

TORAH AND SCIENCE

Institution: Bar-Ilan University

Instructor: Nathan Aviezer

COURSE SYLLABUS

1. Relation Between Torah and Science

Is there any relation at all between Torah and science?

What is the basic difference between the views of Nachmanides and Rashi on this question?

How do their views differ from those of the modern Jewish philosophers - Yeshayahu Leibowitz, Joseph Soloveichik, Abraham Kook?

Required Reading: Gould, "Nonoverlapping Magisteria", *Natural History*, March 1997, pp. 16-25.

Kook, *Faith and Science*, pp. 1-8.

Leibowitz, *Science and Moral Values*, pp. 1-13.

Nachmanides, *Commentary on Genesis*, Chapter 1, verse 1.

Rashi, *Commentary*, *Genesis*, Chapter 1, verse 1.

Soloveichik, *Man of Faith in the Modern World*, pp. 36-42.

Supplementary Reading:

Landa, *Torah and Science*, pp. 313-349.

Schroeder, *Genesis and the Big Bang*, pp. 11-26.

2. Faith and the Era of Science

Are faith and religious belief "unscientific"?

In what ways is scientific knowledge similar to religious knowledge?

Can one prove scientific theories? What is Popper's criterion?

Why are plausibility arguments so important in science?

What is a quark? Why has no scientist ever seen a quark?

Why do all scientists nevertheless believe that quarks exist?

What is the role of plausibility arguments in religion?

How do you explain the fact that each commentator/philosopher seems to have a differing view on such a basic religious question?

Required Reading: Greene, *The Elegant Universe*, pp. 341-349.

Polkinghorne, *One World*, pp. 6-25.

Wheeler, *Geons, Black Holes, and Quantum Foam*, pp. 347-355.

Supplementary Reading:

Soloveitchek, *Man of Faith in the Modern World*, pp. 5-67.

3. Evolution: Is There a Problem Here?

Why are creationists so opposed to biological evolution?

Why was the Church so adamantly opposed to the heliocentric theory?

Does the Bible support the geocentric over the heliocentric system?

Why was Galileo imprisoned for supporting the heliocentric theory, while Copernicus and Kepler were tolerated by the Church?

What similarities and differences do you see between today's controversy regarding biological evolution and the Middle Ages controversy regarding the heliocentric theory?

Required Reading: Carmell and Domb, *Challenge*, pp. 124-140.

Clarke, *Man and the Universe*, pp. 26-34.

Maimonides, *Guide for the Perplexed*, Part II, Chapter 25. Sforno, commentary on Genesis 1:26.

Supplementary Reading:

Redonti, *Galileo: Heretic*, pp. 1-37.

4. Modern Science

Aristotelean science and Newtonian science - how do they differ?

Why was the Arabic contribution to science so important?

What are the basic assumptions of the modern scientific method?

Can science be based on other assumptions?

What is the importance of Popper's criterion - that a meaningful scientific theory must be falsifiable?

Do religions satisfy this criterion?

If not, does that mean that religion is not meaningful?

Are there limits to scientific knowledge?

"The Invincible Ignorance of Science" - what did Pippard mean?

Do you think that Popper and Pippard would agree with each other?

Required Reading: Barbour, *Myths, Models, and Paradigms*, "On the Falsifiability of Scientific Theories", pp. 98-102, "On the Falsifiability of Beliefs", pp. 126-133.

Pippard, "The Invincible Ignorance of Science", *Contemporary Physics*, 1988, vol. 29, pp. 393-405

Supplementary Reading:

Polkinghorne, *One World*, "The Nature of Science", pp. 6-61.

5. Age of the Universe

Is it possible to determine the age of the universe?

On what basis do scientists set the age of the universe at 12 billion years? microwave background radiation, expansion of the galaxies, geological evidence, radioactive dating, paleomagnetic evidence

How can one reconcile the Jewish tradition of 5759 years since creation with the scientific date of about 12 billion years since creation?

Is it necessary to reconcile this contradiction?

Can one reconcile the Genesis and the scientific time-scales using the general theory of relativity and/or the cosmological red-shift?

