years of intense mental effort he prepared *Philosophiae Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*) commonly known as the *Principia,* although this was not published until 1687.

As a firm opponent of the attempt by King James II to make the universities into Catholic institutions, Newton was elected Member of Parliament for the University of Cambridge to the Convention Parliament of 1689, and sat again in 1701-1702. Meanwhile, in 1696, he had moved to London as Warden of the Royal Mint. He became Master of the Mint in 1699, an office he retained to his death. He was elected a Fellow of the Royal Society of London in 1671, and in 1703, he became President, being annually re-elected for the rest of his life. His major work, *Opticks,* appeared the next year; he was knighted in Cambridge in 1705.

As Newtonian science became increasingly accepted on the Continent, and especially after a general peace was restored in 1714, following the War of the Spanish Succession, Newton became the most highly esteemed natural philosopher in Europe. His last decades were passed in revising his major works, polishing his studies of ancient history, and defending himself against critics, as well as carrying out his official duties. Newton was modest, diffident, and a man of simple tastes. He was angered by criticism or opposition, and harbored resentment; he was harsh towards enemies but generous to friends. In government, and at the Royal Society, he proved an able administrator. He never married and lived modestly, but was buried with great pomp in Westminster Abbey.

Web References

http://www-groups.dcs.st-and.ac.uk/%7Ehistory/Biographies/Newton.html

http://www.newton.cam.ac.uk/newtlife.html

Voltaire (1694-1778)

"Those who can make you believe absurdities
can make you commit atrocities."—Voltaire

"The idea of a worldview has a long and distinguished philosophical ancestry, dating back at least as far as Voltaire, who used the notion to characterize the difference between Cartesian and Newtonian science."—Laudan 1996

Francois Marie Arouet (pen name Voltaire) was born on November 21, 1694 in Paris. Voltaire's style, wit, intelligence and keen sense of justice made him one of France's greatest writers and philosophers. In the 18th century, at a time when French culture dominated Europe, Voltaire dominated French culture. Paris society sought his company for his cleverness, humor and remarkable ability to write

verse. His writing includes a vast amount of work in almost every literary form, including 56 plays, dialogues, historical writing, stories and novels, poetry and epic poems, essays, scientific and learned papers, pamphlets, book reviews, and more than 20,000 letters.

In 1717, he was arrested for writing a series of satirical verses ridiculing the French government, and was imprisoned in the Bastille. During his eleven months in prison he wrote his first major play, "Oedipe," which achieved great success in 1718. He adopted his pen name "Voltaire" the same year. In 1726, Voltaire insulted a powerful young nobleman and was given two options: imprisonment or exile. He chose exile and from 1726 to 1729, lived in England. While in England Voltaire was attracted to the philosophy of John Locke and ideas of the great scientist Sir Isaac Newton. After his return to Paris he wrote a book praising English customs and institutions. The book was thought to criticize the French government and Voltaire was forced to flee Paris again.

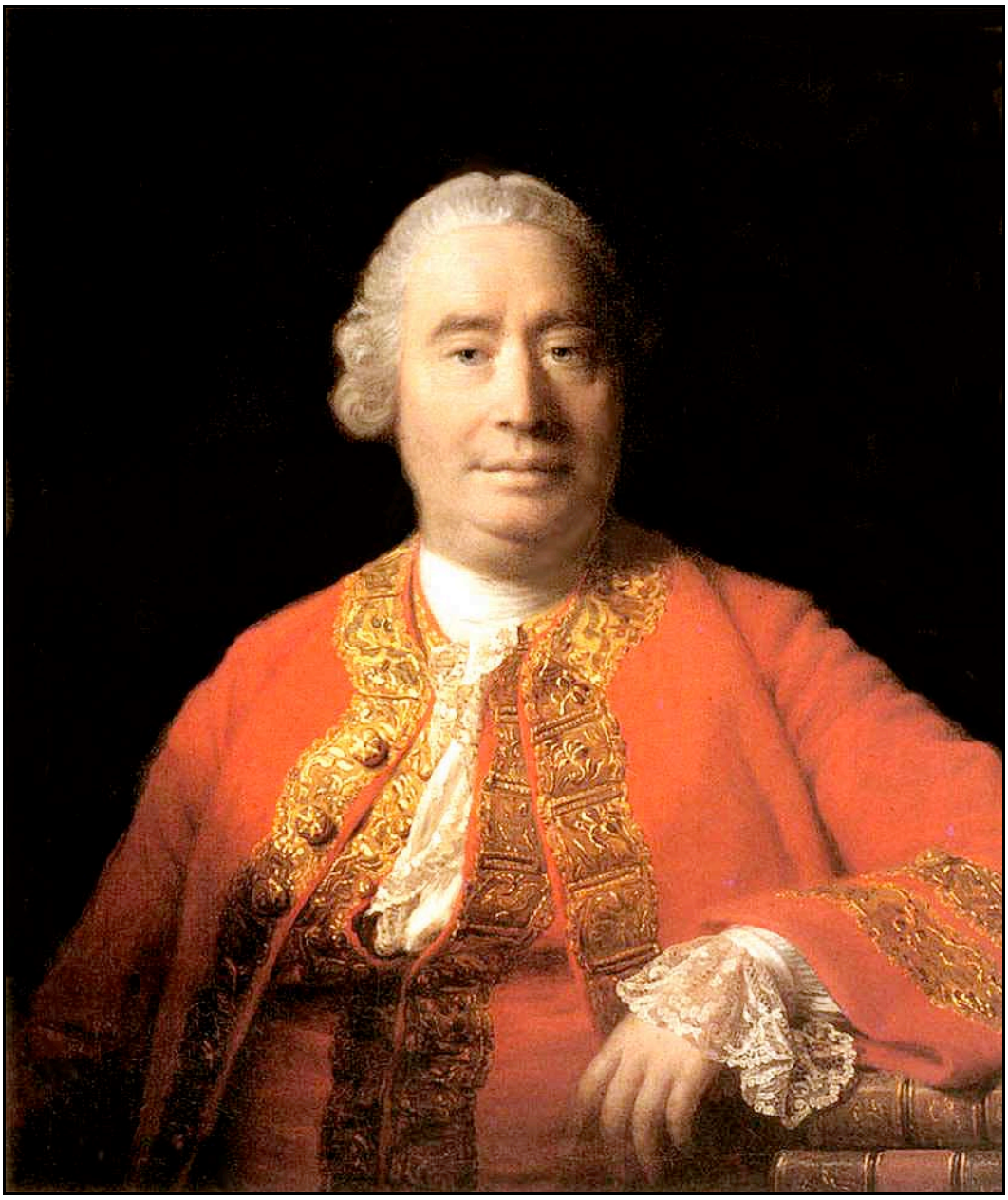
In 1759 Voltaire purchased an estate called "Ferney" near the French-Swiss border where he lived until just before of his death. Ferney soon became the intellectual capitol of Europe. Throughout his years in exile Voltaire produced a constant flow of books, plays, pamphlets, and letters. He was a voice of reason, and an outspoken critic of religious intolerance and persecution.

Voltaire returned to a hero's welcome in Paris at age 83. The excitement of the trip was too much for him and he died in Paris. Because of his criticism of the church Voltaire was denied burial in church ground. He was finally buried at an abbey in Champagne. In 1791, his remains were moved to a resting place at the Pantheon in Paris.

Web References

http://en.wikipedia.org/wiki/Voltaire

http://www.visitvoltaire.com/voltaire_bio.htm



David Hume (1711-1776)

Generally regarded as the most important philosopher ever to write in English, David Hume—the last of the great triumvirate of "British empiricists"—was also noted as an historian and essayist. A master stylist in any genre, Hume's major philosophical works—*A Treatise of Human Nature* (1739-1740), the *Enquiries concerning Human Understanding* (1748) and *Concerning the Principles of Morals* (1751), as well as the posthumously published *Dialogues concerning Natural Religion* (1779)—remain widely and deeply influential.

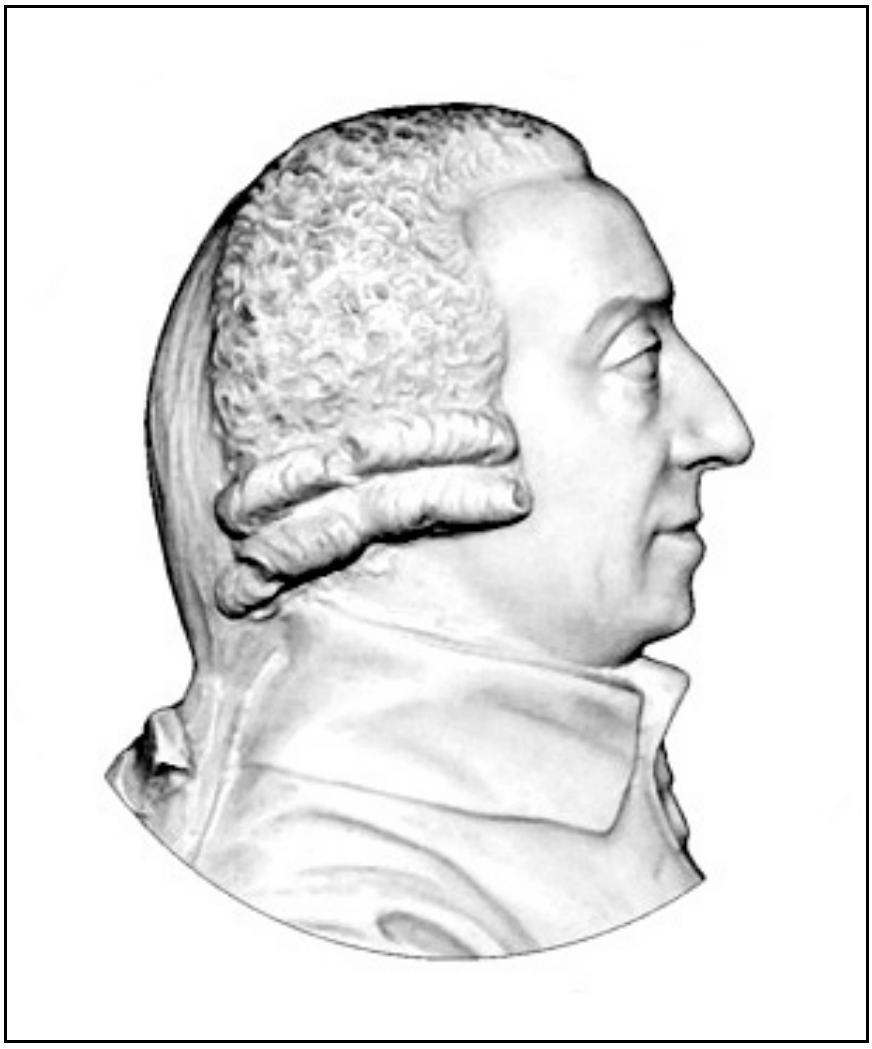
While Hume's influence is evident in the moral philosophy and economic writings of his close friend Adam Smith, he also awakened Immanuel Kant from his "dogmatic slumbers" and "caused the scales to fall" from Jeremy Bentham's eyes. Charles Darwin counted Hume as a central influence, as did "Darwin's bulldog," Thomas Henry Huxley. The diverse directions in which these writers took what they gleaned from reading Hume reflect not only the richness of their sources but also the wide range of Hume's empiricism. Contemporary philosophers recognize Hume as one of the most thoroughgoing exponents of philosophical naturalism.

