Page Back: Future | Unit Up: Palaeos home | Glossary (none as yet) | Page Next: Scientists
Unit Back: Future | Paleontology | References (none as yet) | Unit Next Resources

Science

(to be added)

Science
Scientists and others (Alphabetical listing)
Timeline of discoveries and popular culture

Content to be added...

Page Back: Future | Unit Home | Page Top | Page Next: Scientists

images not loading? | error messages? | broken links? | suggestions? | criticism?

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A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

A.

Abiogenesis: The development of life from non-living systems via natural mechanisms. cf.creation. (W. R. Elsberry talk.origins via W.J. Hudson)

Agnostic: Someone who defers belief or non-belief in a god until the evidence is in. Usually accompanied by the assertion that the evidence is not in. cf. unbelief (W. R. Elsberry talk.origins via W.J. Hudson)

Analysis: Step Six in the Scientific Method. Experimental results are gathered. The experiment should be repeated (replicated) several times to avoid chance error. The results are subjected to statistical analysis. Statistical analysis is designed to help minimize false positives and false negatives. In most statistical procedures in biology, a 5% error rate is allowed to occur and still consider the results viable. This much error is accepted as "due to chance alone." (W. R. Elsberry talk.origins via W.J. Hudson)

Argument from Design: An argument most notably forwarded by the Reverend Paley which brought us the "watchmaker" analogy. At basis, this argues that the complexity and good design seen in natural systems could only be attributed to a superlative designer. Centuries ago, David Hume argued that one can only separate designed from non-designed entities via experiential comparison and contrast. Hence, since we only have one universe, we have no point of reference to argue that the universe is designed (or not designed). More recently, Richard Dawkins has written an excellent summary of at least one way in which good design does not imply the existence and action of a designer. (W. R. Elsberry - talk.origins). See also intelligent design; irreducible complexity, teleology

Atheist: Someone who either states a disbelief in a god or gods ('strong' or 'positive' atheism), or an unbelief in a god or gods ('weak', 'negative' or 'passive' atheism). cf. agnostic. (W.J. Hudson)

B.

Belief: The position of affirming the truth of a proposition. Belief, if asserted as true in a debate, bears a burden of proof (as does disbelief). See also: unbelief. (W.J. Hudson)

Burden of Proof: Also known (especially in legal terminology) as the *onus probandi*. The burden of proof is something shouldered by anyone who makes an assertion regarding a proposition -- a requirement that they support/substantiate their assertions, if they expect anyone else to accept them. It is important to note, however, that simply having a belief or disbelief on a subject does not require the burden of proof -- one must actually assert that one's position is true. cf. unbelief. (W.J. Hudson)

C.

C-decay: Young Earth Creationist assertion that the speed of light has undergone a measurable slowing in recorded history, forwarded by Barry Setterfield. Setterfield further claims that the decay of the speed of light follows an exponential, such that light speed was infinite a few thousand years ago. The talk.origins FAQ deals with the questionable data handling and analysis which Setterfield had to use to obtain his pre-ordained results, and the wholesale rejection of data points which would have lessened the confidence levels which Setterfield claimed. (W. R. Elsberry - talk.origins)

Catastrophism: the theory that the Earth's geological landscape is the result of violent cataclysmic events. Advocates of this theory usually believe that there have been a number of wide-spread violent and sudden natural catastrophes that have destroyed most living things. It was used by George Cuvier to explain the extinction of species. Contrast with uniformitarianism; the two opposed each other during the late 18th and 19th centuries. Young Earth Creationism uses a modified from of Catastrophism, employing the Biblical Flood to explain the fossil record

The Clergy Letter Project: project that gained signatures from over 10,000 members of clergy for An Open Letter Concerning Religion and Science. This letter contains the basic statement: "We the undersigned, Christian clergy from many different traditions, believe that the timeless truths of the Bible and the discoveries of modern science may comfortably coexist. We believe that the theory of evolution is a foundational scientific truth, one that has stood up to rigorous scrutiny and upon which much of human knowledge and achievement rests." (EvoWiki) Compare with Non-overlapping magisteria

Common ancestor: The ancestral species that gave rise to two or more descendant lineages, and thus represents the ancestor they have in common. The idea of a common ancestor is central to evolutionary thinking from Darwin onwards. (MAK)

Creation: The bringing forth of matter from nothing, or the development of life from non-living systems. cf. abiogenesis. (W. R. Elsberry talk.origins via W.J. Hudson)

Creation-Evolution debate: situation that has developed in Western society as a result of the clash between religious traditionalists who advocate a supernatural worldview, and the scientific community which uses empirical method and tends to agnosticism and naturalism. A highly polarised society with a strong religious demographic like America has a larger proportion of creationists than a more secular society like Britain or Australia. Alternative solutions include more science education, non-overlapping magisteria, universe story, theistic evolution, and pantheism. (MAK)

Creation out of nothing: The Judaeo-Christian doctrine that God created the cosmos out of nothing (*ex nihilo* in the famous latin phrase). Rejected by both emanationism and naturalism (MAK)

Creation Science: see Scientific creationism

Creationism: The belief in creation as having a supernatural agent, but usually without limiting the range of mechanisms used by that agent. Variations include Young Earth and Old Earth creationism and religious forms of Intelligent Design. May or may not claim scientific credentials. Creationists generally accept microevolution but not macroeveolution. (W. R. Elsberry talk.origins via W.J. Hudson, MAK)

D.

Darwin fish: parody of the Christian *ichthys* (fish) symbol with feet, legs and Darwin written inside the fish to symbolise Darwin's Theory of evolution by natural selection which is seen in contrast with Biblical creationism which is based on christian fundamentalism (hence the legs and feet attached to it). It is often associated with another parody of the ichthys fish known as the Evolve fish which is depicted as having legs, the word evolve written on it and carrying a wrench. (EvoWiki, from Wikipedia)

Darwinian: Of or pertaining to natural selection, or Darwin's theory of evolution in general. Sometimnes taken to mean natural selection with gradualist assumptions, although it is now considerd doubtful that Darwin was a uniformitarian to this degree. (modified from W. R. Elsberry - talk.origins)

Darwinism: In 1859 Charles Darwin supplied a mechanism, namely natural selection, that could explain how evolution occurs. Darwin's theory of natural selection helped to convince most people that life has evolved and this point has not been seriously challenged in the past one hundred and forty years. It is important to note that Darwin's book "The Origin of Species by Means of Natural Selection" did two things. It summarized all of the evidence in favor of the idea that all organisms have descended with modification from a common ancestor, and thus built a strong case for evolution. In addition Darwin advocated natural selection as a mechanism of evolution. Biologists no longer question whether evolution has occurred or is occurring. That part of Darwin's book is now considered to be so overwhelmingly demonstrated that is is often referred to as the *fact* of evolution. However, the *mechanism* of evolution is still debated. cf. Modern Synthesis. More (W.J. Hudson).

Decision: Step Seven in the Scientific Method: The estimate of error and the allowance for error are analyzed, and the hypothesis is either "rejected" or "not rejected" Please notice that the hypothesis is not 'proven'! The end result of the process is a theory. A theory is what a hypothesis becomes after it has accumulated supporting experimental data. (W.J. Hudson)

Deism: 18th century theology, stemming from the Age of Enlightenment, according to which God, the divine clockmaker, created the universe at the beginning, but did not interfere in any way since. (MAK)

Denialism: any psychological attitude that involves denying empirically verifiable historical or scientific facts, in order to avoid facing the uncomfortable truth such evidence or research reveals. Climate Skepticism (which rejects findings of climate science) and Creation Science (which denies evolutionary theory) are probably the two most influentual forms of denialism today. Denialists of one type of denialism need not agree with those of another; e.g. geologist Ian Plimer, a climate denialist and author of the best-selling *Heaven and Earth*, is also an evolutionist who has vigorously criticised creationists. Denialists may be free thinkers, sincerely concerned about the way established paradigms dominate a particular field of science and unconventional views are rejected. Or they may be deliberate advocates of religious, ideological, or corporate pressure groups or vested interests. (MAK, Wikipedia. Ref: *New Scientist* - Special report, Age of Denial, 15 May 2010, vol 206, no. 2760 (preview, full view for subscribers))

Disbelief: A position which asserts that a proposition is false. This is technically a "positive" position on any matter, and, like belief, must shoulder a burden of proof if it is to be proven. cf. unbelief. (W.J. Hudson)

E.

Empiricism: understanding the natural world by means of verifiable observation via the senses and scientific instruments; an essential component of scientific method and naturalism in general. Also refers to a school of 18th century philosophy which argued that knowledge is only derived through the senses, in contrast to rationalism (knowledge can be derived through pure reasoning; e.g. Cartesian realism). Empiricism can be used to argue for both positivist realism and pragmatist neo-kanteanism. In late 20th century systematics, neo-pragmatist *radical empiricist* methodologies, such as Phenetics and Pattern Cladism, sought to arrive at a perfectly "objective" science (or hypotheses) devoid of any consciousness subjectivity, evolutionary narrative, and "intuition"; such attempts fail because any assesment, e.g. weighting, is itself the result of subjective opinion and "intuition" (MAK)

Evolutionary Creationism: See Theistic evolution

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Evolution (Biology): A change in the gene pool of a population over time. The process of evolution can be summarized in three sentences: Genes mutate. Individuals are selected. Populations evolve. (W.J. Hudson)

Evolutionary Theory: (or **Evolutionary Mechanism Theory**) Any one of several theories in biology dealing explicitly with some aspect of evolution or cumulative evolution. Examples include Sewall Wright's "shifting-balance

theory", Eldredge and Gould's "punctuated equilibrium theory", the theory of common descent, Darwin's "descent with modification", Henry Fairfield Osborn's "orthogenesis", and "Gene Flow". While "evolutionary theory" is equivalent, the point that mechanisms are proposed and tested in evolutionary mechanism theories is worthy of stress and repetition. Some mechanisms increase genetic variation (cf. mutation, recombination, gene flow) and some decrease genetic variation (cf. natural selection, genetic drift) (W. R. Elsberry talk.origins via W.J. Hudson)

Evolutionism: Conditional acceptance of one or more Evolutionary Theories based upon the overwhelming evidence found for such; philosophy of inevitable development. (W. R. Elsberry - talk.origins). Consititutes an *evolutionary narrative*, which is accepted by mainstream science but rejected by both radical empiricism and neo-pragmatism. Evolutionism can be naturalistic, acknowledging only natural selection and mutation or rearrangements of genetic material that allowing successive generations of living beings adapted to changing environments, or it can also include teleological factors such as theistic evolution, conscious evolution and/or a pantheistic/panentheistic Godhead. The opposite of Creationism. (MAK)

Experiment: Step five in the Scientific Method. The system is manipulated and the results are compared against a control setting and the prediction. (W.J. Hudson)

F.

Fact: in science, an observation that has been repeatedly confirmed and for all practical purposes is accepted as "true." Truth in science, however, is never final, and what is accepted as a fact today may be modified or even discarded tomorrow.

G.

Gosse Assertion, The: The belief that a creator created the universe and life by fiat, but with the "appearance of age". Rightly rejected by most theologically astute persons as libelous or blasphemous. Gosse was the author of "Omphalos" (navel), where this assertion was given its fullest treatment. (W. R. Elsberry - talk.origins)

H.

Holism: A non-reductionist descriptive and investigative strategy for generating explanatory principles of whole systems. Attention is focused on the emergent properties of the whole rather than on the reductionist behavior of the isolated parts. The approach typically involves and generates empathetic, experiential, and intuitive understanding, not merely analytic understanding, since by the definition of the approach, these forms are not truly separable. (Wikipedia glossary)

Hypothesis: The third step in the scientific method. A tentative statement about the natural world leading to deductions that can be tested, It provides explanatory and predictive power, and is conditionally held on review of further observations and experiment. If the deductions are verified, it becomes more probable that the hypothesis is correct. If the deductions are incorrect, the original hypothesis can be abandoned or modified. Hypotheses can be used to build more complex inferences and explanations. cf. theory. (W. R. Elsberry talk.origins via W.J. Hudson, modified)

I.

Intelligent Design: is the proposition that "certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection." Usually it a form of creationism restated in non-religious terms, retaining the idea of deity while seeking to embrace scientific method. In this form it is a contemporary adaptation of the traditional teleological argument for the existence of God, but one which deliberately avoids specifying the nature or identity of the intelligent designer. Its leading proponents are associated with the Discovery Institute, a politically conservative religious fundamentalist think tank who believe the designer to be the Christian God. There are however other, non-religious, interpretations of Intelligent Design, such as emanation, panspermia, link: consciousness and quantum physics), universal field, and emanation. Link: EvoWiki

J.