"The universe is really quite young; it only appears old because G-d created it to look old." What is wrong with this argument?

Required Reading: Aviezer, In the Beginning, pp. 1-2.

Schroeder, The Science of G-d, pp. 41-60.

Silk, The Big Bang, pp. 67-77.

Supplementary Reading:

Carmell and Domb, Challenge - Torah Views on Science, pp. 124-140.

6. Challenge of the Creationists

“Creation Science” - what are its basic tenets?

The U. S. Supreme Court recently ruled that creation science may not be taught in the public schools. Is this decision compatible with academic freedom? With freedom of religion?

What is meant by the following assertion: “creation science” is a contradiction in terms?

Why is the creationist agenda incompatible with traditional Judaism?

Is there a problem for the religious person if science and Genesis differ?

Required Reading: Darwin, The Origin of Species, p. 450.

Gould, Bully for Brontosaurus, “William Jennings Bryan’s Last Campaign”, pp. 416-431.

Kook, Faith and Science, pp. 9-13.

Maimonides, Guide for the Perplexed, Part II, Chap. 25.

Supplementary Reading:

Brooke, Science and Religion, “Evolutionary Theory and Religious Belief”, pp. 275-320.

Peacocke, The Sciences and Theology in the Twentieth Century, “How Should Cosmology Relate to Theology?” by McMullin, pp. 17-57.

Polkinghorne, One World - Science and Theology, pp. 62-85.

Stanley, The New Evolutionary Timetable, pp. 165-179.

7. Proofs for the Existence of G-d

Is there a need for such proofs? Is such a proof possible?

Traditional proofs of Maimonides, Thomas Aquinas, and Sa'adia Gaon, including "prime mover" argument and "argument from design."

Has modern science refuted these proofs? How?

What is meant by "the leap of faith"? Is this concept "scientific"?

What is the relationship between proof, plausibility arguments, and faith?

Required Reading: Aquinas, *Summa Theologica*, Volume 1, Question II, Article 3

Leibowitz, *Science and Moral Values*, pp. 1-13.

Maimonides, *Guide for the Perplexed*, Part II, Intro. and Chap. 1

Polkinghorne, *The Faith of a Physicist*, pp. 30-51.

Supplementary Reading:

Atkins, *Creation Revisited*, pp. 3-15, 129-157.

Dawkins, *The Blind Watchmaker*, pp. 1-41.

Peacocke, *The Sciences and Theology in the Twentieth Century*, "The Evidential Value of Religious Experience" by Swinburne, pp. 182-196.

Schroeder, *Genesis and the Big Bang*, pp. 11-26.

8. Life on Other Planets

In 1996, NASA announced that they had discovered signs of life on Mars.

What is the previous history of such claims?

What is the current status of this claim?

Would the discovery of "little green men" somewhere in the universe pose a problem for persons who believe in the Bible?

Does Judaism discuss/deny the possibility of intelligent life elsewhere?

Required Reading: McKay et al., "Search for Past Life on Mars: Meteor ALH84001", *Science*, vol. 273, 16 August 1996, pp. 922-930.

Maimonides, *Guide for the Perplexed*, Part III, Chapter 32.

News, Science, vol. 271, 22 March 1996, p. 1660.

News, Science, vol. 273, 16 August 1996, p. 865.

Supplementary Reading:

Carmell and Domb, Challenge, pp. 354-398.

9. Medical Ethics

What clinical signs determine death? What clinical signs determine life? What is cloning? Do clones differ from identical twins?

What is the situation today regarding cloning?

What are the ethical problems related to cloning?

What is genetic engineering? What ethical problems have been raised?

What are stem cells? Why has research on stem cells been halted in some countries? Isn't it always desirable to cure medical problems?

Required Reading: Jakobovits, "Medical Experimentation on Humans", in Carmell and Domb, eds., Challenge, pp. 472-480.

Kline, "Whose Blood is it Anyway?", Scientific American, April 2001, pp. 30-37.

Wilmut, "Cloning for Medicine", Scientific American, December 1998, pp. 30-35.