Web References

http://plato.stanford.edu/entries/hume/

http://en.wikipedia.org/wiki/David_Hume

http://www.iep.utm.edu/h/humelife.htm



Adam Smith (1723-1790)

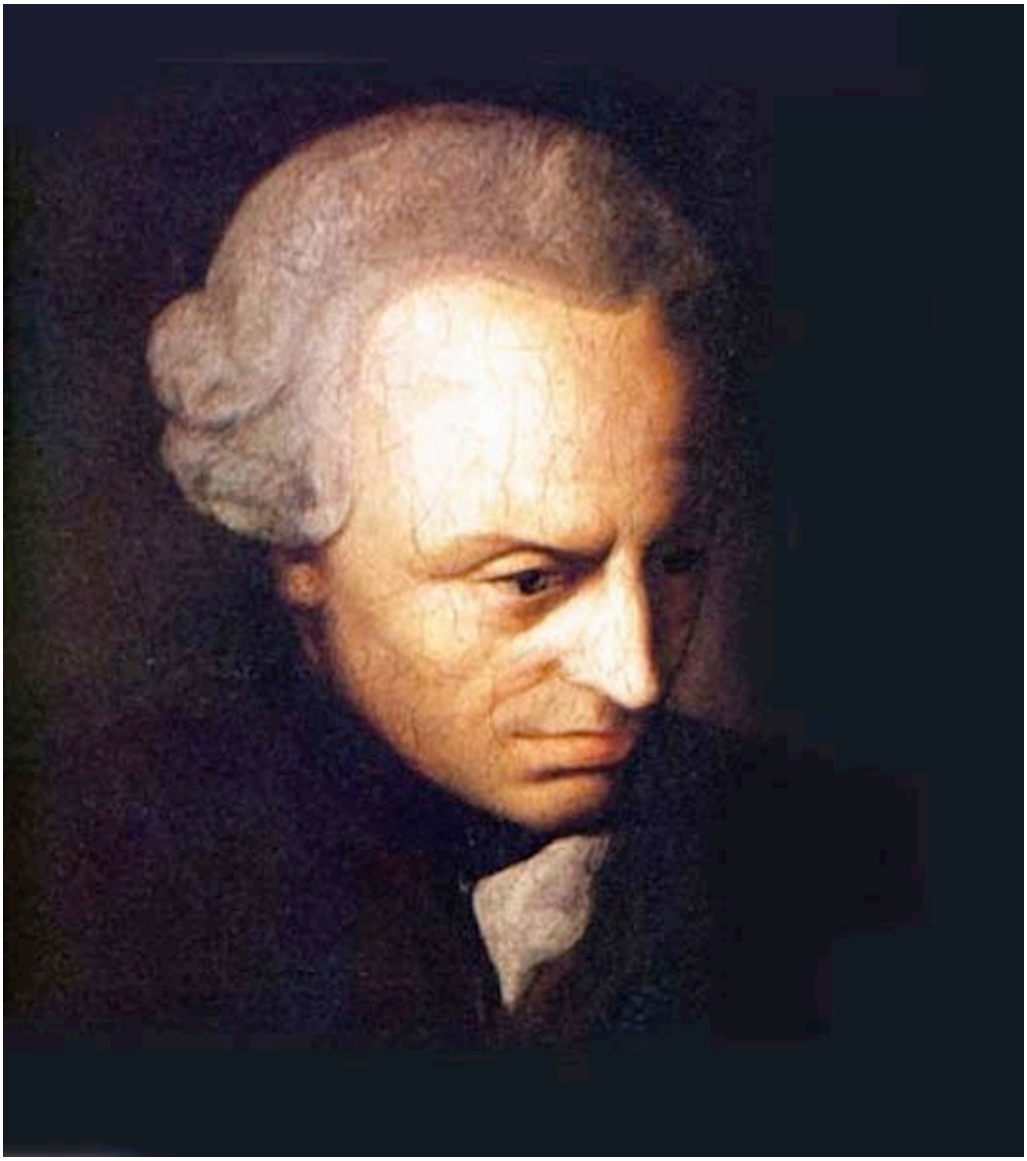
By publishing in 1776, *An Inquiry into the Nature and Causes of the Wealth of Nations*, Adam Smith founded the science of political economy. So significant were the effects of this book for the modern world that it has been described as one of the most important ever written. It is referred to in every history of the subject.

The basic doctrine of *The Wealth of Nations* was that labor is the only source of a nation's wealth. Smith advocated division of labor in the productive process, stressed the importance of individual enterprise and argued the benefits of free trade. The true wealth of a nation, he held, lay not in gold but in the achievement of an abundance of the necessities of life. He warned against unnecessary intervention by the state in this process.

Smith was born in Kirkcaldy, Fife, and his boyhood friends included the Adam brothers, destined to achieve their own fame as architects. As a child, Smith demonstrated an absence of mind which was to be a characteristic throughout his life. He was educated at Glasgow and Oxford, and in 1751, was appointed Professor of Logic at Glasgow University. Eight years later he published his *Theory of Moral Sentiments*, which established his reputation as an author.

The Wealth of Nations, which had been about ten years in the writing, was an immediate success and secured Smith's financial future. In the following year he made his home in Panmure House, which still stands in the Canongate. There he entertained his friends regularly, including such figures of the Enlightenment as the physicist Joseph Black, James Hutton the geologist, and David Hume.

Web Reference
http://en.wikipedia.org/wiki/Adam_Smith



Immanuel Kant (1724-1804)

Immanuel Kant was one of the greatest figures in the history of philosophy. After 1755, he taught at the University of Konigsberg and achieved wide renown through his teachings and writings. According to Kant, his reading of David Hume woke him from his dogmatic slumber and led him to become the "critical philosopher," synthesizing the rationalism of Leibniz and the skepticism of Hume.

Kant proposed that objective reality is known only insofar as it conforms to the essential structure of the knowing mind. Only objects of experience, phenomena, may be known, whereas things lying beyond experience, noumena, are unknowable, even though in some cases we assume a priori knowledge of them.

The existence of such unknowable "things-in-themselves" can be neither confirmed nor denied, nor can they be scientifically demonstrated. Therefore, as Kant showed in the *Critique of Pure Reason* (1781), the great problems of metaphysics—the existence of God, freedom, and immortality—are insoluble by scientific thought. Yet he went on to state in the *Critique of Practical Reason* (1788) that morality requires belief in their existence.

Kant's ethics centered on his categorical imperative, or absolute moral law, "Act as if the maxim from which you act were to become through your will a universal law." His *Critique of Judgment* (1790) considered the concepts of beauty and purposiveness as a bridge between the sensible and the intelligible worlds. Kant's influence on modern philosophy has continued to the present day. His work fostered the development of German idealism. The Neo-Kantianism of the late 19th century applied his insights to the study of the physical sciences, and to the historical and cultural sciences; his influence is also seen in the pragmatism of John Dewey and William James.

Web References

http://www.utm.edu/research/iep/k/kantmeta.htm

http://en.wikipedia.org/wiki/Immanuel_Kant

http://www.newadvent.org/cathen/08603a.htm

Erasmus Darwin (1731-1802)

"For Erasmus Darwin the theory of evolution was no mere scientific hypothesis but the very basis of his philosophy of life. For, if all forms of life have a common microscopic ancestor, we should look on the animals and insects as our cousins—

> 'man . . .
> Should eye with tenderness all living forms,
> His brother-emmets, and his sister-worms.'"—King-Hele 1999

Charles Darwin's grandfather, Erasmus Darwin, was one of the leading intellectuals of eighteenth century England, a man with a remarkable array of interests and pursuits. Erasmus Darwin was a respected physician, a well known poet, philosopher, botanist, and naturalist.

As a naturalist, he formulated one of the first formal theories on evolution in *Zoonomia*, or, *The Laws of Organic Life* (1794-1796). He also presented his evolutionary ideas in verse, in particular in the posthumously published poem *The Temple of Nature*. Although he did not come up with natural selection, he did discuss ideas that his grandson elaborated on sixty years later, such as how life evolved from a single common ancestor, forming "one living filament". He wrestled with the question of how one species could evolve into another. Although some of his ideas on how evolution might occur are quite close to those of Lamarck, Erasmus Darwin also talked about how competition and sexual selection could cause changes in species: "The final course of this contest among males seems to be, that the strongest and most active animal should propagate the species which should thus be improved". Erasmus Darwin arrived at his conclusions through an "integrative" approach: he used his observations of domesticated animals, the behavior of wildlife, and he integrated his vast knowledge of many different fields, such as paleontology, biogeography, systematics, embryology, and comparative anatomy.