Jurassic Park: Bestselling 1990 sci fi thriller novel by Michael Crichton, which became the basis for a very succesful Steven Speilberg 1993 movie of the same name, and eventually an entire franchise of books, films and video games centered on a fictional theme park full of cloned and revived dinosaurs. Crichton either imitated, or indepedently arrived at a very similar premise, to John Brosnan's *Carnosaur*, a 1984 horror novel about theropod dinosaurs running amock. The science of *Jurassic Park* was actually based on a very plausible hypothesis of the time - that dinosaurs could be cloned from their DNA in the stomachs of gnats and mosquitos embedded in amber, although it was discovered that DNA quickly degrades in amber so the hard science premise is unviable (there are also inaccuracies regarding the way the dinosars are decsribed). The story not unexpectedly centered on theropod dinosaurs, especially overgrown velociraptors, as scary monsters chasing the protagonists around the theme park, turning door knobs and opening doors. Neverthless, the movie surved to help popularise dinosaurs among the general public. Incorporated now refuted ideas from Bob Bakker's dinosaur renaissance, such as a 60 kph *Tyrannosaurus* (MAK)

"Just so" story: Used by some neo-pragmatist critics of empirical realism when describing accounts of the evolution of life. According to pheneticists and many early cladists (especially of the Pattern / Transformed orientation), phylogeny such as is described by evolutionary systematicists has no more validity than a Rudyar Kipling fable of how the elephant got its trunk. While pheneticists and cladists did acknowledge the reality of evolution (unlike creationism for example), they reject empirical or literalist interpretations, and argue that all that phenetics and cladistics does is characterise and analyse patterns, these patterns may or may not correspond to actual evolution and phylogeny, but even if they do, it is impossible to prove this for certain, still less to analyse the underlying causes that generate these patterns (Eldredge, 1993, p.34). Quite similar to certain anti-empirical and anti-realist trends in postmodernist philosophy, such as Derridean deconstruction and Wilfred Sellars "myth of the given". Rightly criticised by Richard Dawkins and others. (MAK)

K.

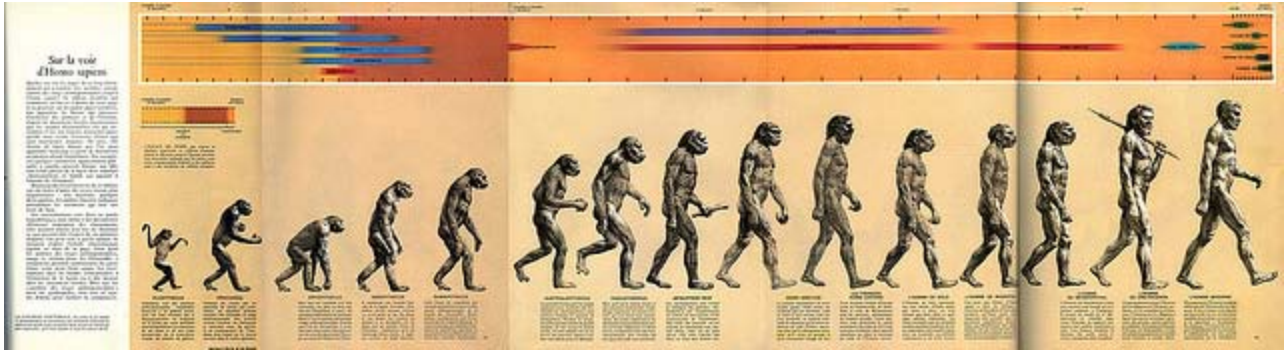
L.

Law: A descriptive generalization about how some aspect of the natural world behaves under stated circumstances.

M.

Macroevolution: Evolution at or above the species level. The boundary between macro- and micro- is fuzzy, as some researchers prefer to include speciation in micro- and others reson that the only macro- process that gives distinctive events is speciation. Speciation events are thus, to many scientists, examples of macroevolution. Another definition is evolution too imperceptible to be observed within the lifetime of one researcher . (W. R. Elsberry talk.origins via W.J. Hudson) link: Macroevolution Its Definition, Philosophy and History by John Wilkins

The March of Progress: one of the most famous and recognizable scientific illustrations ever produced, drawn by noted natural history painter and muralist Rudolph Zallinger. A compressed presentation of 25 million years of human evolution, it depicts 15 human evolutionary forebears lined up as if marching in a parade from left to right. The image has been copied, modified and parodied countless times and has proven controversial in a number of respects. Originally commissioned by Time-Life Books for the *Early Man* volume (1965) of its popular Life Nature Library. This book, authored by anthropologist F. Clark Howell (1925-2007) and the Time-Life editors, included a foldout section of text and images (pages 41-45) entitled "The Road to Homo Sapiens", prominently featuring the sequence of figures . As the popularity of the image grew and achieved iconic status, the name "March of Progress" somehow became attached to it.



The representation of human evolution as progression in a linear, sequential fashion from an ape-like ancestor through various intervening stages of ape-men, to modern human (that is, along a road to a predetermined "ideal form") has been criticised by paleontologist and popular science writer Stephen Jay Gould. Gould explains that evolution as a straight-line from the slime to man and beyond is a concept that really has very little to do with true Darwinism. But Howell remarked that "The artist didn't intend to reduce the evolution of man to a linear sequence, but it was read that way by viewers.[illegible] The graphic overwhelmed the text. It was so powerful and emotional". (MAK, Wikipedia)

Image: March of Progress [illegible] by Rudolph Zallinger, 1965. From Time-Life Books "Early Man" - this image from Mad Art Lab: AI: Have we Made Progress? (includes other variations)

Materialism: the philosophical view that the only thing that can truly be said to 'exist' is matter; that fundamentally, all things are composed of 'material' and all phenomena are the result of material interactions. (note: matter could include energy or other phenomena known to science, in this context materialism and metaphysical naturalism are synonymous). There are a large number of different schools and interpretations, e.g. dialectical materialism (Marxism), eliminative materialism (consciousness. ">consciousness is simply brain functioning and doesn't exist in itself), emergent materialism (just the opposite, mind is an irreducible existent, and the study of mental phenomena is independent of other sciences), reductive materialism, and so on (from Wikipedia glossary)

Microevolution: Evolution within the species level, or a change in allele frequency in a population over time. Note that this connotation is equivalent to evolution. All "Scientific Creationists" so far admit that microevolution is observed. Some Theistic Anti-Evolutionists may not. (W. R. Elsberry talk.origins via W.J. Hudson)

N.

Naturalism: any of several philosophical stances, typically those descended from materialism and pragmatism, that do not distinguish the supernatural (including strange entities like non-natural values, and universals as they are commonly conceived) from nature. Naturalism does not necessarily claim that phenomena or hypotheses commonly labeled as supernatural do not exist or are wrong (in fact it remains agnostic about non-physical things), but insists that all phenomena and hypotheses can be studied by the same methods and therefore anything considered supernatural is either nonexistent, unknowable, or not inherently different from natural phenomena or hypotheses. (Wikipedia glossary). Naturalism is the methodology of science, as opposed to philosophy, religion, idealism, etc. Naturalistic (theories of) evolution explain biological evolution without requiring supernatural or teleological factors. Can however tend to *Metaphysical naturalism* (and thus rejection of theism and theistic evolution), as championed by British evolutionary biologist Richard Dawkins This is the belief that nothing exists but objects, forces, and causes of the kind studied by the natural sciences, and that consciousness, mind, etc can be reduced to physical causes. A metaphysical, rather than a scientific, premise that rejects the existence of supernatural entities (including spirits and souls, non-natural values, and universals as they are commonly conceived) as well as any form of teleology. In practice, metaphysical naturalism tends to reduce to the more specific ontological view of scientific naturalism (scientism), according to which reality consists only of what the concepts of the natural sciences (and especially physics) investigate. Physicalism, reductionism, and atheism are similar and often (putting aside philosophical hair-splitting) synonymous. MAK

Neo-Kantean: sceptical approach to empiricism, derived from the German Transcendental idealist philosopher Immanuel Kant. Reacting to the excessively naive realism of the French rationalist philosopher Descartes (who, following a thought experiment (the original "brain in the vat" experiment) rejected radical doubt and argued not only for the existence of the material world of spatial extension, but also the God of his religion) Kant denied that it was possible to know anything about reality in itself (noumena), all one could know, he argued, are the subjective

phenomena we experience. Kant's hyper-agnostic worldview became lmost influential following the decline of Hegellian metaphysics, and as a reaction to the excessive logical positivism and empiricism of the early 20th century. Neo-Kantean idealism is central to the pluralistic and anti-foundationalist worldview of some representatives of pragmatist and "postmodernist" philosophy. Especially influential here is Wilfred Sellar's Neo-Kantean critique of empiricism (Sellars, 1956/1997), which is both a development of positivism and a rejection of naturalistic realism (so these two tendencies need not be opposed), denies the positivist premise that empirical methodology describes a real world "out there" (Sellars refers to the belief in a pre-given objective reality as the "myth of the given"). Instead, all that science, or philosophy, can do, is examine the linguistic and socio-cultural premises behind such beliefs, or test empirical evidence as hypothetical or historical reconstructions, or as patterns or diagrams thrown up by various methodologies which do not provide proof or factual representation of the objective world. In evolutionary science, examples of neo-kantean theorising can be found in phenetics and Pattern cladism (see "just so" story); ironically these are methodologies that tried to totally eliminate subjectivism in favour of extreme empiricism, and hence one would expect them to be the opposite of postmodernism. More recently, philosopher of science Karl Popper however has refuted such arguments as examples of the "myth of the framework (thebelief that socio-cultural factors determine everything we can know about reality). (MAK)

Non-missing link: Although creationists often claim that no transitional forms are known in the fossil record, in fact the reverse is the case. (see Link). As it would be oxymoronic to refer to these intermediate species by their popular moniker as "missing link" (e.g. link link) I have coined the informal term "non-missing link". See also anagenesis, ancestor, common ancestor, basal taxon, stem group. Note that even though, in view of the vagaries of the fossil record, the non-missing link may not necessarily be the actual, literal, common ancestor of all later species in that lineage (although in some cases where stratigraphic preservation is very good it might), but it would certainly be a closely related form (MAK)

Non-overlapping magisteria: is the view advocated by Stephen Jay Gould as the solution to the supposed conflict between science and religion. His idea of Non-Overlapping Magisteria (NOMA) states that science and religion are compatible and each magistrate(or layer) occupies a separate realm of human understanding. Essentially, this is an appeal to the separation of Church and State; or in this instance Church and Science. Gould's position here has been criticised on a number of grounds by Richard Dawkins (see Wikipedia link for more) who argues instead for the atheistic position. Compare with Clergy Letter Project as similarily supporting the non-conflict between science and religion. Contrast with integral theory, pantheism, and Teilhard de Chardin as examples of unified framework integrating science and religion in a single undividvded worldview (rather than two distinct magisteria). (MAK, Wikipedia, EvoWiki)

O.

Observation: This is the first step in the scientific method. The scientific method is founded upon direct observation of the world around us. A scientist looks critically and attempts to avoid all sources of bias in this observation. But more than looking, a scientist measures to quantify the observations; this helps in avoiding bias. (W.J. Hudson)

Old Earth creationism: Old Earth creationism holds that the physical universe was created by God, but that the creation event of Genesis is not to be taken strictly literally. This group generally believes that the age of the Universe and the age of the Earth are as described by astronomers and geologists, but that details of the evolutionary theory are questionable. Old Earth creationists interpret the Genesis creation narrative in a number of ways, that each differ from the six, consecutive, 24-hour day creation of the Young Earth Creationist view. Gap creationism, Day-Age Creationism, and Progressive creationism are related or variant forms.

P.

Panspermia: the hypothesis that life did not originate on Earth but was seeded from elsewhere in the universe. There are several forms:

- *Naturalistic Panspermia* asserts that life evolved on another planet, and was ejected and transferred to Earth by meteorites, or else it originated in deep space from complex molocules found in nebula or comets; the genetic material is then carried to Earth by comets (Fred Hoyle and Chandra Wickramasinghe).
- *Directed Panspermia* is the premise that intelligent extra-terrestrials intentionally seeded other planets with

genetic material, even if they didn't travel there themselves. Directed Panspermia was first proposed by Francis Crick, co-discoverer of DNA

- *Ancient Astronaut hypothesis* is the belief that extra-terrestrial astronauts visted Earth in past ages and created the human race through genetic engineering. These aliens were believed to be gods and became the gods of mythology. Popular proponents include Erich von Danniken and Zecharia Sitchin. Does not say anything about the origin or evolution of the rest of life on Earth. Arthur C Clarke and Stanley Kubrick's 2001: A Space Odyssey provides another take on this, and doesn't pretend to be anything other than science fiction.