Supplementary Reading:

Shafran, Selected Studies in Medical Ethics, pp. 1-87.

Tendler, "Medical Ethics and Torah Morality", in Carmell and Domb, eds., Challenge, pp. 492-499.

10. Free Will and the Laws of Science - Quantum Theory and Chaos

Can there be religion without free will?

Does mechanistic determinism refute free will?

What did Laplace mean in his famous answer to Napoleon that "I have no need in my science for the hypothesis of G-d"?

Does quantum physics imply abandoning determinism?

Can science exist without the ability to predict the result of an experiment?

What is “chaos”? How does chaos restrict the ability to predict?

The “butterfly effect” - is it really so important?

Required Reading: Davies, G-d and the New Physics, “Free Will and Determinism”, pp. 135-143.

Feynman, Six Easy Pieces, “Quantum Behavior”, pp. 134-138.

Polkinghorne, Science and Creation, “Order and Disorder”, pp. 34-50.

Schroedinger, What is Life?, “On Determinism and Free Will”, pp. 86-90.

Supplementary Reading:

Gleick, Chaos, pp. 1-69.

11. Miracles

Must a “miracle” be a deviation from the laws of nature?

Is it at all possible for there to be deviations from the laws of nature?

In analyzing “miracles,” what role is played by statistics and “luck”?

Why are “miraculous events” not recognizable as such by everybody?

Does the identification of an event as a “miracle” depend on the faith of the observer?

Required Reading: Polkinghorne, Science and Providence, “Miracle”, pp. 45-58.

Landa, Torah and Science, “Miracles”, pp. 346-347.

Supplementary Reading:

Dawkins, The Blind Watchmaker, “Origins and Miracles”, pp. 139-166

12. Prayer

Why does one pray to G-d?

Do we really expect G-d to alter the laws of nature just for our benefit?

Why does Jewish law forbid praying for a public miracle?

How can one reconcile Divine providence with scientific causality?

Can religion provide an answer to these questions?

Required Reading: Polkinghorne, *Science and Providence*, "Prayer", pp. 69-76.

Kook, *Faith and Science*, pp. 15-18.

Soloveichik, *Man of Faith in the Modern World*, pp. 3-12.

13. Anthropic Principle

Why has the "anthropic principle" aroused such great interest?

In what sense does the universe appear as if it were specifically designed to permit the existence and well-being of human beings?

Solar energy - the "Goldilocks problem" - the "carbon bottleneck".

What did Freeman Dyson and Francis Crick (both atheists) mean when they wrote that "miracles" seem necessary to produce life and humans?

The sudden destruction of all the world's dinosaurs:

Why was this event of crucial importance for human beings?

The anthropic principle: is it a scientific principle or a religious principle?

Does the anthropic principle have any religious significance?

Required Reading: Aviezer, *In the Beginning*, pp. 36-38, 72-74.

Barbour, *Religion and Science*, "Anthropic Principle", pp. 204-209

Gale, "The Anthropic Principle", *Scientific American*, December 1981, pp. 114-122.

Talmud, Sanhedrin 38a.

14. Creation of the Universe

The Big Bang: What scientific evidence supports this theory?

Do scientists claim that the universe was literally created from nothing?

How does the big bang theory relate to the Genesis version of creation?

("In the beginning, G-d created")

What was the primeval lightball - known as the big bang?

("And there was light")

What is meant by the "decoupling" of the light from the dark plasma?

("He separated the light from the darkness")

What role did chaos play in the development of the early universe?

("Tohu va-vohu")

Required Reading: Aviezer, In the Beginning, pp. 1-18.

Barbour, Religion and Science, "The Big Bang", pp. 195-201.

Davies, G-d and the New Physics, "Genesis", pp. 9-24.

Genesis, Chapter 1, verses 1-5.

Weinberg, The First Three Minutes, pp. 102-119.

Supplementary Reading:

Schroeder, Genesis and the Big Bang, pp. 56-95.

Silk, The Big Bang, pp. 1-89.

Worthing, G-d, Creation, and Contemporary Physics,

"Did G-d Create the Universe From Nothing?", pp. 73-110.