In addition to Erasmus Darwin's contributions to the future of biological studies, he was also a leader in an intellectual community that contributed to the emergence of the industrial era. Among his intellectual peers were James Watt, Matthew Boulton, Joseph Priestly, and Josiah Wedgwood. It is probably no coincidence that Charles Darwin, the grandson of such a progressive thinker, produced some of the most important work in the history of biological and social thought.

Web References

http://www.ucmp.berkeley.edu/history/Edarwin.html

http://en.wikipedia.org/wiki/Erasmus_Darwin

Antoine-Laurent Lavoisier (1743-1794) and his wife,
Marie-Anne Pierrette Paulze (1758-1836)

In this 1788, painting by Jacques-Louis David, Lavoisier is pictured in his study with his wife, Marie-Anne, whose drawings illustrated all of his works. To the right of the quill pens is a gasometer of the type Lavoisier used to determine the composition of air in the 1780s.

Antoine-Laurent Lavoisier, chemist, philosopher, economist was born in Paris on August 26, 1743, and guillotined May 8, 1794. He was the son of Jean-Antoine Lavoisier, a lawyer of distinction, and Emilie Punctis, who belonged to a rich and influential family. She died when Antoine-Laurent was five years old.

Lavoisier began his career by entering the profession of the law, but soon abandoned this to return to his favorite studies of chemistry and mineralogy. His first scientific communication to the French Academy of Sciences was on the composition and properties of gypsum and plaster of Paris, and is still, today, a classic and valuable contribution to our knowledge of crystallizing cements. He early on learned to use the balance for help in defining facts, and found its great value particularly when he began to study the phenomena we now know as "combustion" or oxidation, and "reduction" or deoxidation.

The chemical philosophers of the day taught that there was something in every combustible substance which was driven out by the burning, and that the reduction of an oxide of a metal to the metallic state meant the absorption of this substance or principle, which Stahl had called phlogiston. Lavoisier studied the teaching of the phlogistonists, but having also mastered physics and pneumatic experimentation he became dissatisfied with their theory. He seized upon two important discoveries, that of oxygen by Priestley in 1774, and of the compound nature of water by Cavendish in 1781. Lavoisier by a masterly stroke of genius reconciled discordant appearances and illuminated every phase of reacting elements. His theory, for a long time thereafter was known as the antiphlogists' theory, as it was the reverse of the phlogistonists. It stated that something was absorbed when combustion took place; that it was obtained from the surrounding air; that the increase in the weight of a metallic substance when burned was equal to the decrease in the weight of the air used; that most substances thus burned were converted into acids, or metals into metallic oxides. Priestly had called this absorbed substance dephlogisticated air; Lavoisier called it "air strictly pure" or "very respirable air" as distinct from the other and non-respirable constituent of the atmosphere. Later, he named it "oxygen" because it was acid-making (*oxys*, and *geinomai*).

A great change ensued in experimental chemistry, and in theory and nomenclature, and such a mass of facts was coordinated and explained by Lavoisier that he has been justly called "the father of modern chemistry." He was the first to explain definitely, the formation of acids and salts, to enunciate the principle of conservation as set forth by chemical equations, to develop quantitative analysis, gas analysis, and calorimetry, and to create a consistent

system of chemical nomenclature. His memoirs and contributions to the French Academy were extraordinary in number and variety.

His life in other areas was romantic, full of interest and a social triumph, but sadly destined to end in tragedy. Happily married, his wife help him in conducting and recording of his experiments. And he drew around his fireside and to his library at the State Gunpowder Works a circle of brilliant French savants and distinguished travelers from other lands.

Early in his career he felt the need to increase his resources to meet the cost of his scientific experiments. With this in view he became a deputy *fermier-général*, which increased his income considerably. But joining this association of State protected tax collectors only prepared the way for many years of bitter attack and a share of the public odium attached to their privilege. Having incurred the hatred of Marat he found himself, together with his fellow *fermiers-général*, growing more and more unpopular during the terrible days of the Revolution.

Finally in 1794, he was imprisoned with twenty-seven others. A farcical trial speedily followed and he and his companions, amongst them Jacques Alexis Paulze, his father-in-law, were condemned to death. Before his own death Lavoisier, who was devoted to him, was forced to watch M. Paulze's head fall under the guillotine on May 8, 1794. Lavoisier was 51 years old. His goods and chattels and all his scientific instruments were appropriated on the day following his execution, though Mme Lavoisier succeeded in having some restored to her. She was childless and long survived her husband, dying in 1836, at the age of 78.

Web References

http://en.wikipedia.org/wiki/Antoine_Lavoisier

http://en.wikipedia.org/wiki/Marie-Anne_Pierrette_Paulze

http://www.bc.edu/bc_org/avp/cas/his/CoreArt/art/neocl_dav_lavois.html

William Whewell (1794-1866)

Whewell was one of the most important and influential figures in nineteenth-century Britain. Whewell, a polymath, wrote extensively on numerous subjects, including mechanics, mineralogy, geology, astronomy, political economy, theology, and architecture, as well as the works that remain the most well-known today in philosophy of science, history of science, and moral philosophy. He was one of the founding members and an early president of the British Association for the Advancement of Science, a fellow of the Royal Society, president of the Geological Society, and longtime Master of Trinity College, Cambridge.

In his own time his influence was acknowledged by the major scientists of the day, such as John Herschel, Charles Darwin, Charles Lyell and Michael Faraday, who frequently turned to Whewell for philosophical and scientific advice, and, interestingly, for terminological assistance. Whewell invented the terms "anode," "cathode," and "ion" for Faraday. Upon the request of the poet Coleridge in 1833, Whewell invented the English word "scientist;" before this time the only terms in use were "natural philosopher" and "man of science."

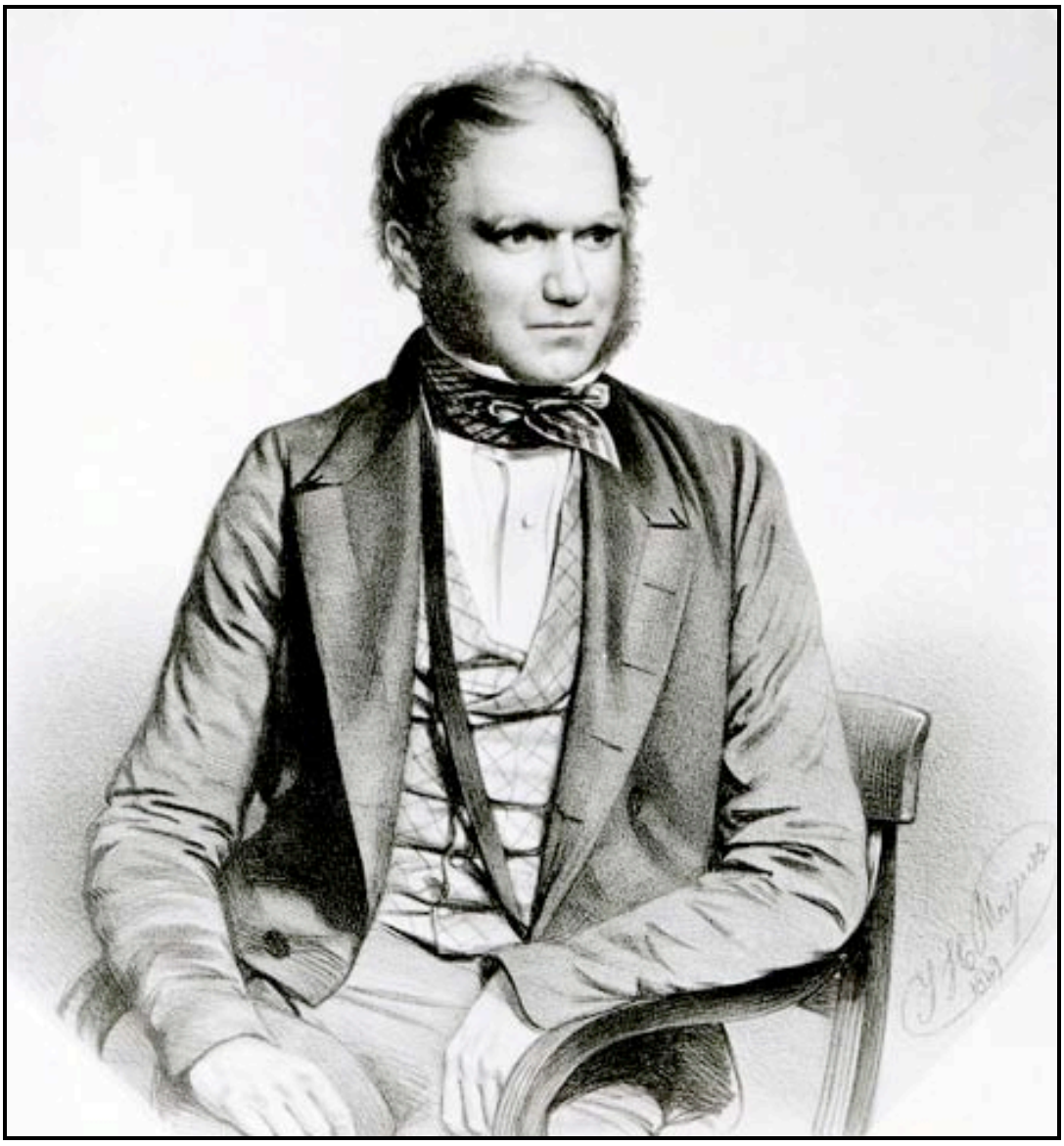
Whewell is most known today for his massive works on the History and Philosophy of Science. His philosophy of science was attacked by John Stuart Mill in his *System of Logic*, causing an interesting and fruitful debate between them over the nature of inductive reasoning in science. It is in the context of this debate that Whewell's philosophy was rediscovered in the 20th century by critics of logical positivism.