Directed and Ancient Astronaut Panspermia are clearly variations on the Intelligent Design approach which attempt to circumvent supernatural explanations. The problem with panspermia though, even naturalistic interpretations, is that it still doesn't explain how life appeared in the first place. Even if life or intelligence didn't evolve first on Earth, it still had to evolve somewhere else in the universe. Links: Panspermia (large web site, naturalistic approach); Problems with Panspermia or Extraterrestrial Origin of Life Scenarios

Pantheism, Panentheism: *Pantheism* is a form of monism that asserts that God is the same as the cosmos, and vice versa. Hence divine laws and natural laws are the same. Einstein famously advocated this position; he was inspired by the philosophy of Spinoza. Pantheism allows both science and spirituality and metaphysics to co-exist. Also popular in the New Age movement. *Panentheism* is similar except that it asserts that God is not only the same as the cosmos and everything in it (pantheism), but also transcends the cosmos. Panentheism tends to be preferred by mystics, amd ties in also with emanation. (MAK)

Paradigm: as defined by historian of science Thomas Kuhn as the set of practices that define a scientific discipline at any particular period of time. In his landmark book in *The Structure of Scientific Revolutions*, Kuhn defines a scientific paradigm as:

- what is to be observed and scrutinized
- the kind of questions that are supposed to be asked and probed for answers in relation to this subject
- how these questions are to be structured
- how the results of scientific investigations should be interpreted

Within *normal science*, the paradigm is the set of exemplary experiments that are likely to be copied or emulated. In this scientific context, the prevailing paradigm often represents a more specific way of viewing reality, or limitations on acceptable programs for future research, than the more general scientific method.

When one paradigm is replaced or overthrown by another, that is called a *Paradigm Shift*. Kuhn considered that transition from one paradigm to another via revolution is the usual developmental pattern of mature science. Hence paradigm shifts tend to be most dramatic in sciences that appear to be stable and mature, as in physics, where around the turn of the 20th century, classical netwonian physics was replaced by relativity and quantum mechanics. The mid-19th century transition from a more static biology to a Darwinian-derived evolutionary one would be another example. Evolutionary Theory itself underwent a number of paradigm shifts, such as Darwinism, Neo-Darwinism, Modern Synthesis, and now more recent ideas incorporating molecular phylogeny, evo-devo, cladistics, systems theory, and so on. In terms of mapping out the history of life there was a qute dramatic paradigm shift in the 1980s, from evolutionary systematics to phylogenetic systematics (two other paradigms, phenetics and pattern cladistics, played a much more minor role), more recently there has been a further shift from morphology based cladistics to molecular phylogeny

Advocates of specific paradigms tend to be feircely passionate about their own preferred paradigm, extolling its strengths and virtues and minimising its weaknesses, while at the same time being uncompromisingly critical, dismissing, and ridiculing their oponents' paradigms. In this way, a paradigm becomes like a religion or a political ideology, something that may indeed have good qualities, but which is held to with irrational fervour. In the current iteration of Palaeos I have tried to balance and include many paradigms, not just dominant ones, while acknowledging that inevitavbly, whatever paradigms are used will be supplemanted or supplanted in the future by paradigms which we have no conception of now, and even if we did, would probably not believe. (Wikipedia, MAK)

Parsimony: Also known as Occam's Razor (after the medieval theologian William of Ockham (c. 1285–1349), who rejected the idea of universals) is the principle that recommends when choosing between two competing hypotheses, that the simplest explanation of the evidence or observation is to be preferred, when the hypotheses are equal in other respects

Piltdown Man: famous 1912 hoax of early fossil man, consiting of a human skull, ape jaw, and filed down teeth. Had a significant detrimental impact on early research on human evolution: discoveries of Australopithecine fossils found in the 1920s in South Africa were ignored and instead the popular (but erroneous) theory argued that the human brain expanded in size before the jaw adapted to new types of food. rather than the reverse. Definitively exposed as a forgery by scientists back in 1953 (MAK, Wikipedia)

Positivism: philosophical position that the only authentic knowledge is scientific knowledge (see naturalism). It is an approach to the philosophy of science, deriving from Enlightenment thinkers like Pierre-Simon Laplace and Auguste Compte. **Logical positivism** is a school of philosophy that combines empiricism - the idea that observational evidence is indispensable for knowledge of the world - with a version of rationalism incorporating mathematical and logico-linguistic constructs and deductions in epistemology. It grew from the discussions of a group of philosophers called the "Vienna Circle" which gathered at the Caf  Central, a coffeehouse in Vienna frequented by intellectuals, in the years immediately preceeding and following World War I. (MAK, Wikipedia glossary)

Pragmatism: American philosophical tradition centered around the linking of practice and theory. It describes a process where theory is extracted from practice, and applied back to practice to form what is called *intelligent practice*. Important positions characteristic of pragmatism include instrumentalism (the view that a scientific theory is a useful instrument in understanding the world, and should be evaluated by how effectively it explains and predicts phenomena, not how accurately it describes objective reality as such), radical empiricism, verificationism, conceptual relativity and a denial of the fact-value distinction (overlaps with postmodernism), a high regard for science, and fallibilism (the philosophical principle that human beings could be wrong about their beliefs, expectations, or their understanding of the world; the position of the natural sciences. Originally established by Charles Sanders Peirce, and further developed by William James, John Dewey and George Santayana. W. V. O. Quine and Wilfrid Sellars used a revised pragmatism to criticize logical positivism in the 1960s. Another brand of pragmatism, known sometimes as *neopragmatism*, gained influence through Richard Rorty, the most influential of the late 20th-century pragmatists (Wikipedia) However I would also use neo-pragmatism to include any anti-realist and radical empiricist approach, in contrast to the less nihilistic pragmatism of Pierce and James. (MAK)

Prediction: Step four in the scientific method. The prediction is a formal way to put a hypothesis to a test. If you have carefully designed your hypothesis to be sure it is falsifiable, then you know precisely what to predict. The prediction has three parts: 1. If my hypothesis is true... 2. Then _____ should happen ... 3. When _____ is manipulated. The manipulation is what you knew would likely falsify your hypothesis. (W.J. Hudson)

Preformationism: historical and obsolete 17th and 18th century scientific theory that all living beings were created at the same time, and that succeeding generations grow from homunculi, animalcules, or other fully formed but miniature versions of themselves that have existed since the beginning of creation. Hence the entire human race, down to the last individuals prior to the Day of Judgment, pre-exist in the ovaries of Eve, or the testes of Adam, depending on where one locates the miniature homunculi. Although Preformationism sounds (and is) ridiculous to us todauy, it made sense to the logic of pre-evolutionary Christendom, according to which the entire lifespan of the universe from beginning to end would be no more than six or seven thousand years. Moreover, after the invention of the microscope and the discovery of microscopic organisms, but before modern cell theory, there was no reason not to assume that "big fleas have little fleas to bite 'em", and so on ad infinitum. (MAK) Link: Each Sperm Cell has a Fully Formed Human Waiting Inside; graphic Preformation, drawn by N. Hartsoecker 1695

Proposition: A statement which can be either true or false, as opposed to interrogative, exclamatory, or imperative sentences. See also: belief, unbelief, disbelief. (W.J. Hudson)

Punctuated Equilibria, Punctuated evolution: evolutionary theory that argues that new species evolve suddenly and in geographically isolated areas. Hence speciation is rarely found in the fossil record, because established, populous and widespread species (the sort that are most likely simply through greater numbers to leave fossil remains) usually change slowly, if at all, during their time of residence. See punctuated equilibria FAQ on the talk.origins archive site. (W. R. Elsberry talk.origins via W.J. Hudson, modified).

Q.

Question: The second step in the scientific method is to formulate a question. The question must be answerable. "Why am I here?" is not a question that is answerable by science; it is, to use the colloquialism: "metaphysics rather than physics". (W.J. Hudson, modified)

Quote mining. The intellectually dishonest art of deliberately selection of quotes, normally out of context, to refute the original author's point. This tactic is widely used among Young Earth Creationists to attempt to discredit evolution. Quote mining - RationalWiki

R.

Random: Unpredictable in some way. Mutations are "random" in the sense that the sort of mutation that occurs cannot generally be predicted based upon the needs of the organism. However, this does not imply that all mutations are equally likely to occur or that mutations happen without any physical cause. Indeed, some regions of the genome are more likely to sustain mutations than others, and various physical causes (e.g., radiation) are known to cause particular types of mutations. (UCMP Understanding Evolution Glossary)

Realism: philosophical premise that reality ontologically independent of individual conception, perception, etc. Objects have certain properties regardless of any thought to the contrary. As pertains to a scientific or contemporary philosophical understanding of the world, a distinction can be made between *na**ve realism*, the common view of the world including the claims that it is as it is perceived, that objects have the properties attributed to them, and that they maintain these properties when not being perceived, and *critical realism*, the view that certain types of sense data accurately represent a mind-independent reality while other types do not, for example the primary/secondary quality distinction. Na**ve realism is now universally rejected, whereas critical realism represents the current accepted paradigm. Contrast with pragmatism. (MAK, Wikipedia glossary).

Reductionism: in Philosophy, a number of related, contentious theories that hold, very roughly, that the nature of complex things can always be reduced to (be explained by) simpler or more fundamental things. This is said of objects, phenomena, explanations, theories, and meanings. In short, it is philosophical materialism taken to its logical consequences. *Ontological reductionism* is the idea that everything that exists is made from a small number of basic substances that behave in regular ways. Compare to monism, contrast with holism, emergence. *Methodological reductionism*: the idea that explanations of things, such as scientific explanations, ought to be continually reduced to the very simplest entities possible (but no simpler). Occam's Razor forms the basis of this type of reductionism. Compare with scepticism. *Scientific reductionism*: has been used to describe all of the above ideas as they relate to science, but is most often used to describe the idea that all phenomena can be reduced to scientific explanations. Also known as *Scientism*. Compare with naturalism and materialism, contrast with idealism. (from Wikipedia glossary). In Systems Theory, one kind of scientific orientation that seeks to understand phenomena by a) breaking them down into their smallest possible parts: a process known as *analytic reductionism*, or conversely b) conflating them to a one-dimensional totality: a process known as *holistic reductionism*. (Wikipedia glossary).

S.

Scepticism: generally refers to any questioning attitude of knowledge, facts, opinions, or beliefs stated as facts, or doubt regarding claims that are taken for granted elsewhere. A sceptical attitude is central to scientific method (MAK, Wikipedia)

Scala Naturae "Natural ladder", is a sort of proto-taxonomy first developed by Aristotle, according to which the natural world can be arranged in a single linear series from inanimate matter through plants, invertebrates, higher vertebrates, and finally man. Along with Plato's Principle of Plenitude it led to the idea of the Great chain of being. Scala Naturae and Great Chain of Being remained central ideas in natural philosophy until the mid 19th century.

Scientific Creationism: The belief that scientific evidence supports the literal factuality of the first eleven or so chapters of the book of Genesis in the bible, in contradiction to evolutionary mechanism theories. This is derived from early sources of the term; later ones try to dissociate "scientific creationism" from "biblical creationism" by the expedient course of not actually mentioning the Bible when discussing "scientific creationism". "Scientific Creationists" are distinguished by two features from the theistic anti-evolutionists: "Scientific Creationism" is associated only with literal inerrantist interpretations of Genesis, and "scientific creationists" take a proactive stance

on pushing their conjectures into secondary school science classrooms as science alongside or in replacement of evolutionary mechanism theories. (W. R. Elsberry talk.origins via W.J. Hudson) As with other forms of denialism, claim their own approach is more scientific than that of the consensus scientific or academic community. See also creationism (MAK)

Scientific Method: Science can be defined as "a methodical approach to the acquisition of knowledge." This distinguishes how a scientist works from how other people learn about the world. Science is an approach that is methodical, and that approach helps acquire knowledge. Science is not the knowledge gained through the approach. Knowledge can be gained through a variety of ways, but science acquires knowledge methodically. Thescientific method can be described as having seven steps: 1. Observation; 2. Question; 3. Hypothesis; 4. Prediction; 5. Experiment; 6. Analysis; 7. Decision. The end result of the scientific method is either a rejected hypothesis, or a supported hypothesis. A hypothesis that has gathered enough supporting observations and experimental results is a theory. (W.J. Hudson)

Separate creation: The theory that species, or higher taxa of an indeterminate rank, have separate origins (being created by God as separate and distinct "kinds"), there is no evolutionary relationship between them, and they never change after their origin, or only change at the microevolutionary level. A central premise of creationism, which was falling out of favour even before Darwin (see Naturphilosophie and Lamarck) (MAK)

Social Darwinism: a 19th century political philosophy which attempted to explain differences in social status (particularly class and racial differences) on the basis of evolutionary fitness. Based on the misinterpretation of Darwinian theory, Social Darwinism is generally considered unscientific by modern philosophers of science. (Wikipedia glossary)

Supernatural, Supra-physical: over and apart from the natural or physical world, and hence tending to imply a dualistic worldview. May refer to theological ideas (God, souls, etc) or pop-culture (vampires, ghosts etc). The opposite of naturalism. (MAK).