15. Six Days of Creation

Are there any areas of agreement between the Genesis creation story and scientific discoveries about the development of the universe?

Whipple theory of comets ("the waters above the heavens").

Milankovitz theory of ice ages ("let the waters gather to one place").

Plate tectonics and continental drift ("let the dry land appear").

Cambrian explosion of lifeforms

("let the waters swarm with living creatures").

Ediacaran fauna (“tanninim”).

What, if any, are the implications of these areas of agreement between modern science and Genesis?

Required Reading: Aviezer, *In the Beginning*, pp. 21-38, 79-88

Barbour, *Religion and Science*, “Interpretation of Genesis Today”, pp. 202-204.

Genesis, Chapter 1.

Supplementary Reading:

Schroeder, *Genesis and the Big Bang*, pp. 96-127.

16. Scientific Evidence for Biological Evolution

Is biological evolution “just a theory”?

Why do all mainstream scientists believe that the animal and plant kingdoms were vastly different in the distant past?

Fossil evidence, “molecular clock” for DNA, “protein clock”, geological evidence, embryology.

If so much scientific evidence exists, why do creationists reject evolution?

Is this a scientific debate? A religious debate?

Can one believe that Genesis was written by G-d and still accept evolution?

Required Reading: Dennett, *Darwin’s Dangerous Idea*, pp. 42-47.

Stanley, *The New Evolutionary Timetable*, pp. 3-34.

17. Darwin's Theory of Evolution

The basic principles of Darwin’s theory of evolution.

Neo-Darwinism - what was lacking in Darwin’s original theory?

Is Darwin’s theory based solely on “chance” mutations?

“Natural Selection” and the “sieve”.

What was Darwin’s explanation for the “missing intermediate forms”?

Is this explanation acceptable today?

Is the sudden extinction of all the world's dinosaurs a problem for Darwin?

The significance of the Burgess-shale fossils.

Required Reading: Darwin, *The Origin of Species*, pp. 287-289.

Gould, *The Panda's Thumb*, pp. 149-161.

Gould, *Wonderful Life*, pp. 227-239.

Barbour, *Religion and Science*, "Theological Issues in Evolution", pp. 57-63.

Supplementary Reading:

Dawkins, *The Blind Watchmaker*, pp. 1-74.

Dennett, *Darwin's Dangerous Idea*, pp. 17-60.

18. Important Modern Concepts in Evolution

"Punctuated Equilibrium" - the fossil evidence that led Gould and Eldredge to propose this concept.

Why are Dawkins and Dennett so opposed to this concept?

"Mass Extinctions" - What are they and how many have occurred?

Are mass extinctions a problem for Darwinian "natural selection"?

"Contingency" - How does Gould's concept explain the recent fossil data?

"Impact Theory" - The connection between the Alvarez theory and Raup's title: "Extinctions: Bad Genes or Bad Luck?"

"Selfish Gene" - What did Dawkins mean?

"Regulatory Genes" - Can they produce Goldschmidt's "hopeful monster"?

Required Reading: Dawkins, *The Blind Watchmaker*, pp. 223-242

Dennett, *Darwin's Dangerous Idea*, pp. 282-299.

Gould, *The Panda's Thumb*, "Caring Groups and Selfish Genes", pp. 72-78.

Raup, "Extinctions: Bad Genes or Bad Luck?"

Acta Geologica Hispanica, 1981, vol. 15, pp. 25-33.

Supplementary Reading:

Eldredge, *Reinventing Darwin: The Great Evolutionary Debate*, pp. 1-123.

Dawkins, *The Selfish Gene*, pp. 1-89.

Raup, *Extinctions: Bad Genes or Bad Luck?*, pp. 3-43

Stanley, *The New Evolutionary Timetable*, pp. 110-137.

19. Non-Darwinian Theories of Evolution

Neutral theory of molecular evolution of Motoo Kimura.

Complexity theory of Stuart Kauffman.

Impact theory of Luis and Walter Alvarez.

How do each of these theories differ from Darwin's theory?

Are these non-Darwinian theories important for explaining the fossil data?