Web References

http://en.wikipedia.org/wiki/William_Whewell

http://cepa.newschool.edu/het/profiles/whewell.htm

http://plato.stanford.edu/entries/whewell/



Charles Darwin (1809-1882)

Darwin, whose life spanned much of the nineteenth century, is the most influential biologist to have ever lived. Not only did he change the course of biological science but he changed forever how philosophers and theologians conceive of man's place in nature.

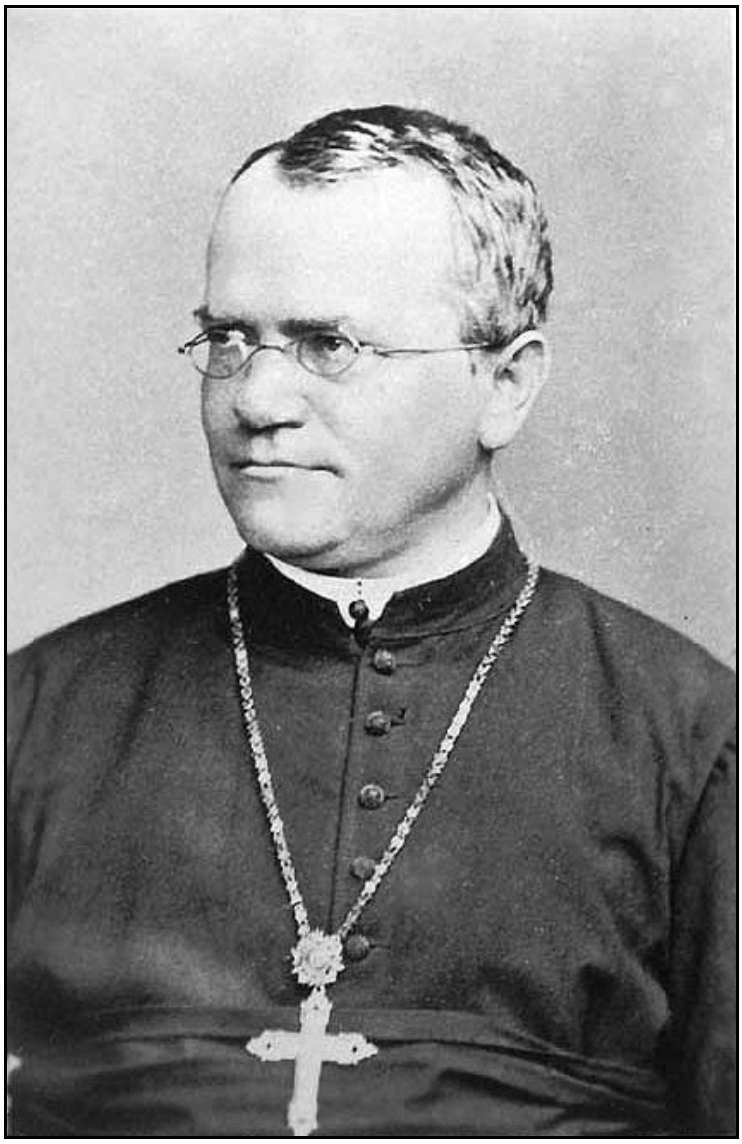
"The concept of evolution, which seems so obvious to us today, emerged only in the eighteenth century. Immanuel Kant's assertion that the universe was the product of slow change over eons of time was among the earliest examples of an evolutionary outlook. Another was the recognition by geologists that the earth, too, had a history, that it had not always been as it appeared. Once there had been mountains where there were plains, seas where deserts now stood. Others applied the idea of slow change over time to living nature, seeing an evolution of animals from simple to complex forms. Among such proponents was Erasmus Darwin, the grandfather of Charles. In more ways than one, in short, Charles Darwin's work is best seen as the culmination rather than the initiation of a line of thought that saw evolutionary change in man and nature. Yet simply because Darwin was the culmination, he shaped men's thinking about evolution and man's relations to animals. He rephrased, as no one before him, what it meant to be human."—Degler 1991, p. 5-6

Web References

http://en.wikipedia.org/wiki/Charles_Darwin

http://www.talkorigins.org/faqs/darwin-precursors.html

http://www.csuchico.edu/~curban/Darwin/DarwinSem-S95.html



Gregor Mendel (1822-1884)

Mendel is often portrayed as an obscure monk working quietly in a monastery garden somewhere in the backwaters of Europe. But was Mendel's discovery of the mechanism of inheritance really an isolated incident far removed from the rest of science in the nineteenth century?

Mendel lived and worked most of his life in the city of Brno, located 110 kilometers (70 miles) north of Vienna, then capital of the Austrian Empire. At the start of the nineteenth century, Brno became the center of the textile industry of the Hapsburg monarchy. To improve wool production through scientific breeding, those concerned with textile development promoted the natural sciences by organizing learned societies. In 1806, the Moravian Society for the Improvement of Agriculture, Natural Science, and Knowledge of the Country (later referred to as

the Agricultural Society) was inaugurated. The accomplished naturalist Christian Carl Andre was one of its foremost figures, and in 1815, drew up a program of scientific development for the Society that emphasized the importance of developing basic and applied research in the natural sciences. From this progressive beginning the Agricultural Society continued to promote the scientific study of plant and animal breeding during the following decades.

Parallel to these developments, Emperor Franz I in 1807, ordered that the members of the Brno Augustinian monastery take on the teaching of mathematics and biblical studies in the newly established Philosophy Institute. C. F. Napp, Mendel's predecessor as abbot of the Brno monastery, accepted with enthusiasm the imperial directive for the monastery to prepare its monks for the teaching profession: the interpretation he put upon it was that they should assist in spreading the word on the latest scientific findings.

In 1849, Mendel was sent by Abbot Napp to the University of Vienna to study science in preparation for teaching. Specifically, Napp sent Mendel to study exact physics at the newly established institute headed by Professor Christian Doppler, discoverer of the Doppler effect. Before coming to Vienna Doppler had taught mathematics and the second edition of his arithmetic and algebra textbook was published during Mendel's studies in Vienna. In it Doppler outlined the principles of combinatorial theory and the theory of probability in relation to the needs of applied science. Doppler's teaching emphasized experimental research and how to solve scientific problems. Mendel would later use these principles in his research on plant hybridization.

In addition to Doppler's influence, a book which may have been of major importance to Mendel was that published by the Viennese astronomer L.L. Littrow, who informed his readers of the probability theory developed by his fellow astronomer P. S. de Laplace (1749-1827) and fellow mathematician J.F.K. Gauss (1777-1827). According to Littrow: "All phenomena, even those which seem most dependent on pure chance, exhibit, when they are repeated often enough, a tendency to more and more constant relations, and are subject to some usually very simple law."

In addition to physics Mendel also signed on for additional lectures in mathematics, chemistry, zoology, botany, the physiology of plants, and paleontology. Plant physiology was a new subject at the University of Vienna and was taught by F. Unger (1800-1870). Unger's scientific orientation was significantly influenced by J.M. Schleiden (1804-1881), who is associated with the development of the cell theory in plants. In his most outstanding work, *Principles of Scientific Botany*, Schleiden stated that he was above all offering a guide to the new manner of researching into plants. Schleiden's masterpiece was bought by Mendel, and it can be assumed that he read the methodological part of it. His

research was conducted in accordance with Schleiden's maxims. Unger had a tremendous influence on Mendel. In addition to introducing Mendel to the work of Schleiden, his writings on the hybridization of plants also drew attention to the use of the artificial pollination of plants to create new varieties. Unger's lectures aroused the interest of his students not only in study, but also in experimentation.

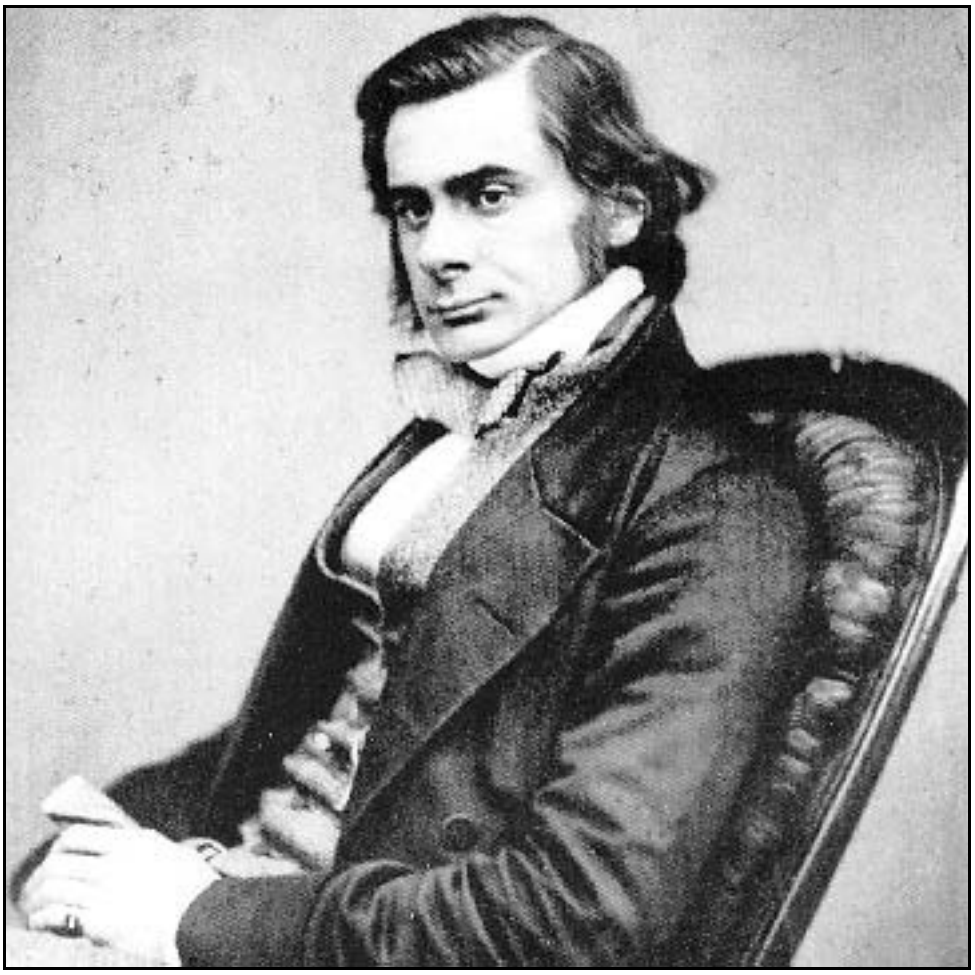
Mendel finished his university studies in 1853. In 1854, Professor Zawadski of the Brno *Realschule* (equivalent to a modern technical high school) proposed to the Natural Science Section of the Agricultural Society that his young colleague, the new physics teacher at the *Realschule*, Friar Gregor Mendel, should be confirmed as a full member. Professor Zawadski nurtured his students' interest in the natural sciences at the *Realschule*, and in the learned societies he belonged to he encouraged members to perform research. In the year Mendel was inducted into the Agricultural Society, Zawadski had given a series of three lectures to the Society on the enigma of procreation, which must have fascinated Mendel, since he had attended Professor Unger's lectures on the same topic, and it was closely connected with the subject of his own research.