Systems theory: the transdisciplinary study of systems in general, with the goal of elucidating principles that can be applied to all types of systems in all fields of research. The term does not yet have a well-established, precise meaning, but systems theory can reasonably be considered a specialization of systems thinking and a generalization of systems science. The term originates from Ludwig von Bertalanffy's General System Theory (GST). In this context the word "systems" is used to refer specifically to self-regulating systems, i.e. that are self-correcting through feedback. Self-regulating systems are found in nature, including the physiological systems of our body, in local and global ecosystems, and in climate. See also complex system, emergence. (Wikipedia)

T.

TalkOrigins Archive: website that presents a comprehesive scientific critique of claims by young-earth, old-earth, and intelligent design creationists, and useful introduction to various evolution science topics. Uses material from the talk.origins newsgroup, collected by Brett J. Vickers in 1994 and posted as a website in 1995. Still the most comprehensive and easily accessible anti-creationism website around. Some of the material in this glossary is originally from TalkOrigins (MAK) Website

Teleology: the philosophical supposition that there is design, purpose, directive principle, or final causes in the works and processes of nature, and therefore that either design and purpose analogous to that found in human actions are inherent also in the rest of nature. Teleology is rejected by both metaphysical naturalism (e.g. Richard Dawkins), neo-pragmatism, and postmodern philosophy (as an example of a "grand narrative"). (MAK, and Wikipedia glossary)

Theism: Refers to the position of belief in a God or gods. Some more narrowly-construed versions of belief in God include: monotheism (belief in one God), polytheism (belief in many gods), pantheism (belief that God is everything), and deism (belief in a God which created the universe, but does not "interfere" with it). contrast with atheism, agnosticism (W. R. Elsberry talk.origins via W.J. Hudson, modified)

Theistic Anti-Evolutionist: Any person who expresses opposition to evolutionary mechanism theories when motivated by religious doctrine, as contrasted with those who propose alternative hypotheses and theories within the framework of the scientific method. The theistic anti-evolutionist tends to confuseevolution and evolutionary mechanism theories, which typically results in the theistic anti-evolutionist making specific criticisms of a particular

evolutionary mechanism theory while asserting that all evolutionary mechanism theories are affected. (W. R. Elsberry talk.origins via W.J. Hudson). Basically synonymous with Creationism

Theistic evolution: the view that some or all classical religious teachings about God and creation are compatible with some or all of modern scientific theory, including, specifically, evolution. It generally views evolution as a tool used by a creator god, who is both the first cause and immanent sustainer/upholder of the universe; it is therefore well accepted by people of strong theistic (as opposed to deistic) convictions. Most adherents consider that the first chapters of Genesis should not be interpreted as a "literal" description, but rather as a literary framework or allegory. Theistic evolutionists have frequently been prominent in opposing creationism

There is a continuum between theistic evolution (*sensu stricta*) and evolutionary creationism, the belief that things evolve but that God intervenes and directs evolution towards a goal (i.e. Humanity). The term *deistic evolution* has also been proposed to describe the model in which God started creation, but do not interfere in any way. Famous theistic evolutionists included Asa Gray, Darwin's correspondent, and Henry Drummond, whose *Ascent of Man* was a popular apologetic work of the 1890s. An alternative, non-supernaturalist approach is evolutionary pan(en)theism (e.g. Teilhard de Chardin) (MAK, Wikipedia, EvoWiki)

Theory: In science, a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses. It proposes a natural mechanism for a phenomenon, where the mechanism is amenable to test, provides explanatory and predictive power, is conditionally held on review of further observations and experiment, and has accumulated supporting observations and experimental results. cf. hypothesis, scientific method. (W. R. Elsberry talk.origins via W.J. Hudson)

U.

Unbelief: The position of not believing a proposition. This is distinct from disbelief in that it does not assert that the proposition is false; rather, it merely states that there is no good reason to assert that it is true or false. Unbelief is, in essence, a position of suspension of judgment on a matter, and as such does not bear any burden of proof. cf. belief (W.J. Hudson)

Uniformitarianism: Assumption that processes acting in the past are the same as those acting in the present. proposed the late 18th century theory of James Hutton that the natural forces now changing the shape of the earth's surface have been operating in the past much in the same way. The most important implication is that the earth is very old (deep time) and that the present is the key to understanding the past. Developed by Charles Lyell in the 19th century, who in turn influenced Darwin. Contrast with catastrophism, punctuated equilibrium.

V.

Victorian age: in Britian and the British colonies, the period of Queen Victoria's reign (from 1837 to 1901). A long and propsreous period, and also a tiome of graet scientific, technological, and social advancement. Evolutionary thinking and the science of paleontology are among the developments that stem from this period (and also from equivalent contemporary developments in France, Germany, and the United States)

W.

Walking with Dinosaurs: six-part natural history documentary television miniseries that was produced by the BBC, narrated by Kenneth Branagh, and first aired in the UK, in 1999. It subsequently aired in North America on the Discovery Channel in 2000, with Branagh's voice replaced with that of Avery Brooks. The programme's aim was to simulate the style of a nature documentary and therefore does not include "talking head" interviews. The series used palaeontologists such as Michael Benton, Peter Dodson, Peter Larson and James Farlow as advisors. Computer-generated imagery and animatronics were used to recreate the life of the Mesozoic, showing dinosaurs and their contemporaries as realistic animals, instead of the absurdities of Jurassic Park with its demonic velociraptors. Nevertheless, there was a lot of dramatic license taken; a lot of behavioural, colour, and other reconstructions were speculative, and for somne reason almost every animal featured had tto be described as being one and a half to twice its actual linear dimensions, or sometimes three times (who can forget the *25* meter long *Liopleurodon*?). The writers

also seemed to feel that each episode requires an obligatory tragic ending. The series was followed by other *Walking with*... series, such as 2001 the sequel *Walking with Beasts*, set in the Cenozoic era and thankfully avoiding the tear-jeerker endings; this series featured extinct mammals and birds such as *Indricotherium* and *Gastornis*. In 2005 the prequel *Walking with Monsters*, set primarily in the Paleozoic era, and showing various invertebbrates, fish, amphbians, and early reptiles. More than a decade later, the *Walking with Dinosaurs* still sets the bar for paleo reconstruction. (MAK, Wikipedia)

X.

Y.

Young Earth creationism: the belief that the Earth along with the entire cosmos was created by God within the last 10,000 years, or even 6000 or so years ago (for example the Jewish calender and the Ussher chronology) as described literally in Genesis, within the approximate timeframe of biblical genealogies. Generally Young Earth Creationists interpret the Bible literally , including not just the special, separate creation of human beings and all other species, but the historicity of Noah's flood, and attempts by some creationist thinkers to give the universe an age consistent with the Ussher chronology and other Young-Earth timeframes, e.g. C-decay.

Z.

Science : References

Science
Glossary
References

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History of Evolutionary ideas

Timeline : evolutionary biology, philosophy, popular culture, and more

Science
- Biographies
- Historical timeline
- Glossary
- References

Historical timeline
- Pre 19th Century
- 19th Century
- Early 20th Century
- Late 20th Century
- 21st Century
- References

The following pages present a timeline based on a number of different themes, to show how all of these ideas and discoveries intermixed and influenced boths cience and popular culture

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Timeline : Pre 19th Century

Science
- Biographies
- Historical timeline
- Glossary
- References

Historical timeline
- Pre 19th Century
- 19th Century
- Early 20th Century
- Late 20th Century
- 21st Century
- References

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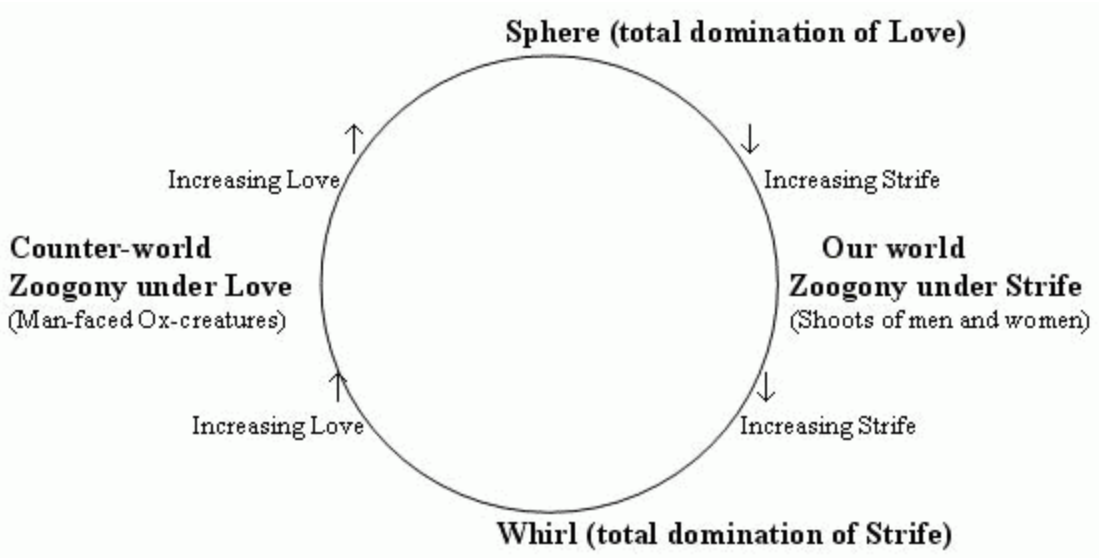
610-546 BCE: Greek philosopher, astronomer and biologist Anaximander argues that all lifeforms evolved from fish in the seas and underwent modification once it established itself on land. Anaximander also believed in an early concept of abiogenesis which stated that primitive life on earth formed from mist. (EvoWiki)

570-480 BCE: The Greek philosopher and student of Anaximander Xenophanes developed Anaximander's theories further. Xenophanes was one of the first people in history to observe the fossil record and he concluded that most of the world was covered by water in the past by observing the fossil record. (EvoWiki)

fl. 450 BCE: Empedocles, the Greek pre-Socratic philosopher who developed a cyclic cosmology based on the four classical elements and the polarity of primal powers called *Love and Strife*, which bring about the mixture and the separation of the elements respectively. Empedocles proposed that chance combinations of organs once



arose, but died out due to lack of adaptive function. This was among the first to speculate on a natural theory of evolution . (Wikipedia, EvoWiki)

Links: Internet Encyclopeadia of Philosophy - Empedocles; The Big View - Empedocles

Graphic: Empedocles's Cosmic Cycle, ©: Gordon Campbell; Internet Encyclopeadia of Philosophy.

fl. 99-55 BCE: Lucretius argues that life postdates the formation of the earth, and changes according to random variation. (EvoWiki)

800s c.e.: The medieval Muslim scientist and philosopher Al-Jahiz first describes the struggle for existence which was similar to natural selection. (EvoWiki)

1000s c.e.: The Muslim scholar Ibn al-Haitham elaborates Al-Jahiz's theories and writes a book that explicitly argued for biological evolution (although not by natural selection). (EvoWiki)

c. 1025: Abu Rayhan al-Biruni publishes the *Kitab fi Tahqiq ma li'l-Hind* (Researches on India), in which he discusses the geology of India and hypothesizes that it was once a sea. (Salam 1984). (Wikipedia - Timeline of Geology)

1027: The Persian naturalist, Avicenna, explains how the stoniness of fossils is caused in *The Book of Healing*, proposing the theory of petrifying fluids (*succus lapidificatus*). (Wikipedia - Timeline of Paleontology) . In the same work he also hypothesizes on two causes of mountains (), and proposes the law of superposition and the concept of uniformitarianism (). (Wikipedia - Timeline of Geology)

1031-1095: The Chinese naturalist, Shen Kuo, uses the evidence of marine fossils found in the Taihang Mountains to infer the existence of geological processes of geomorphology and shifting of seashores over time (in *Dream Pool Essays*), and using his observation of preserved petrified bamboos found underground in Yan'an, he argues for a theory of gradual climate change (Needham, 1986). (Wikipedia - Timeline of Paleontology)

1320-1390: Avicenna's theory of petrifying fluids (*succus lapidificatus*) is was elaborated on by Albert of Saxony in the 14th century. (Wikipedia - Timeline of Paleontology)

16th century: The theory of petrifying fluids (*succus lapidificatus*) is accepted in some form by most naturalists by this time. (Wikipedia - Timeline of Paleontology)

1556: Agricola publishes *De re metallica*. This book acts as the standard mining and assaying text for the next 250 years.(Wikipedia - Timeline of Geology)

1650: Anglican Archbishop James Usher of Ireland states that the universe was created in 4004 BCE, in direct conflict with the former prevailing Aristotlian view of a cyclical and eternal earth. (Wikipedia)

1669: Nicolas Steno puts forward his theory that sedimentary strata had been deposited in former seas, and that fossils were organic in origin. (Wikipedia - Timeline of Geology)

1676: Part of a bone, now known to have been the femur of a Megalosaurus, was recovered from a limestone quarry at Cornwell near Chipping Norton, Oxfordshire, England. The fragment was sent to Robert Plot, Professor of Chemistry at the University of Oxford and first curator of the Ashmolean Museum, who published a description in his Natural History of Oxfordshire in 1677. He correctly identified the bone as the lower extremity of the femur of a large animal, and recognized that it was too large to belong to any known species. He therefore concluded it to be the thigh bone of a giant human similar to those mentioned in the Bible. (Wikipedia - Dinosaur)

1690-1740: height of British **Deism**. the 17th century Age of Reason and 18th century Age of Enlightenment, led, via Newton and others, to *Deism*, the theory that God, the divine clockmaker, created the universe at the beginning, but did not interfere in any way since. Central to Deism and other forms of progressive 18th and 19th century theism is the idea of God as the supreme designer.