Required Reading: Alvarez, "Mass Extinctions Caused by Large Bolide Impacts", *Physics Today*, July 1987, pp. 29-33.

Kauffman, *The Origins of Order*, pp. xiii-xviii.

Kimura, "The Neutral Theory of Molecular Evolution" *Scientific American*, November 1979, pp. 94-101.

Supplementary Reading:

Hsu, *The Great Dying*, pp. 1-24, 89-159.

20. Misreading the Fossils: the Dark Side of Evolutionary Biology

Why did the scientific community require over 40 years to recognize the fraudulent claims regarding "Piltdown Man"?

Hesperopithecus - "The Man Who Was a Pig".

The much maligned Neanderthal Man - why?

The repeated gross misunderstanding of prehistoric hominid fossils by world-famous evolutionary biologists.

Required Reading: Eldredge, *The Myths of Human Evolution*, pp. 75-80.

Gould, *Bully for Brontosaurus*, "An Essay on a Roast Pig", pp. 432-447.

Lewin, *Bones of Contention - The Search for Human Origins*, pp. 63-84.

Supplementary Reading:

Trinkaus and Shipman, *The Neanderthals*, pp. 174-208.

21. Origin of Life

What conclusions were initially drawn from Miller's 1953 experiment for producing "life in a test tube"?

Why were these conclusions later rejected?

The paradox of "the chicken and the egg."

The proposal of Graham Cairns-Smith.

What is the current scientific understanding of the "origin of life"?

Required Reading: Barbour, *Religion and Science*, "Religion and Human Nature", pp. 263-272.

Dyson, *Origins of Life*, pp. 19-39.

Supplementary Reading:

Davies, *G-d and the New Physics*, pp. 59-71.

22. The Scientific Quest for the Origins of Mankind

What are the basic characteristics of the hominid or man-like species?

What are the two competing theories for the origins of mankind?

What makes the scientific arguments on this issue so vociferous?

What did Professor Niles Eldredge mean by the title of his book: *The Myths of Human Evolution*? To which myths was he referring?

Required Reading: Eldredge, *The Myths of Human Evolution*, pp. 29-53.

Thorne and Wolpoff, "The Multiregional Evolution of Humans", *Scientific American*, April 1992, pp. 28-33.

Wilson and Cahn, "The Recent African Origins of Humans", *Scientific American*, April 1992, pp. 22-27.

Supplementary Reading:

Tattersall, *The Fossil Trail*, pp. 119-139, 229-246.

23. Uniqueness of Man

Homo sapiens sapiens - the uniqueness of Modern Man.

How do archaeologists "explain" this uniqueness?

Why was the "Agricultural Revolution" truly revolutionary?

Neanderthal Man - How is he different from all other prehistoric hominids?

What is so remarkable about paleolithic tools?

Are there any parallels between these recent archaeological data and the words in Genesis: "And G-d created man in His image"?

Required Reading: Kook, *Faith and Science*, pp. 51-62.

Leibowitz, *Science and Moral Values*, pp. 31-34.

Polkinghorne, *The Faith of a Physicist*, pp. 9-29.

24. Man as the Pinnacle of Creation

According to Genesis, are human beings just another of the two million species who inhabit this planet?

The unusual Divine blessing to mankind that appears in Genesis.

Chemical elements, supernova explosions, and the Divine blessing to mankind - is there a connection?

What did The Cambridge Encyclopedia of Astronomy mean by the words: "We are the children of the universe"?

Is there a parallel between the above statement and the talmudic statement: "Man is the pinnacle of creation"?

Required Reading: Aviezer, *In the Beginning*, pp. 107-113.

Leibowitz, *Science and Moral Values*, pp. 22-27.

Nachmanides, *Commentary on Genesis*, Chapter 1, verses 26-29.

Soloveichik, *Man of Faith in the Modern World*, pp. 60-72.

READING LIST

Atkins, Peter, *Creation Revisited* (W. H. Freeman, Oxford, 1992).

Aviezer, Nathan, *In the Beginning: Biblical Creation and Science* (Ktav Publishing, New York, 1990; in Hebrew, 1993).