In 1859, a new society was formed from the Natural Science Section of the Agricultural Society. The Natural Science Society was formed to devote its members to "pure science" as opposed to applied. Mendel was one of the 142 founding members. In 1865, Mendel presented a paper to the Natural Science Society entitled *Experiments in Plant-Hybridization*, and with it the modern science of genetics began.

Why was Mendel so far ahead of his time, i.e. with his application of reductionism and statistics to biology? Mendel is one of the first examples, if not the first, of a scientist trained in the physical sciences that went on to make major contributions to biology. Fisher, Haldane, Sewall Wright, Max Delbruk, and John Maynard Smith are later examples of this tradition. And common to all is their skill in mathematics and commitment to the reductionist program. Mendel, because of his training, was simply fifty years ahead of his contemporaries in biology, almost all of whom were innumerate.

Excerpts from *Gregor Mendel—the First Geneticist* by Vitezslav Orel (1996)

Web Reference
http://en.wikipedia.org/wiki/Gregor_Mendel



Thomas Henry Huxley (1825-1895)

T. H. Huxley was the first to forge the connection between professional scientists and public education, i.e. with the training of science teachers and the link to training doctors. Huxley was also an example of the new breed of scientists who relied solely on their income earned as a professional scientist. Darwin, in contrast, was independently wealthy and did all of his research without having a professional position.

Thomas Henry Huxley was born at Ealing, near London, and, having studied medicine, went to sea as assistant surgeon in the navy. After leaving government service, he became Professor of Natural History at the Royal School of Mines, and Fullerian Professor of Physiology at the Royal Institution, and later held many commissions and received many distinctions in the scientific world. His special field was morphology, and in it he produced a large number of monographs and several comprehensive manuals.

It is not, however, by his original contributions to knowledge that Huxley's name is best known to readers outside of technical science, but rather by his labors in popularization and in polemics. He was one of the foremost and most effective champions of Darwinism, and no scientist has been more conspicuous in the battle between the doctrine of evolution and religious orthodoxy. Outside of this particular issue, he was a vigorous opponent of supernaturalism in all its forms, and a supporter of the agnosticism which demands that nothing shall be believed "with greater assurance than the evidence warrants", the evidence intended being, of course, of the same kind as that admitted in natural science.

Huxley's interests thus extended from pure science into many adjoining fields, such as those of theology, philosophy (where he wrote an admirable book on Hume), and education. Of his attitude toward this last, a clear idea may be gained from his address on "Science and Culture," a singularly forcible plea for the importance of natural science in general education.

In all his writings Huxley commands a style excellently adapted to his purpose: clear, forcible, free from mannerism, yet telling and often memorable in phrase. Whatever may be the exact magnitude of his services to pure science, he was a master in the writing of English for the purposes of exposition and controversy, and a powerful intellectual influence on all the classes of his generation.

Web References

http://www.ucmp.berkeley.edu/history/thuxley.html

http://aleph0.clarku.edu/huxley/

John Dewey (1859-1952)

> "The conditions that generate insecurity for the many no longer spring from nature. They are found in institutions and arrangements that are within deliberate human control. Surely this change marks one of the greatest revolutions that has taken place in all human history."—John Dewey from *Liberalism and Social Action*, 1935

Dewey was an American psychologist, philosopher, educator, social critic and political activist. He was born in Burlington, Vermont, on October 20, 1852. Dewey graduated from the University of Vermont in 1879, and received his Ph.D. from Johns Hopkins University in 1884.

While at the University of Vermont, Dewey was exposed to evolutionary theory through the teaching of G.H. Perkins and *Lessons in Elementary Physiology*, a text by T.H. Huxley, the famous English evolutionist. The theory of natural selection continued to have a life-long impact upon Dewey's thought, suggesting the barrenness of static models of nature, and the importance of focusing on the interaction between the human organism and its environment when considering questions of psychology and the theory of knowledge.

He started his professional career at the University of Michigan, teaching there from 1884 to 1894. In 1894, he became the chairman of the department of philosophy, psychology, and pedagogy at the University of Chicago. Dewey taught at Columbia University from 1904 until he retired in 1930, and was professor emeritus until 1939.

Dewey never ignored American social issues; he was outspoken on education, domestic and international politics, and numerous social movements. Among the many concerns that attracted Dewey's support were women's suffrage, progressive education, educator's rights, the Humanistic movement, and world peace. On June 1, 1952, Dewey died in New York City.

Dewey made major contributions to nearly every aspect of philosophy. Besides his role as a primary originator of both functionalist and behaviorist psychology, Dewey was a top-rank contributor to the empiricist, naturalist, contextualist, and process traditions of philosophy. Dewey ranks with the greatest philosophers of this or any age on the subjects of pedagogy, philosophy of mind, metaphysics, epistemology, philosophy of science, and social and political theory. All of this combined with his pragmatic approaches to ethics, aesthetics, and religion assures his stature as one of the 20th century's premier philosophers.

Web References

http://www.utm.edu/research/iep/d/dewey.htm

http://en.wikipedia.org/wiki/John_Dewey

Albert Einstein (1879-1955)

(photograph taken in 1912)

“A human being is part of the whole, called by us 'Universe'; a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest—a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and affection for a few persons nearest us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.”—Einstein, as quoted in *Quantum Reality, Beyond the New Physics*

Einstein was born at Ulm, in Württemberg, Germany, on March 14, 1879. Soon after the family moved to Munich. Einstein began his schooling at the Luitpold Gymnasium in Munich. Later, his family moved to Italy and Albert continued his education at Aarau, Switzerland. In 1896, he entered the Swiss Federal Polytechnic School in Zurich to be trained as a teacher in physics and mathematics. In 1901, the year he gained his diploma, he acquired Swiss citizenship and, as he was unable to find a teaching post, he accepted a position as technical assistant in the Swiss Patent Office. In 1905 he obtained his doctor's degree.

During his time working at the Patent Office, he produced much of his remarkable work, and in 1908, he was appointed Privatdozent in Berne. In 1909, he became Professor Extraordinary at Zurich, in 1911, Professor of Theoretical Physics at Prague, returning to Zurich in the following year to fill a similar post. In 1914, he was appointed Director of the Kaiser Wilhelm Physical Institute and Professor in the University of Berlin. He became a German citizen in 1914, and remained in Berlin until 1933, when he renounced his citizenship for political reasons and emigrated to America to take the position of Professor of Theoretical Physics at the Institute for Advanced Study, Princeton. He became a United States citizen in 1940, and retired from his post in 1945.

At the start of his scientific work, Einstein realized the inadequacies of Newtonian mechanics and his special theory of relativity stemmed from an attempt to reconcile the laws of mechanics with the laws of the electromagnetic field. He dealt with classical problems of statistical mechanics and problems in which they were merged with quantum theory: This led to an explanation of the Brownian movement of molecules. He investigated the thermal properties of light with a low radiation density and his observations laid the foundation of the photon theory of light.

In his early days in Berlin, Einstein postulated that the correct interpretation of the special theory of relativity must also furnish a theory of gravitation and in 1916, he published his paper on the general theory of relativity. During this time he also contributed to the problems of the theory of radiation and statistical mechanics. In the 1920's, Einstein embarked on the construction of unified field theories, although he continued to work on the probabilistic interpretation of quantum theory, and he persevered with this work in America. He contributed to statistical mechanics by his development of the quantum theory of a monatomic gas and he also accomplished valuable work in connection with atomic transition probabilities and relativistic cosmology. After his retirement he continued to work

towards the unification of the basic concepts of physics, taking the opposite approach, geometrisation, to the majority of physicists.

Einstein's researches are, of course, well chronicled and his more important works include *Special Theory of Relativity* (1905), *Relativity* (English translations, 1920 and 1950), *General Theory of Relativity* (1916), *Investigations on Theory of Brownian Movement* (1926), and *The Evolution of Physics* (1938). Among his non-scientific works, *About Zionism* (1930), *Why War?* (1933), *My Philosophy* (1934), and *Out of My Later Years* (1950) are perhaps the most important.

Albert Einstein received honorary doctorate degrees in science, medicine and philosophy from many European and American universities. During the 1920's he lectured in Europe, America and the Far East and he was awarded Fellowships or Memberships of all the leading scientific academies throughout the world. He gained numerous awards in recognition of his work, including the Nobel Prize in Physics in 1921, the Copley Medal of the Royal Society of London in 1925, and the Franklin Medal of the Franklin Institute in 1935.