1701: Edmund Halley suggests using the salinity and evaporation of the Mediterranean to determine the age of the Earth. (Wikipedia - Timeline of Geology)

1730: Matthew Tindal's *Christianity as Old as the Creation* "became, very soon after its publication, the focal center of the deist controversy. Because almost every argument, quotation, and issue raised for decades can be found here, the work is often termed 'the deist's Bible'."

1735: Linnaeus publishes the first edition of his *Systema Naturae*, the primary antecedent of the modern science of taxonomy. Linnaeus believed in an early concept of common descent, with all plants having evolved from a common ancestor but humans and animals having been directly created by God. (EvoWiki)

1743: Dr Christopher Packe produces a geological map of south-east England. (Wikipedia - Timeline of Geology)

1746: Jean-Étienne Guettard presents the first mineralogical map of France to the French Academy of Sciences.(Wikipedia - Timeline of Geology)

1760: John Michell suggests earthquakes are caused by one layer of rocks rubbing against another. (Wikipedia - Timeline of Geology)

1764-6: The fossilised bones of a huge animal (later (in 1822 named*Mosasaurus*) are found in a quarry near Maastricht in the Netherlands. The first remains known to science were a fragmentary skull from a chalk quarry in the St Pietersberg, a hill near Maastricht, Netherlands, found in 1764 and collected by lieutenant Jean Baptiste Drouin in 1766. (Wikipedia - Timeline of Paleontology, Wikipedia - Mosasaurus)

1770: Baron d'Holbach one of the first atheists in the Western world publishes *The System of Nature* which contains early evolutionary concepts such as the idea that humans evolved over the course of time and that every living thing changes in response to its environment. (EvoWiki)

1776: James Keir suggests that some rocks, such as those at the Giant's Causeway, might have been formed by the crystallisation of molten lava. (Wikipedia - Timeline of Geology)

1779: Comte de Buffon speculates that the Earth is older than the 6,000 years suggested by the Bible. (Wikipedia - Timeline of Geology)

1785: - James Hutton presented his theory of uniformitarianism, in the *Theory of the Earth*, explaining that the Earth must be much older than previously supposed to allow time for mountains to be eroded and for sediment to form new rocks at the bottom of the sea, which in turn were raised up to become dry land. (Wikipedia)

Late 18th century: German writer, pictorial artist, biologist, theoretical physicist, and polymath Johann Wolfgang von Goethe (1749-1832) developed a distinct form of science very different to the Netwonian model, "Goethe's science is essentially qualitative and teleological in the Aristotelian sense in which processes are understood as a manifestation of "form," which is not to be explained only in causal terms. (Hjalmar Hegge - Transcending Darwinism in the Spirit of Goethe's Science: A Philosophical Perspective on the Works of Adolf Portmann). His focus on morphology and what was later called homology influenced 19th century naturalists, although his ideas of transformation were about the continuous metamorphosis of living things and did not relate to contemporary ideas of "transformisme" or transmutation of species. Homology, or as Étienne Geoffroy Saint-Hilaire called it "analogie", was used by Charles Darwin as strong evidence of common descent and of laws of variation. In 1790, he published his Metamorphosis of Plants. (Wikipedia) Goethian philosophy was to be very influential in German Naturphilosophie and more recently Anthroposophy

1794: to **1796:** - Erasmus Darwin published Zoönomia with ideas on evolution and all warm-blooded animals arising from one living filament. (Wikipedia)

1795: Georges Cuvier identifies the Mosasaur skull found in the Netherlands as belonging to an extinct reptile.. (Wikipedia - Timeline of Paleontology)

1799: William Smith produces the first large scale geological map, of the area around Bath. (Wikipedia - Timeline of Geology)

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Timeline : Early 20th Century

Science
- Biographies
- Historical timeline
- Glossary
- References

Historical timeline
- Pre 19th Century
- 19th Century
- Early 20th Century
- Late 20th Century
- 21st Century
- References

1900: Hugo De Vries and Carl Correns rediscover the work of Gregor Mendel, and publish papers the same year (EvoWiki).

1903: George Darwin and John Joly claim that radioactivity is partially responsible for the Earth's heat. (Wikipedia - Timeline of Geology)

1905: *Tyrannosaurus rex* is described and named by Henry Fairfield Osborn. (Wikipedia - Timeline of Paleontology)

1905: The Saurian Expedition of 1905, a paleontological research mission in northern Nevada, led by Professor John C. Merriam of the University of California. The expedition recovered many of the finest specimens of ichthyosaur ever found, (*Shonisaurus*, which later became the Nevada's state fossil)

1907: The French philosopher Henri Bergson's book *L'Evolution créatrice* publised (transl. into English as *Creative Evolution*, 1910); rejects naturalistic explanations of evolution in favour of immediate experience and intuition

1907: Bertram Boltwood proposes that the amount of lead in uranium and thorium ores might be used to determine the Earth's age and crudely dates some rocks to have ages between 410—2200 million years. (Wikipedia - Timeline of Geology)

1908: Godfrey H. Hardy & Wilhelm Weinberg formulate Hardy-Weinberg principle, mathematically relating the frequencies of genotypes and alleles in randomly mating populations (EvoWiki).

1909: William Bateson coins the term "genetics" (EvoWiki).

1909: Charles Walcott discovers the Burgess Shale, in the Canadian Rockies (EvoWiki).

1911: Arthur Holmes uses radioactivity to date rocks, the oldest being 1.6 billion years old. (Wikipedia - Timeline of Geology)

1912 - George Barrow mappes zones of metamorphism (the Barrovian sequence) in southern Scotland. (Wikipedia - Timeline of Geology)

1912: Alfred Wegener publishes his theory of continental drift, leading to plate tectonics and explanation of many surface features. He proposes that all the continents once formed a single landmass called Pangaea that broke apart via continental drift. (EvoWiki, Wikipedia - Timeline of Geology, Wikipedia - Timeline of Paleontology)

1912: Arthur Smith Woodward describes "Piltdown man" (EvoWiki).

1912: *The Lost World*, a novel by Sir Arthur Conan Doyle concerning an expedition to a plateau in the Amazon basin of South America where prehistoric animals (dinosaurs and other extinct creatures) still survive, alongside native americans and a tribe of ape-like creatures. This very popular work of fiction perhaps started the whole dinosaurs and cave men trend that continued through to the 1960s (Flintstones, One Million Years B.C.). Available at Project Gutenberg

1913: Albert Michelson measures tides in the solid body of the Earth. (Wikipedia - Timeline of Geology)

1913: Robert Broom describes *Euparkeria capensis* fom the Lower Triassic redbeds of South Africa, and formulates for the first time, a "thecodont" hypothesis for the origin of birds (EvoWiki).

1914: Sri Aurobindo begins writing (and publishing in installments) *The Life Divine* and other works, synthesising popular evolutionary thinking with Eastern monism. His philosophy has a number of parallels with that later and independently articulated by Teilhard de Chardin, including evolution as moving towards a collective Divine transformation.

1915: *Spinosaurus* to be found in North Africa is speculated to be the largest terrestrial predator that ever lived. (Wikipedia - Timeline of Paleontology)

1920: Andrew Douglass proposes dendrochronology dating. (Wikipedia - Timeline of Paleontology)

1920: Milutin Milankovic proposes that long term climatic cycles may be due to changes in the eccentricity of the Earth's orbit and changes in the Earth's obliquity. (Wikipedia - Timeline of Paleontology)

1920: Pentti Eskola developes the concept of metamorphic facies in geology. (Wikipedia - Timeline of Geology)

1923: *The New Geology* by Seventh-day Adventist George McCready Price was inspiration and basis for Morris and Whitcom's *The Genesis Flood* (see 1960 below). (Wikipedia)

1924: The first hominid fossil from Africa, Australopithecus africanus, is discovered by Raymond Dart. It is described the following year (EvoWiki).

1924: *The Land That Time Forgot*, a science fiction novel by Edgar Rice Burroughs, set in WWI, features the crew of a lost submarine who come across a mysterious island populated by dinosaurs, prehistoric mammals, beast men, and neanderthals. Clearly influenced by Conan Doyle's *The Lost World*. The book is in public domain and available at Project Gutenberg

1925: The Scopes Trial (Dayton, TN U.S.A.) tested the new Butler Act, which made it illegal to teach that man descended from animals in public schools. Scopes was found guilty and fined $100; prosecution lawyer William Jennings Bryan offered to pay it, but it was later set aside on a technicality after appeal to the Tennessee Supreme Court. (Wikipedia)

1925: Charles R. Knight, the greatest paleo artist of his day, produced an elaborate mural for the Natural History Museum of Los Angeles County which portrayed some of the birds and mammals whose remains had been found in the nearby La Brea Tar Pits. The following year, Knight began a 28-mural series for Chicago's Field Museum of Natural History, a project which chronicled the history of life on earth and took four years to complete. At the Field Museum, he produced one of his best-known pieces, a mural featuring *Tyrannosaurus* and *Triceratops*. This confrontation scene between a predator and its prey would inspire a huge number of imitations, establishing the two dinosaurs as "mortal enemies" in the popular consciousness. (Wikipedia)

1926-1927: the Jesuit Paleontologist Pierre Teilhard de Chardin, wrote *Le Milieu Divin* (the Divine Medium).

Teilhard prepared the first pages of his main work *Le Phénomène humain* (The Phenomenon of Man).

1928: Fredrick Griffith discovers genetic transformation of a bacterium, names agent responsible the "transforming principle" which is later shown to be DNA (EvoWiki).

1928: N. L. Bowen publishes *The Evolution of the Igneous Rocks*, revolutionizing experimental igneous petrology. (Wikipedia - Timeline of Geology)

1930: Ronald Fisher publishes Genetical Theory of Natural Selection, the first major work in what would become the Modern Synthesis (EvoWiki).

1931: Curt Stern shows recombination in *Drosophila* is due to an exchange of chromosomes (EvoWiki).

1932: The first remains of *Ichthyostega stensioei*, a stem-tetrapod from Greenland, are described by Save-Soderbergh (EvoWiki).

1933: *Vertebrate Paleontology* by Alfred Sherwood Romer published; the book would run through two more editions (1945 and 1966)

1933: King Kong, the story of a gigantic yet sympathetic ape (which, like all monster movies, ignores the inverse square law) uses stop-motion techniques of Willis O'Brien to bring dinosaurs to life, merging the tropes of dinosaur combat and dinosaurs in a lost world. O'Brien's protégé Ray Harryhausen would continue to refine this method in a number of other superb fantasy movies (Wikipedia, MAK).

1935: Charles Richter invents a logarithmic scale to measure the intensity of earthquakes (ML). (Wikipedia - Timeline of Geology)

1937: The Russian evolutionary biologist Theodosius Dobzhansky publishes *Genetics and the Origin of Species*, which fused evolutionary biology with genetics and gave rise to the Modern Synthesis (EvoWiki, Aukland Uni).