Barbour, Ian, *Myths, Models, and Paradigms* (Harper and Row, New York, 1974).

-----, *Religion and Science* (Harper Collins, San Francisco, 1997).

Brooke, John, *Science and Religion* (Cambridge University Press, 1991).

Carmell, Arye, and Domb, Cyril, eds., *Challenge - Torah Views on Science* (Feldheim, Jerusalem, 1976).

Clarke, John, *Man and the Universe* (Simon and Schuster, New York, 1974).

Darwin, Charles, *The Origin of Species* (1859; reprint edition, Mentor Books, New York, 1958).

Davies, Paul, *G-d and the New Physics* (Simon and Schuster, New York, 1983).

Dawkins, Richard, *The Blind Watchmaker* (W. W. Norton, New York, 1986).

-----, *The Selfish Gene* (Oxford University Press, 1976).

Dennett, Daniel, *Darwin's Dangerous Idea* (Penguin, New York, 1995).

Dyson, Freeman, *Origins of Life* (Cambridge University Press, 1985).

Eldredge, Niles, *The Myths of Human Evolution* (Columbia University Press, 1982).

-----, *Reinventing Darwin - the Great Evolutionary Debate* (Phoenix, London, 1995).

Feynman, Richard, *Six Easy Pieces* (Addison-Wesley, New York, 1995).

Gleick, James, *Chaos* (Viking, New York, 1987).

Gould, Stephen Jay, *Bully for Brontosaurus* (Penguin Books, New York, 1991).

-----, *The Panda's Thumb* (W. W. Norton, New York, 1980).

-----, *Wonderful Life* (W. W. Norton, New York, 1989).

Greene, Brian, *The Elegant Universe* (Jonathan Cape, London, 1999).

Hsu, Kenneth, *The Great Dying* (Harcourt, Brace, Jovanovich, New York, 1986).

Kauffman, Stuart, *The Origins of Order - Self-Organization and Selection in Evolution* (Oxford University Press, 1993).

Kook, Abraham Isaac, *Faith and Science* (in Hebrew).

Landa, Judah, *Torah and Science* (Ktav Publishing, New York, 1991).

Leibowitz, Yeshayahu, *Science and Moral Values* (in Hebrew)

Lewin, Roger, *Bones of Contention* (Penguin, London, 1987).

Peacocke, Arthur, ed., *The Sciences and Theology in the Twentieth Century* (University of Notre Dame Press, 1981).

Polkinghorne, John, *The Faith of a Physicist* (Princeton University Press, 1994).

-----, *One World - the Interaction of Science and Theology* (SPCK, London, 1986).

-----, *Science and Creation* (SPCK, London, 1988).

-----, *Science and Providence* (SPCK, London, 1989).

Raup, David, *Extinctions - Bad Genes or Bad Luck?* (Oxford University Press, 1991).

Redonti, Phillip, *Galileo: Heretic* (Princeton University Press, 1987).

Schroeder, Gerald, *Genesis and the Big Bang* (Bantum, New York, 1991).

-----, *The Science of G-d* (Simon and Schuster, New York, 1997).

Schroedinger, Erwin, *What is Life?* (Cambridge University Press, 1944).

Shafran, Yigal, *Selected Studies in Medical Ethics* (Ktav Publishing, New York, 1994).

Silk, Joseph, *The Big Bang* (W. H. Freeman, New York, 1989).

Soloveichik, Joseph Dov, *Man of Faith in the Modern World* (in Hebrew).

Stanley, Steven, *The New Evolutionary Timetable* (Basic Books, New York, 1981).

Tattersall, Ian, *The Fossil Trail* (Oxford University Press, 1995).

Trinkaus, Eric, and Shipman, Pat, *The Neanderthals* (Jonathan Cape, London, 1993).

Wheeler, John, *Geons, Black Holes, and Quantum Foam* (Norton, New York, 1998).

Weinberg, Steven, *The First Three Minutes* (Andre Deutsch and Fontana, London, 1977).

Worthing, Mark, *G-d, Creation, Contemporary Physics* (Fortress, Minneapolis, 1996).