Einstein's gifts inevitably resulted in his dwelling much in intellectual solitude and, for relaxation, music played an important part in his life. He married Mileva Maritsch in 1901 and they had two sons; their marriage was dissolved and in 1917 he married his cousin, Elsa Einstein, who died in 1936. He died on April 18, 1955 at Princeton, New Jersey.

Web References

http://en.wikipedia.org/wiki/Albert_Einstein

http://nobelprize.org/nobel_prizes/physics/laureates/1921/

http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/General_relativity.html

Sir Karl Popper (1902-1994)

Sir Karl Raimund Popper was born in Vienna on July 28, 1902. His rise from a modest background as an assistant cabinet maker and school teacher to one of the most influential theorists and leading philosophers was characteristically Austrian. Popper commanded international audiences and conversation with him was an intellectual adventure—even if a little rough—animated by a myriad of philosophical problems. His intense desire to tear away at the veneer of falsity in pursuit of the truth lead him to contribute to a field of thought encompassing (among others) political theory, quantum mechanics, logic, scientific method and evolutionary theory.

Popper challenged some of the ruling orthodoxies of philosophy: logical positivism, Marxism, determinism and linguistic philosophy. He argued that there are no subject matters but only problems and our desire to solve them. He said that scientific theories cannot be verified but only tentatively refuted, and that the best

philosophy is about profound problems, not word meanings. Isaiah Berlin rightly said that Popper produced one of the most devastating refutations of Marxism.

Through his ideas Popper promoted a critical ethos, a world in which the give and take of debate is highly esteemed in the precept that we are all infinitely ignorant, that we differ only in the little bits of knowledge that we do have, and that with some co-operative effort we may get nearer to the truth. Nearly every first-year philosophy student knows that Popper regarded his solutions to the problems of induction and the demarcation of science from pseudo-science as his greatest contributions.

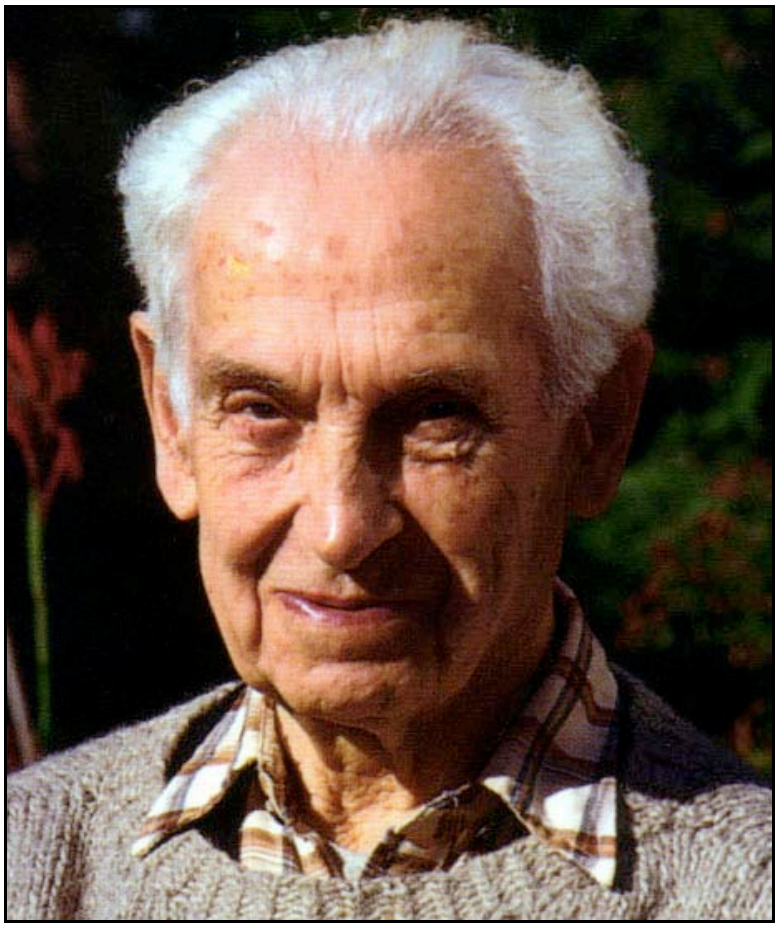
Popper was a Fellow of the Royal Society, Fellow of the British Academy, and Membre de I'Institute de France. He was an Honorary member of the Harvard Chapter of Phi Beta Kappa, and an Honorary Fellow of the London School of Economics, King's College London, and of Darwin College Cambridge. He was awarded prizes and honors throughout the world, including the Austrian Grand Decoration of Honor in Gold, the Lippincott Award of the American Political Science Association, and the Sonning Prize for merit in work which had furthered European civilization.

Karl Popper was knighted by Queen Elizabeth II in 1965, and invested by her with the Insignia of a Companion of Honor in 1982. Sir Karl Popper, who died on 17th September 1994, will continue to stimulate the best minds through his work, which now has a life of its own.

Web References

http://www.eeng.dcu.ie/~tkpw/intro_popper/intro_popper.html

http://plato.stanford.edu/entries/popper/

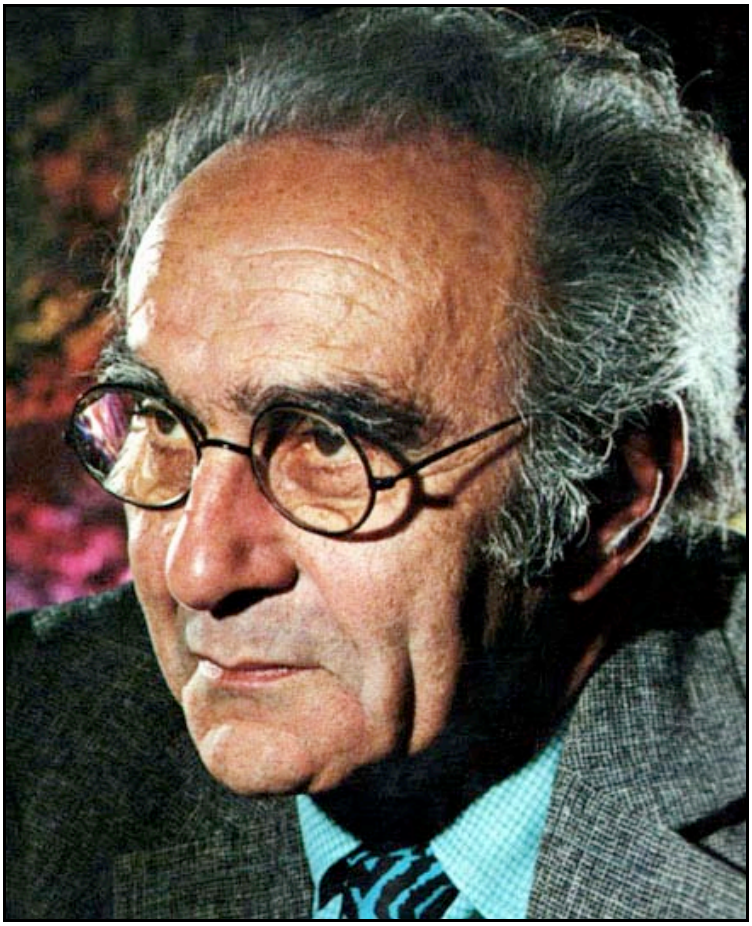


Ernst Mayr (1905-2005)

"For biologists of today, evolution is no longer a hypothesis but simply a fact, documented by the changes in the gene pools of species from generation to generation and by the changes in the fossil biota in accurately dated geological strata. Current resistance is limited entirely to opponents with religious commitments."—Mayr 1982

Ernst Mayr was one of the 20th century's leading biologists. His work contributed to the conceptual revolution that led to the synthesis of Mendelian genetics and Darwinian evolution. His most important work on the history and philosophy of science is his 1982 book *The Growth of Biological Thought: Diversity, Evolution, and Inheritance*. His last book, *What Evolution Is*, was published when he was ninety-six. Mayr was Emeritus Professor of Zoology at Harvard University until his death. He died in 2005, at the age of one hundred.

Web Reference
http://www.edge.org/3rd_culture/bios/mayr.html



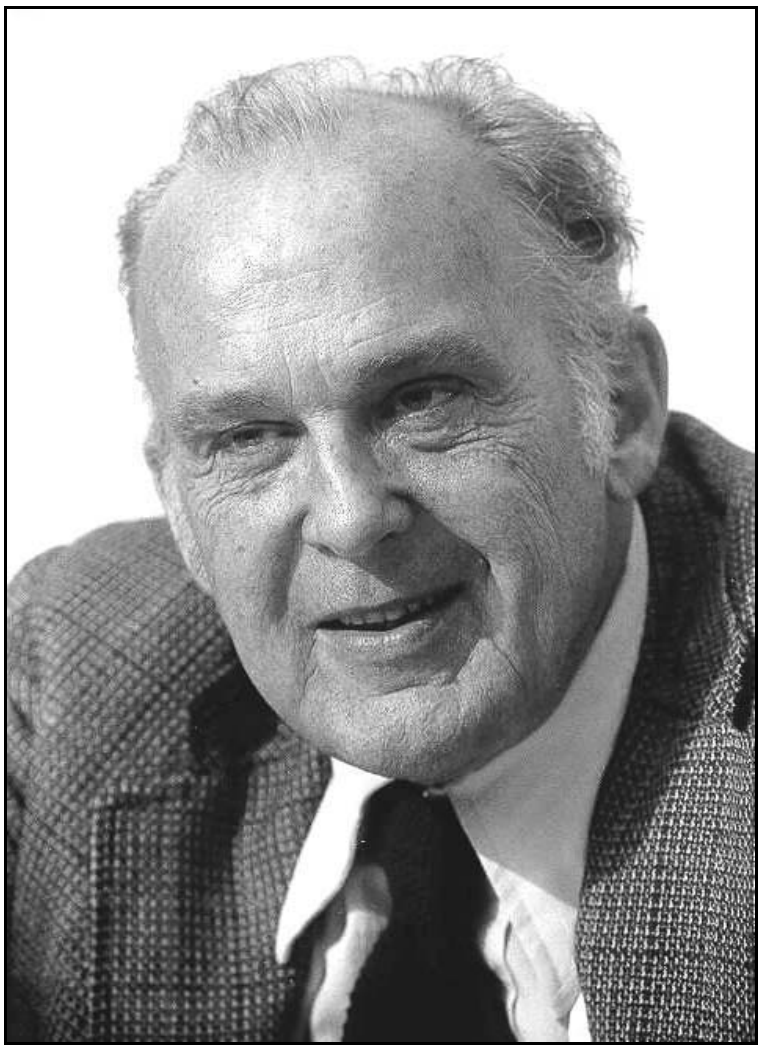
Jacob Bronowski (1908-1974)