1938: A South African schoolboy discovers *Australopithecus robustus* (EvoWiki).

1941: Teilhard submitted to Rome his most important work *Le Phenomena Humaine*. In 1947 the Church forbade him to write or teach on philosophical subjects (Wikipedia). *The Phenomenon of Man* was only published posthumously. According to this cosmology, which represents a synthesis of Darwinism and Catholicism, Consciousness and Matter are aspects of the same reality. Evolution proceeds through successive stages of increasing consciousness and complexity: (a) the layers of the Earth such as geosphere, lithosophere, atmosphere etc (i.e. development of inanimate matter), (b) the Biosphere (life); (c) the Noosphere (self conscious thought, or mind; i.e. mankind); and (e) the Omega Point (all humans are united in a single Divine Christ-consciousness). Teilhard ideas later became extremely influential, in popular thought, science fiction, transhumanism, the New Age movement, and big history MAK990312

1941: Nickel-Strunz classification, Karl H. Strunz, Mineralogische Tabellen. (Wikipedia - Timeline of Geology)

1942: Ernst Mayr publishes *Systematics and the Origin of Species*, the work which arguably secured the primacy of the Modern Synthesis, and restored the validity of allopatry as a mechanism of speciation (EvoWiki).

1947: Willard Libby introduces carbon-14 dating. (Wikipedia - Timeline of Paleontology)

1947: Rudolph Zallinger paints the iconic mural The Age of Reptiles, for the Yale Peabody Museum

(1948 - 1959): Felix Andries Vening Meinesz investigations show gravity anomalies, implying that the crust is moving (together with J.H.F. Umbgrove, B.G. Escher and Ph.H. Kuenen). (Wikipedia - Timeline of Geology)

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Timeline : Late 20th Century

Science
Biographies
Historical timeline
Glossary
References

Historical timeline
Pre 19th Century
19th Century
Early 20th Century
Late 20th Century
21st Century
References

1950: Barbara McClintock publishes evidence of movable genes called transposable elements (EvoWiki).

1951: Alfred Rittmann links subduction, volcanism and the Wadati-Benioff zone. (Wikipedia - Timeline of Geology)

1953: Maurice Ewing and Bruce Heezen discover the Great Global Rift running along the Mid-Atlantic Ridge. (Wikipedia - Timeline of Geology)

1953: Francis Crick and James Watson publish a paper describing the structure of DNA, creating the field of molecular biology (EvoWiki).

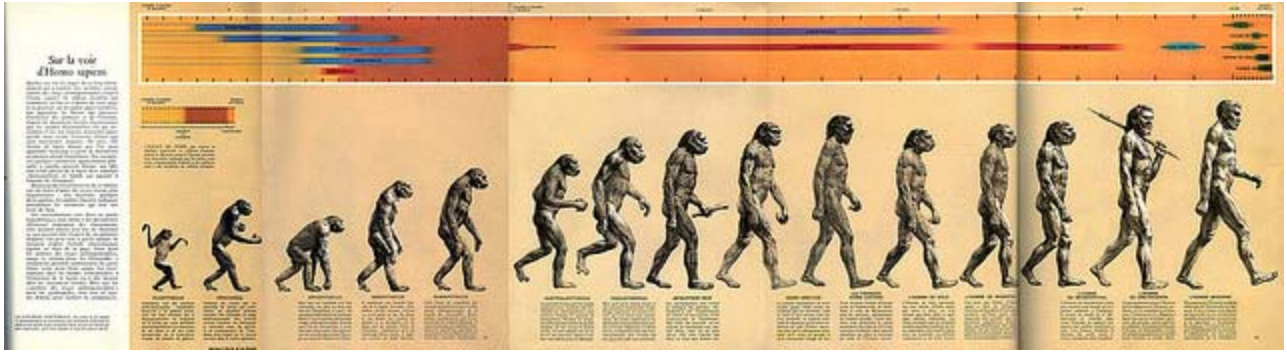
1953: First volume of the *Treatise on Invertebrate Paleontology* (or TIP) published by the Geological Society of America and the University of Kansas Press, edited by Raymond C. Moore, appears in print - Part G. Bryozoa, by Ray S. Bassler

1954: A. S. Romer publishes his legendary work, *Osteology of the Reptiles*, a book whose masterly scholarship future students of the subject are forever indebted to (EvoWiki).

1954: The Japanese sci fi movie *Godzilla* (American release 1956) portrays a huge dinosaur-like prehistoric creature that go on rampages after being awakened by atomic bomb tests, creating one of the most charismatic and recognisable monster-heros of the modren world. Ironically, Godzilla is a more sympathetic figure than the demonic raptors of Crichton and Speilberg's *Jurassic Park* more than a quarter of a century later. The 1998 American remake of Godzilla takes itself much too seriously and is a huge dissapointment (MAK)

1956: de Beer presents compelling evidence for the neotenic status of the paleognathous palate in a monographic treatment of ratite evolution (EvoWiki).

1956: *The March of Progress*, one



of the most iconic scientific illustrations ever produced, drawn by Rudolph Zallinger fpr Time-Life Books *Early Man* volume more

1959: Mary Leakey discovers "Nutcracker Man", *Australopithecus boisei* (EvoWiki).

1960: *Homo habilis* is discovered in Tanzania by the Leakeys. Initially, four specimens are recovered (EvoWiki).

1960: Harry Hess proposes that new sea floor might be created at mid-ocean rifts and destroyed at deep sea trenches. (Wikipedia - Timeline of Geology)

1960: *The Genesis Flood* by Henry Morris and John C. Whitcomb, Jr. reinvigorated the creationist movement. (Wikipedia). *Young Earth Creationism*, which claims scientific credentials, make the rather extraordinary claim that the entire geological column, with the complete fossil record it contains, is an aberration of Noah's flood! (this is known as *flood geology* - link wikipedia; link evowiki) The reasoning goes like this: dinosaurs were slower and clumbsier than mammals; they could not escape the rushing waters and were quickly overwelmed; thus their fossils occur in lower (Mesozoic) rocks. The agile mammals and birds made it to higher ground before they too were swept away; their remains thus occur in higher (Cenozoic) rocks. And so on. Disproof of this thesis is easy and has already been pointed out by Stephen Jay Gould and others. Pterosaurs could fly; some dinosaurs were very agile, some mammals very slow. Why aren't fossil sloths found with brontosaurs, hypsilophodons (a fast running dinosaur) with gazelles, and pteranodons with albatrosses? And what about invertebrates and marine life? A single modern mammal in Cambrian rocks would be sufficent to disprove evolution - none has been found. **Links:** The Talk Origins Archive - Exploring the Creation-Evolution Controversy - gives good arguments refuting Creationism. The arguments can also applies to other poor alternatives like Anthroposophy and Brahma Kumaris (Raja Yoga). See especially: The Age of the Earth by Chris Stassen - refutation of the Creationist arguments for a young Earth. MAK980528 MAK110419.

1963: Frederick Vine and Drummond Matthews explain the stripes of magnetized rocks with alternating magnetic polarities running parallel to mid- ocean ridges as due to sea floor spreading and the periodic geomagnetic field reversals (Vine–Matthews–Morley hypothesis). (Wikipedia - Timeline of Geology)

1964: William D. Hamilton formulates inclusive fitness and kin selection (EvoWiki).

1964: John H. Ostrom discovers *Deinonychus antirrhopus* from late Lower Cretaceous sediments of the Cloverly Formation, in Montana (EvoWiki).

1965: Rudolph Zallinger's iconic March of Progress appears in the Time-Life Book *Early Man*. One of the most iconic scientific illustrations ever produced, , depicting a line of human evolutionary forebears as if marching in a parade from left to right, and copied and parodied countless times

1966: George C. Williams publishes his *Adpation and Natural Selection*, effectivly putting to rest the ostensible role of group selection in evolutionary history (EvoWiki). Williams strongly critiqued explanations of adaptations worded in terms of "survival of the species" (group selection arguments). Such explanations were largely replaced by a gene-centered view of evolution, epitomized by the kin selection arguments of W. D. Hamilton, George R. Price and John Maynard Smith. (Wikipedia)

1966: Keiiti Aki discovers the seismic moment (M0). (Wikipedia - Timeline of Geology)

1966: Cladistic methodology for phylogenetic reconstruction gains popularity following the translation of German entomologist Willi Hennig's tome, Phylogenetic Systematics (EvoWiki).

1966: British fantasy film *One Million Years B.C.* that helped popularise the idea that cavemen and dinosaurs lived at

the same time. The movie, with an utterly forgettable storyline, was made famous by Raquel Welch in a fur bikini. Special effects maestro Ray Harryhausen used stop motion photography to recreate the dinosaurs. The movie was a remake of a 1940 Hollywood film of the same name. The influence of Conan Doyle's *The Lost World* is obvious in all these movies. It was released in the United States in 1967.

1969: Ostrom describes *Deinonychus antirrhopus*, sparking a revolution in dinosaur paleontology and single-handedly resurrecting the theropod origin of birds (EvoWiki).

1969: American western-fantasy film *The Valley of Gwangi* features a cowboy and dinosaur mash up (perhaps analogous to the more recent Cowboys and Aliens). It was filmed in Technicolor and is known for its creature effects provided by Ray Harryhausen, being the last prehistoric-themed film he animated. Wikipedia

1970: The Ghugua Fossil Park set up in Madhya Pradesh, India after the discovery of plant and fish fossils found in the area (Wikipedia - Timeline of Paleontology)

1972: Stephen Jay Gould and Niles Eldredge first argue for a drastically modified concept of punctuated equilibrium, in which bradytely is discounted. They argued that there was a pattern of fossil species that remained largely unchanged for long periods (*stasis*), interspersed with relatively brief periods of rapid change during speciation (EvoWiki, Wikipedia).

1973:, Leigh Van Valen proposed the term "Red Queen", which he took from *Through the Looking-Glass* by Lewis Carroll, to describe a scenario where a species involved in one or more evolutionary arms races would have to constantly change just to keep pace with the species with which it was co-evolving. Hamilton, Williams and others suggested that this idea might explain the evolution of sexual reproduction: the increased genetic diversity caused by sexual reproduction would help maintain resistance against rapidly evolving parasites, thus making sexual reproduction common, despite the tremendous cost from the gene-centric point of view of a system where only half of an organism's genome is passed on during reproduction. The gene-centric view has also led to an increased interest in Darwin's old idea of sexual selection, and more recently in topics such as sexual conflict and intragenomic conflict. (Wikipedia)

1974: Donald Johanson and Tom Gray discover a 3.5 million-year-old female hominid fossil that is 40% complete and name it "Lucy". (Wikipedia - Timeline of Paleontology)

1974: Bakker and Galton propose the monophyly of the Dinosauria, rekindling a notion discredited in the modernist consensus on archosaur phylogeny (EvoWiki).

1975, E.O. Wilson published the influential and highly controversial book *Sociobiology: The New Synthesis* which claimed evolutionary theory could help explain many aspects of animal, including human, behavior. (Wikipedia)

1975: Allan Wilson and Marie-Claire King discover the astonishing similarity between human and chimp DNA (EvoWiki).

1976: *The Selfish Gene* by Richard Dawkins summarizes and popularizes the gene-centered view of evolution

1977: Walter Gilbert & Frederick Sanger devise methods for sequencing DNA (EvoWiki).

1977: Carl Woese defines Archaebacteria by molecular phylogeny of 16S ribosomal RNA, a technique pioneered by Woese and now standard practice (Wikipedia)

1978: term "Epic of Evolution" used by Harvard biologist Edward O. Wilson to refer to a 'myth' in the sense of a grand narrative that provides a people with a meaningful placement in time, (Wikipedia)

1979: Austrian astrophysicist Erich Jantsch lectures in System Science at the University of California in Berkely, tthe following year these were expanded and published as *The Self-Organizing Universe* by Pergamon Press, providing a unifying evolutionary paradigm that incorporates cosmology, biology, sociology, psychology, and consciousness.

1979: Thomas C. Hanks and Hiroo Kanamori, Moment magnitude scale (MW), it succeeds the Richter magnitude scale. (Wikipedia - Timeline of Geology)

1980: Physicist Luis Alvarez, his son geologist Walter Alvarez, Frank Asaro, and Helen Michel propose that that the

impact of a large extraterrestrial object such as a giant comet or asteroid may have struck the Earth approximately 65 million years ago thereby causing massive extinctions (including the extinction of the dinosaurs) and enriching the iridium in the K-T boundary. (Wikipedia - Timeline of Paleontology, Wikipedia - Timeline of Geology)

1983: Phil Gingerich discovers the oldest known whale, *Pakicetus* (EvoWiki).