"I hold that the scientific revolution from 1500 onward was an essential part of the Renaissance, ..." "Since that time we have been in the unique position of trying to form a single picture of the whole of nature including man. That is a new enterprise; it differs from the preceding enterprises in that it's not magical, by which I mean that it does not suppose the existence of two logics, a natural logic and a supernatural logic."—Bronowski 1978

Bronowski, Polish-born, British mathematician and man of letters, eloquently presented the case for the humanistic aspects of science. His best known book, *Science and Human Values* (1956), still provides one of the best portraits of the common ground between science and the humanities. His last major project was the authorship and narration of the BBC television series *The Ascent of Man* (1973), a brilliant account of science, art, and philosophy in human history. From 1964 until his death Bronowski was a resident fellow of the Salk Institute of Biological Sciences.

Web Reference

http://www-groups.dcs.st-and.ac.uk/%7Ehistory/Biographies/Bronowski.html



Donald T. Campbell (1917-1996)

> "Donald T. Campbell, one of the most respected philosophers of science of this century, had a vision of science in which flawed, venal people together yield the noblest of products. His hypothetical realism is addressed to those with faith that science edges towards truth, and shows us how—via variation and selective retention, and competition among the cooperators—ego-involved, over-committed, and under-informed mortals could bring this about."—Heyes 1997

Dr. Campbell was by training and his Berkeley doctorate a social psychologist, but it was a tribute to his bewildering range as a master methodologist that when he took up his last academic post, at Lehigh University, in 1982, university officials threw up their hands and simply designated him

"university professor," with faculty listings in the departments of psychology, sociology and anthropology and the department of education.

They could easily have thrown in biology, the philosophy of science and market research. For a generation, virtually no respectable researcher this side of the chemistry lab has designed or carried out a reputable scientific study without a thorough grounding in what Dr. Campbell called quasi-experimentation, the highly sophisticated statistics-based approach he invented to replicate the effects of the truly randomized scientific studies that are all but impossible in the slippery and unruly world of human interactions.

Whether he was doing what he called veranda research among the tribal peoples of East Africa or studying Head Start programs in the United States, his abiding interest was the very study of knowledge: how it is acquired, recognized, evaluated, refined and passed on—and sometimes lost. Although he worked on the most abstruse levels of the most arcane fields, Dr. Campbell, who turned out more than 200 scholarly papers, had an impish streak. One of his most compelling "crackpot papers," as he called them, was titled "The Fish Scale Model of Omniscience," his whimsical term for his dead-serious theory that knowledge is analogous to the overlapping scales on a fish, each representing a distinct field of study.

Curiously, Dr. Campbell, who proposed what he called evolutionary epistemology as a unifying theory of knowledge, had as a major focus throughout his career the study of false knowledge—the biases and prejudices that poison everything from race relations to academic disciplines where erroneous theories are perpetuated by those with vested interests in them.

Indeed, he made his first mark as a young psychologist by discovering that the very conflicting misconceptions that underlie ethnic, racial, national and other group biases tended to be reflections of those that inform, or rather misinform, the rival prejudices of city dwellers and country people. Within a decade, Dr. Campbell had identified fundamental flaws in the way social scientists were approaching research and was arguing that the sophisticated use of many approaches, each with its own distinct but measurable flaws, was required to design reliable research projects. It is a reflection of the complexity of the subject that the paper he wrote with Donald W. Fiske to present his thesis was titled "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix."

It is a measure of its influence that archivists have called the thesis the most frequently cited paper in social science.

Yet Dr. Campbell was just getting warmed up. In a 1973 collaboration with a statistician, Julian C. Stanley, he published "Experimentation and Quasi Experimental Designs for Research," his 79-page prescription for replicating randomized experiments. Dr. Campbell and his colleague at Northwestern, Thomas D. Cook, deepened and expanded the thesis in 1979 with *Quasi-Experimentation: Design and Analysis Issues for Field Settings*. It has become the research bible, particularly in evaluating social intervention programs like Head Start, but the original refuses to be displaced: More than 300,000 copies of the Campbell-Stanley book have been sold, a formidable figure for such a highly technical work.

When Dr. Campbell came up with the notion of evolutionary epistemology, his view that the development of human knowledge closely parallels that of the species, it seemed he might be on the verge of creating an all-embracing academic discipline of his very own. But Dr. Campbell would have none of it. He had, after all, studied how academic departments often stifle the advance of knowledge. Disciples were not for him. The man who helped revolutionize social science preferred to trust the future to the academic rebels of tomorrow.

Web References

http://pespmc1.vub.ac.be/CAMPBEL.html

http://www.iaccp.org/bulletin/V30.2_1996/Campbell.html

E. O. Wilson (1929 -)

"Four splendid lines of Virgil came to mind, the only ones I ever memorized, where the Sibyl warns Aeneas of the Underworld:

> The way downward is easy from Avernus.
> Black Dis's door stands open night and day.
> But to retrace your steps to heaven's air,
> There is the trouble, there is the toil . . ."

We do not understand ourselves yet and descend farther from heaven's air if we forget how much the natural world means to us."—E. O. Wilson from *The Diversity of Life* 1992

Edward O. Wilson was born in Birmingham, Alabama, in 1929. He received his B.S. and M.S. in biology from the University of Alabama and, in 1955, his Ph.D. in biology from Harvard, where he has taught since, and where he has received both of its college-wide teaching awards. He is currently University Research Professor and Honorary Curator in Entomology of the Museum of Comparative Zoology at Harvard. He is the author of two Pulitzer Prize-winning books, *On Human Nature* (1978), *The Ants* (1990, with Bert Hölldobler), as well as his books *Sociobiology* (1975), *The Diversity of Life* (1992), *Naturalist* (1994), and *Consilience: The Unity of Knowledge* (1998).

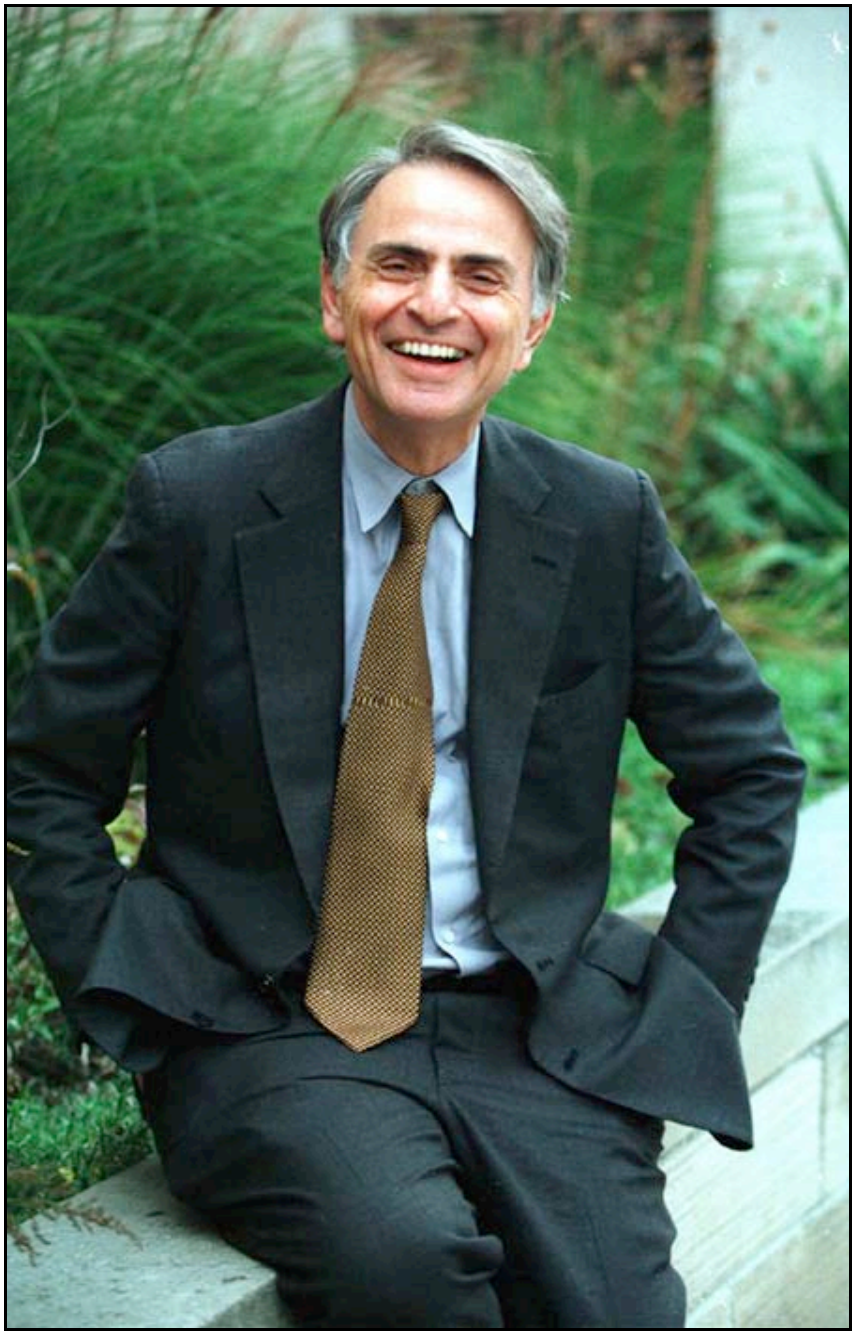
He is the recipient of many fellowships, honors, and awards, including the 1977 National Medal of Science, the Crafoord Prize from the Royal Swedish Academy of Sciences (1990), the International Prize for Biology from Japan (1993), and, for his conservation efforts, the Gold Medal of the Worldwide Fund for Nature (1990) and the Audubon Medal of the National Audubon Society (1995). He is on the Board of Directors of The Nature Conservancy, Conservation International, and the American Museum of Natural History.