1984: Hou Xianguang discovers the Chengjiang Cambrian fossil site. (Wikipedia - Timeline of Paleontology)

1984: The International Archaeopteryx Conference convenes in Eichstatt, Germany (EvoWiki).

1986: Monophyly of Dinosauria becomes widely accepted following the work of Jacques Gauthier (EvoWiki).

1986: The Phylogenetic Species Concept is first elaborated. (EvoWiki).

1986: The first Antarctic dinosaur to be discovered, the ankylosaurid *Antarctopelta oliveroi*, was found on Ross Island

1988: Greg Paul's *Predatory Dinosaurs of the World* provides the first "field guide" to dinosaurs informed by the new feathered, endothermic proto-bird dinosaur renaissance paradigm of dinosaur physiology and evolution, as well as introducing Paul's magnificent iconographic skeleton drawings. Aimed at a popular audience, yet scientifically rigorous, this book shaped the imagination and ideas of a generation of paleo geeks (much as the artwork of Charles R Knight and Zdenek Burian had the previous generation), and remains a foundational work of modern popular paleontology. It also informed part of the *Jurassic Park* novel, as indicated by acknowledgement from author Michael Crichton.

1989: Stephen Jay Gould's *Wonderful Life*, the first popular account of the Cambrian Explosian and the Burgess Shale. Gould was very opposed to any concept of ascent, and uncompromising rejected the idea of evolution as leading to intelligence or higher forms of life. Later Simon Conway Morris would present a counter argument. (MAK)

1980s Protein sequencing and cladistics changed the study of taxonomy by uniting molecular evolution with evolutionary biology (which had previously relied on traditional taxonomic methods such as morphology). Modern polymerase chain reaction (PCR) techniques increased the speed of genetic analysis and discovery of greater numbers of genes, making it easier to sequence complete genomes. (Aukland Uni)

1990: Coates and Clack describe *Acanthostega gunnari*, the most basal stem-tetrapod (EvoWiki).

1990: Carl Woese proposes the three-domain system (Eubacteria, Archaea, Eucarya)

1990: Michael Crichton publishes the sci fi thriller novel *Jurassic Park*, about cloned dinosaurs that run wild, wreaking havoc on an isolated island. Crichton either was directly influenced by, or indepedently arrived at a very similar premise, to John Brosnan's *Carnosaur*, a 1984 horror novel full of gratuitous gore, about theropod dinosaurs running amock. The science of *Jurassic Park* was actually based on a very plausible hypothesis of the time - that dinosaurs could be cloned from their DNA in the stomachs of gnats and mosquitos embedded in amber, although it was discovered that DNA quickly degrades in amber so the hard science premise is unviable (there are also inaccuracies regarding the way the dinosars are described).

1990: The Discovery Institute, a non-profit free market Christian think tank based in Seattle, Washington, best known for its advocacy of intelligent design creationism.

1991: *Darwin on Trial* by Phillip E. Johnson initiated the intelligent design movement at the popular level. (Wikipedia)

1992: Eco-theologian Thomas Berry and and astro-physicist Brian Swimme's *The Universe Story From the Primordial Flaring Forth to the Ecozoic Era, A Celebration of the Unfolding of the Cosmos*, published. This work, and others by scientists, religionists, and popular writers, that follow it, have been inspired by Teilhard de Chardin to develop a religious perspective on cosmic evolution and complexification, although at the same time rejecting Teilhard's metaphysical and eschatological ideas (Omega Point, Christogenesis, etc) and his excessive anthropocentrism. These authors use terms such as *New Story*, *Universal Story*, *Great Story*, and *Everybody's Story*, and argue that science and religious faith are not mutually exclusive. The epic of cosmic, biological, and human evolution, revealed by science, becomes the basis for an inspiring and meaningful view of our place in the universe, replacing the old supernatural model such as the literal account of Genesis. More

1993: Steven Speilberg's *Jurassic Park*, based on Michael Crichton's novel of the same name, was the first popular movie to break away from the convention set by Arthur Conan Doyle's *The Lost World* with co-existing humans and dinosaurs, and, like Chrichton, attempt to portray dinosurs in a more realistic manner. The movie, as successful in its own time as Conan Doyle's book and radio adaptations was in his, leads to an entire franchise of books, films and video games centered on a fictional theme park populated with cloned and revived dinosaurs. The story not unexpectedly focused on presenting theropod dinosaurs, especially overgrown velociraptors, as evil scary monsters chasing the protagonists around the theme park, turning door knobs and opening doors. Neverthless, the movie helped popularise dinosaurs among the general public, and played a significant part in raising public awareness of Bob Bakker's dinosaur renaissance; for the first time in a major film, dinosaurs were portrayed as intelligent, agile, warm-blooded animals; although not without scientific implausibilities, such as Bakker's 60 kph *Tyrannosaurus*. How Crichton and Speilberg missed the feathered dinosaurs already present in Greg Paul's *Predatory Dinosaurs* is not clear, but the unfortunate result is that many people still think of dinosaurs as scaly reptiles.. (MAK)

Early 1990s: (more accurate date to be confirmed) UCMP website established. This was one of the very first sites devoted to paleo subjects, and for many years provided the most comprehensive and readable coverage on the topic

1994: The discovery of *Ambulocetus natans*, the walking whale, is announced by Hans Thewissen (EvoWiki).

1994: The Tree of Life Web Project established. The Tree of Life, or ToL, is an ongoing collaborative peer reviewed Internet project providing information about the diversity and phylogeny of life on Earth

1994-5: The TalkOrigins Archive began in 1994 when Brett J. Vickers collected several separately posted FAQs from the talk.origins newsgroup and made them conveniently available from a single anonymous FTP site. In 1995, Vickers created the TalkOrigins Archive web site. (Wikipedia)

1996: Michael J. Behe wrote *Darwin's Black Box*, which proposed that some biological systems are irreducibly complex. (Wikipedia)

1996: *The Structure of Big History: From the Big Bang until Today* by Fred Spier offers an ambitious defense of Big History and constructs a unified account of history across all time scales. More

1996: On October 22, Pope John Paul II sent the message On Evolution to the Pontifical Academy of Sciences, stating that "fresh knowledge" requires one to realize that evolution is "more than a hypothesis." (Wikipedia)

1996: Oceans of Kansas website founded by Michael J. Everhart. The site is still the best single resource for anything concerning Cretaceous marine reptiles and the Cretaceous inland sea.

1996: After taking Tom Holtz' Topics in Dinosaur Research class, T. Mike Keesey establishes the *Dinosauricon* on a cladistic foundation, using ascii dendrograms ("cladograms"). The Dinosauricon was the first website devoted exclusively to dinosaur phylogeny and paleo art. (ref link)

1997: The first "downy-dino", *Sinosauropteryx prima* is described (EvoWiki).

1998: Simon Conway Morris's *The Crucible of Creation: The Burgess Shale and the Rise of Animals*, a popular science book that provides a counterpole to Gould's *Wonderful Life*

1999: *Walking with Dinosaurs*, six-part British natural history documentary television miniseries that was produced by the BBC, narrated by Kenneth Branagh. It subsequently aired in North America on the Discovery Channel in 2000, with Branagh's voice replaced with that of Avery Brooks. With its CGI dinosaurs and attempt at realism, one cannot help but see the influence of *Jurassic Park*, except taht the dinos are presented much more sympathetically. The programme's aim was to simulate the style of a nature documentary and therefore does not include "talking head" interviews. The series used palaeontologists such as Michael Benton, Peter Dodson, Peter Larson and James Farlow as advisors. Computer-generated imagery and animatronics were used to recreate the life of the Mesozoic, showing dinosaurs and their contemporaries as realistic animals, instead of the absurdities of Jurassic Park with its demonic velociraptors. Nevertheless, there was a lot of dramatic license taken; a lot of behavioural, colour, and other reconstructions were speculative, and for somne reason almost every animal featured had tto be described as being one and a half to twice its actual linear dimensions, or sometimes three times (who can forget the *25* meter long *Liopleurodon*?). The writers also seemed to feel that each episode requires an obligatory tragic ending. The series was followed by other *Walking with*... series, such as 2001 the sequel *Walking with Beasts*, set in the Cenozoic era and thankfully avoiding the tear-jeerker endings; this series featured extinct mammals and birds such as *Indricotherium*

and *Gastornis*. More than a decade later, the *Walking with Dinosaurs* still sets the bar for paleo reconstruction.

Dec 1999: Pinnacle of the Dinosauricon

late 90s: By the late 1990s, many previously print journals were available electronically. 'Open access' online publication of journals also became more common, using a system whereby institutes pay for articles published by their staff, rather than a fixed subscription. (Aukland Uni)

A timeline of important events in paleontology : 19th Century

Science
Biographies
Historical timeline
Glossary
References

Historical timeline
Pre 19th Century
19th Century
Early 20th Century
Late 20th Century
21st Century
References

1800: William Smith developed the principle of faunal succession from his studies of stratigraphy in England. (EvoWiki)

1800: Georges Cuvier argues that fossils represent extinct species of living things. (EvoWiki)

1801: exhumation of a mastodon at artist/scientist Charles Willson Peale's Barber Farm Mastodon Exhumation Site, near Montgomery, New York, claimed to be the first articulated prehistoric skeleton. Wikipedia

1801: French botanist Augustin Augier publishes the first branching (tree) diagram

1802: William Paley publishes *Natural Theology* which uses the watchmaker analogy to argue for the existence of God from signs of intelligent design in the living world. (Wikipedia)

1809: William Maclure conducts the first geological survey of the eastern United States. (Wikipedia - Timeline of Geology)

1809: Jean-Baptiste Lamarck publishes his *Philosophie Zoologique*, one of the first systematic attempts at a theory of evolution. Although he did not believe all living things shared a common ancestor, he did believe they formed evolutionary gradients (EvoWiki). Lamarck believed that an innate life force drove species to become more complex over time, advancing up a linear ladder of complexity that was related to the great chain of being. Lamarck argued that changes in an organism would be inherited by the next generation and produce slow adaptation to the environment. It was this secondary mechanism of adaptation through the inheritance of acquired characteristics that would become known as Lamarckism and would influence discussions of evolution into the 20th century.

A radical British school of comparative anatomy that included the anatomist Robert Grant was closely in touch with Lamarck's French school of Transformationism. One of the French scientists who influenced Grant was the anatomist

Étienne Geoffroy Saint-Hilaire, whose ideas on the unity of various animal body plans and the homology of certain anatomical structures would be widely influential and lead to intense debate with his colleague Georges Cuvier. Grant became an authority on the anatomy and reproduction of marine invertebrates. He developed Lamarck's and Erasmus Darwin's ideas of transmutation and evolutionism, and investigated homology, even proposing that plants and animals had a common evolutionary starting point. As a young student Charles Darwin joined Grant in investigations of the life cycle of marine animals. In 1826 an anonymous paper, probably written by Robert Jameson, praised Lamarck for explaining how higher animals had "evolved" from the simplest worms; this was the first use of the word "evolved" in a modern sense. (Wikipedia)

1811: (or one or two years earlier?) Mary Anning and her brother Joseph unearthed the skull and skeleton of a 5.2 meter long animal at Lyme Regis. It would later be named *Ichthyosaurus* (now classified as *Temnodontosaurus platyodon*), which helped popularise the idea of extinct saurians

1813: Cuvier publishes *An Essay on the Theory of the Earth*, considered the first major breakthrough in biostratigraphy (EvoWiki).

1815: William Smith published The Map that Changed the World, the first geologic map of England, Wales, and southern Scotland.. (Wikipedia - Timeline of Paleontology)

1818: The first material attributed formally to a dinosaur is recovered from near Oxfordshire, England by William Buckland (EvoWiki).

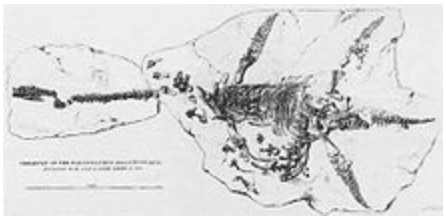
1821: William Buckland finds the remains of a hyenas' den in Yorkshire, containing the bones of lions, elephants and rhinoceros.. (Wikipedia - Timeline of Paleontology)

1821: Henry De la Beche and William Conybeare write the first scientific description of the *Ichthyosaurus* (*Notice of the discovery of a new Fossil Animal, forming a link between the Ichthyosaurus and Crocodile, together -with general remarks on the Osteology of the Ichthyosaurus*). The *Plesiosaurus* was descrined in the same paper.