Web References

http://en.wikipedia.org/wiki/Edward_Osborne_Wilson

http://www.paulagordon.com/shows/wilson/

http://dnr.metrokc.gov/swd/naturalconnections/edward_wilson_bio.htm



Carl Sagan (1934-1996)

“The world is so exquisite, with so much love and moral depth, that there is no reason to deceive ourselves with pretty stories for which there's little good evidence. Far better, it seems to me, in our vulnerability, is to look Death in the eye and to be grateful every day for the brief but magnificent opportunity that life provides.”—Sagan

Carl Sagan played a leading role in the American space program since its inception. He was a consultant and adviser to NASA beginning in the 1950s, briefed the Apollo astronauts before their flights to the Moon, and was an experimenter on the Mariner, Viking, Voyager, and Galileo expeditions to the planets. He helped solve the mysteries of the high temperature of Venus (a massive greenhouse effect), and the seasonal changes on Mars (windblown dust).

As a scientist trained in both astronomy and biology, Dr. Sagan made seminal contributions to the study of planetary atmospheres, planetary surfaces, the history of the Earth, and exobiology. Many of the most productive planetary scientists working today are his present and former students and associates. He is also the 1994 recipient of the Public Welfare Medal, the highest award of the National Academy of Sciences for distinguished contributions in the application of science to the public welfare.

> "Carl Sagan has been enormously successful in communicating the wonder and importance of science. His ability to capture the imagination of millions and to explain difficult concepts in understandable terms is a magnificent achievement."

A Pulitzer Prize winner, Dr. Sagan was the author of many bestsellers, including *Cosmos*, which became the best-selling science book ever published in the English language. The accompanying Emmy and Peabody award-winning television series has been seen by 500 million people in 60 countries. He received 20 honorary degrees from American colleges and universities for his contributions to science, literature, education, and the preservation of the environment.

At the time of his death on December 20, 1996, he served as the David Duncan Professor of Astronomy and Space Sciences at Cornell University. Dr. Sagan's *The Demon-Haunted World: Science as a Candle in the Dark* was released by Random House in March 1996. He was co-producer and co-writer of the acclaimed Warner Brothers movie *Contact*, based on his novel.

Web References

http://en.wikipedia.org/wiki/Carl_Sagan

http://csicop.org/si/2007-01/sagan.html

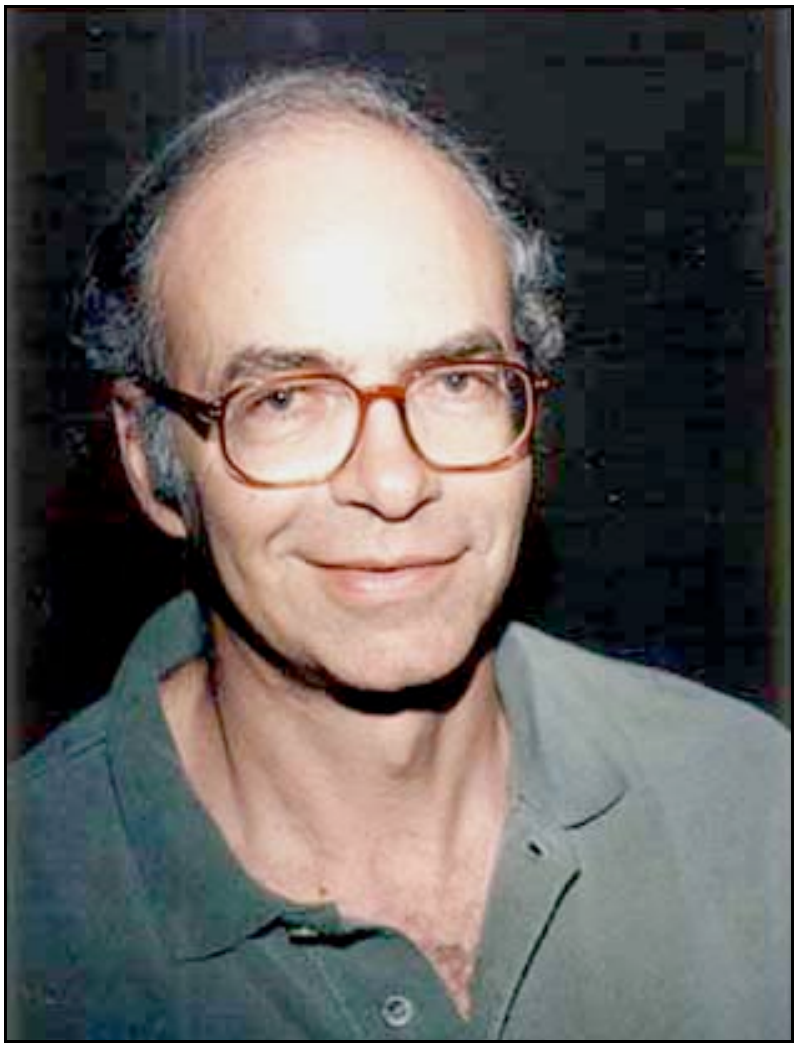
Michael Ruse (1940 -)

"Against the background presumption that our aim is to understand the world of experience, a world of unbroken regularity, these [epistemic] values are tools or standards that we cherish, since 'they are presumed to promote the truth-like character of science, its character as the most secure knowledge available to us of the world we seek to understand' Hence, an 'epistemic value is one we have reason to believe will, if pursued, help toward the attainment of such knowledge'"—Ruse from *Monad to Man: The Concept of Progress in Evolutionary Biology* 1996

Michael Ruse is Lucyle T. Werkmeister Professor of Philosophy, Florida State University. The author of many books including *Mystery of Mysteries Is Evolution a Social Construction? Monad to Man: The Concept of Progress in Evolutionary Biology, The Philosophy of Biology,* and *Taking Darwin Seriously*, *Can a Darwinian be a Christian? The Relationship Between Science and Religion, The Evolution Wars,* and *Cloning* (edited volume). He is also the founder and editor of the journal *Biology & Philosophy*, and editor of the *Cambridge University Press Series in the Philosophy of Biology*.

Ruse received his BA from the University of Bristol, England in 1962 his MA from McMaster University, Hamilton, Ontario 1964 and his PhD at the University of Bristol in 1970. He is known for his numerous books on the philosophy of biology, particularly on Darwin's theory of evolution. He has tried to define the difference between science and pseudo-science. Ruse was called to testify as an expert witness in the celebrated "creationism trial" in Arkansas in the 1980s in which a federal judge ultimately ruled that a law requiring the teaching of biblical creation in high school was unconstitutional. Ruse's testimony was probably an important factor in the judge's decision on a definition of science.

Web Reference
http://en.wikipedia.org/wiki/Michael_Ruse



Peter Singer (1946 -)

"My work is based on the assumption that clarity and consistency in our moral thinking is likely, in the long run, to lead us to hold better views on ethical issues."—Singer in Heilpädagogik online, 01/03, p. 53

Peter Singer was born in Melbourne, Australia, in 1946, and educated at the University of Melbourne and the University of Oxford. He has taught at the University of Oxford, La Trobe University and Monash University, and has held several other visiting appointments. Since 1999, he has been Ira W. DeCamp Professor of Bioethics in the University Center for Human Values at Princeton University.

Singer was the founding President of the International Association of Bioethics, and with Helga Kuhse, founding co-editor of the journal *Bioethics*. He first became well-known internationally after the publication of *Animal Liberation*. His other books include: *Democracy and Disobedience*; *Practical Ethics*; *The Expanding Circle*; *The Reproduction Revolution* (with Deane Wells), *Should the Baby Live?* (with Helga Kuhse), *How Are We to Live?*, *Rethinking Life and Death*, *Ethics into Action*, *A Darwinian Left,* and *One World: The Ethics of Globalization*.

Web References

http://en.wikipedia.org/wiki/Peter_Singer

http://www.petersingerlinks.com/

References

Bronowski, J. (1978). *The Visionary Eye*. Cambridge: The MIT Press.

Degler, C. N. (1991). *In Search of Human Nature: The Decline and Revival of Darwinism in American Social Thought*. New York: Oxford University Press.

Heyes, C. (1997). A Tribute to Donald T. Campbell. *Biology and Philosophy,* 12, 299-301.

King-Hele, D. (1999). *Erasmus Darwin: A Life of Unequalled Achievement*. London: Giles de la Mare.

Laudan, L. (1996). *Beyond Positivsim and Relativism*. Boulder: Westview Press.

Mayr, E. (1982). *The Growth of Biological Thought: Diversity, Evolution, and Inheritance*. Cambridge, MA: Harvard University Press.

Orel, V.(1996). *Gregor Mendel the First Geneticist*. Oxford, U.K.: Oxford University Press.

Ruse, M. (1996). *Monad to Man: The concept of Progress in Evolutionary Biology*. Cambridge: Harvard University Press.

Wilson, E. O. (1992). *The Diversity of Life*. Cambridge, MA: Belknap Harvard.

For further information on related topics go to:

Alles Biology 101 Lecture *The Nature of Science*
http://fire.biol.wwu.edu/trent/alles/101Lectures_Index.html

Alles Biology Home Page
http://fire.biol.wwu.edu/trent/alles/index.html