1821-1822: Mary Anning discovers the world's first Plesiosaur skeleton at Lyme Regis.. (Wikipedia - Timeline of Paleontology)

1822: Gideon Mantell discovers the fossilized skeleton of an Iguanodon dinosaur. (Wikipedia - Timeline of Paleontology)

1823: Human bones are found with those of the woolly mammoth at Paviland Cave on the Gower Peninsula, proving that the two had lived on earth at the same time.. (Wikipedia - Timeline of Paleontology)



1823: Mary Anning discovers a nearly complete *Plesiosaurus dolichodeirus* skeleton.

1824: The first dinosaur taxon, *Megalosaurus*, is described, by William Buckland (EvoWiki).

1829: description of the huge Pliocene proboscidean *Deinotherium giganteum* by German naturalist Johann Jakob Kaup. In 1836 an entire skull, was found in the Lower Pliocene beds of Eppelsheim, Hesse-Darmstadt, indicating an animal exceeding modern elephants in size.

1830: *Duria Antiquior - A more Ancient Dorset*, watercolour painted by geologist Henry De la Beche based on fossils found by Mary Anning; the first pictorial representation of a scene from deep time based on fossil evidence.

1830 - 1833: Sir Charles Lyell (student of Buckland) publishes his *Principles of Geology*, wherein he formulates uniformitarianism and refutes catastrophism, and describes the world as being several hundred million years old. (EvoWiki, Wikipedia - Timeline of Geology).

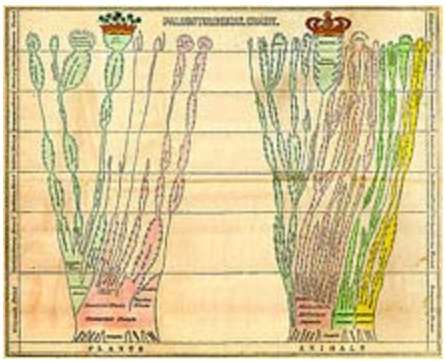
1831: Charles Darwin departs on his voyage on the Beagle (EvoWiki).

1836: American geologist Edward Hitchcock describes the footprints of giant birds from Jurassic formations in Connecticut. (Wikipedia - Timeline of Paleontology)

1836: William Buckland, theologian and geologist, publishes *Geological and Mineralogical Considerations with Reference to Natural Theology* which was sixth in the Bridgewater Treatises series and rejected a global flood. (Wikipedia)

1837: Louis Agassiz begins his glaciation studies which eventually demonstrate that the Earth has had at least one ice age. (Wikipedia - Timeline of Geology)

1838: Charles Darwin formulates the theory of natural selection (EvoWiki).



Fold-out paleontological chart of Edward Hitchcock in 'Elementary Geology' (1840). It shows two trees: one for plants, one for animals. This 'tree of life' is the earliest known version that incorporates paleontological and geological information. However, unlike the later trees of Haeckel, Hitchcock did not intend this to erepresent a naturalistic theory of evolution. Wikipedia; Public Domain)

1840: Edward Hitchcock publishes the first Tree of Life based on paleontology. It shows a branching diagram of the plant and animal kingdom against a geological background (the vertical axis). He referred to it as a tree. However, it is not a true evolutionary tree of life, because Hitchcock saw a Deity as the agent of change (Wikipedia)

1841: August Breithaupt, Vollstandiges Handbuch der Mineralogie. (Wikipedia - Timeline of Geology)

1842: Richard Owen applies the name Dinosauria to a group of extinct Mesozoic reptiles (EvoWiki).

1844: Charles Darwin writes his unpublished Essay on evolution by natural selection (EvoWiki).

1844: Scottish publisher Robert Chambers anonymously published an extremely controversial but widely read book entitled *Vestiges of the Natural History of Creation*. This book proposed an evolutionary scenario for the origins of the Solar System and life on Earth. It claimed that the fossil record showed a progressive ascent of animals with current animals being branches off a main line that leads progressively to humanity. It implied that the transmutations lead to the unfolding of a preordained plan that had been woven into the laws that governed the universe. In this sense it was less completely materialistic than the ideas of radicals like Robert Grant, but its implication that humans were only the last step in the ascent of animal life incensed many conservative thinkers. The high profile of the public debate over *Vestiges*, with its depiction of evolution as a progressive process, would greatly influence the perception of Darwin's theory a decade later.(Wikipedia)

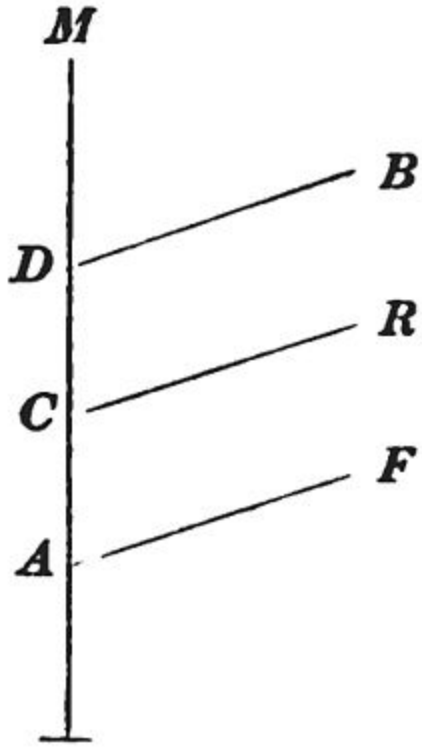


Diagram from *Vestiges of the Natural History of Creation* (1844) by Robert Chambers shows a model of development where fish (F), reptiles (R), and birds (B) represent branches from a path leading to mammals (M). Wikipedia; Public Domain)

1848: James Dwight Dana, Manual of Mineralogy. (Wikipedia - Timeline of Geology)

1851: Carl Jacob Sundevall is among the first to propose that myology might be useful in understanding avian relationships (EvoWiki).

1854: Alfred Russel Wallace departs for the Malay Archipelago (EvoWiki).

1854: Unveiling of the *Crystal Palace Dinosaurs*, a series of sculptures of dinosaurs and extinct mammals located in Crystal Palace, London. Commissioned in 1852 and unveiled in 1854, they were the first dinosaur sculptures in the world, pre-dating the publication of Charles Darwin's *On the Origin of Species* by six years. Designed and sculpted by Benjamin

Woodcut of the famous banquet in Benjamin Waterhouse Hawkins' standing Crystal Palace Iguanodon, New Year's Eve 1853. Wikipedia; Public Domain)

Waterhouse Hawkins under the guidance of Richard Owen (Wikipedia)

1855: The first *Archaeopteryx* fossil found in Bavaria, Germany. (Wikipedia - Timeline of Paleontology)

1856: Neanderthal man (*Homo neanderthalensis* holotype) discovered by Johann Fuhlrott in the Neander Valley, Germany (EvoWiki).

1857: Philip Henry Gosse published *Omphalos: An Attempt to Untie the Geological Knot*. Omphalos is Greek for "navel". Gosse was a brilliant naturalist who invented the first stable seawater aquarium. Gosse's book was an attempt to reconcile biblical literalism with geological uniformitarianism by adopting a Surrealist or Surrogate Realist (an anti commonsense realist) view of uniformitarianism and science generally. The book's Surrealist interpretation of science can be summed up God created the world *as if* the teachings of geology & science are true. Gosse's position is sometimes referred to as "Theological Surrealism" (see Jarrett Lepin for less trivial examples of Surrealism). Gosse's theme within the book was whether Adam and Eve had belly buttons (remnants of a link between the placenta and the baby). Since Adam and Eve did not have human parents they should not have belly buttons. This theme underlies the tension between geological records and biblical fundamentalism. His book was rejected by both sides of the debate because it "cuts no ice". Much of 21st century Creationist, Intelligent Design Theories flirt with Gosse's surrealist tenets to create an alternative and competing science. (Wikipedia)

1858: Charles Darwin and Alfred Russel Wallace publish a joint paper on natural selection (EvoWiki).

1858: The first first dinosaur skeleton was discovered, in marl pits in the small town of Haddonfield, New Jersey (although fossils had been found before, their nature had not been correctly discerned). It was described by Joseph Leidy, who named the creature was named *Hadrosaurus foulkii*, and realised it to be clearly a bipedal creature, in contrqast to the quadrapedal and incorrect Crystal Palace Dinosaurs. (Wikipedia - Dinosaur)

1859: Charles Darwin published *The Origin of Species* regarding the theory of evolution, after over 20 years of research and discovery.. The printing sells out on the first day. Darwin was prompted to publish by the publication of an essay by Alfred Russel Wallace, which independently summarized the theory. The theory's most profound element, "natural selection," challenged the generally accepted idea of divine intervention in species formation, leading to strong reaction to Darwin's theory. (Wikipedia)

1860: Liberal theologians published Essays and Reviews supporting Darwin. A debate of Darwin's theory was arranged at the Oxford Museum, with Thomas Huxley among its defenders and Samuel Wilberforce, the Bishop of Oxford leading its critics. Later accounts indicate Sir Joseph Hooker was most vocal in defending Darwinism. (Wikipedia).

1861: The London *Archaeopteryx* specimen is discovered in Germany (EvoWiki).

1862: Lord Kelvin attempts to find the age of the Earth by examining its cooling time and estimates that the Earth is between 20—400 million years old. (Wikipedia - Timeline of Geology)

1862: Henry Bates describes Batesian mimicry using coloring on butterflies (EvoWiki).

1865: Gregor Mendel publishes his primary research on inheritance (EvoWiki).

1866: Ernst Haeckel's *Generelle Morphologie der Organismen* forms the foundation for evolutionary systematics, phylogeny, embryology, and more. Haeckel's work essentially integrates Naturphilosophie and Darwinism.

1867: Thomas H. Huxley publishes the first major classification of the class Aves since the work of Spencer Fullerton Baird (1858), using the morphology of the sternum and palatal configuration as key characters for understanding avian relationships (EvoWiki).

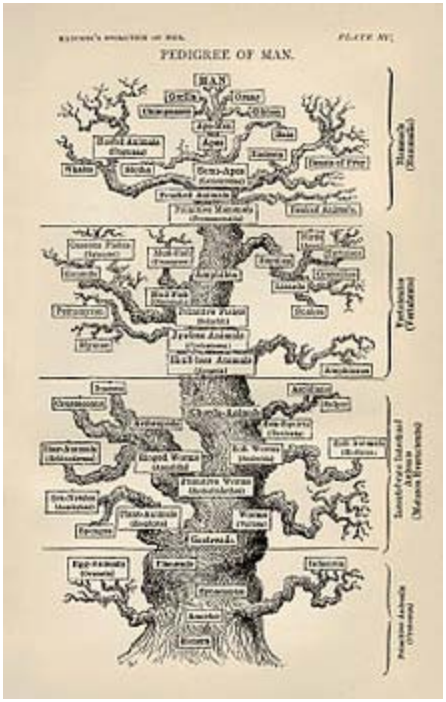
1868: Thomas H. Huxley proposes the theropod ancestry of birds (EvoWiki).

1869: Joseph Lockyer starts the scientific journal *Nature*. (Wikipedia - Timeline of Paleontology)

1871: Othniel Charles Marsh discovers the first American pterosaur fossils.. (Wikipedia - Timeline of Paleontology)

1877: The Berlin *Archaeopteryx* is described (EvoWiki).

1878: The first *Diplodocus* skeleton is found at Como Bluff, Wyoming. (Wikipedia - Timeline of Paleontology)



The Tree of Life as seen by Ernst Haeckel in *The Evolution of Man* (1879). Haeckel was an atheistic philosopher and scientist and staunch supporter of Darwinism and naturalistic theories of evolution. Diagram from Wikipedia; Public Domain

1879: Ernst Haeckel's famous illustration published in *The Evolution of Man*, which shows a Great Chain of Being model with *Homo sapiens* at the top. Although this would seem an anthropocentric step backwards in relation to his earlier but more contemporary-looking three-kingdom model, it should be remembered that for Haeckel, as for many 19th century evolutionists, humans were considered the pinnacle of evolution. Teilhard de Chardin serves as an early 20th century example.

1884: Marcel Alexandre Bertrand, Nappe and Thrust fault theory.(Wikipedia - Timeline of Geology)

1891: Haeckel's student Eugene Dubois discovers *Pithecanthropus* (now known as *Homo erectus*) specimen on the Indonesian island of Java ("Java Man") (EvoWiki).

Page Back | Unit home | Page Top | Page Next

images not loading? | error messages? | broken links? | suggestions? | criticism?

contact us


>

Timeline : 21st Century

Science
- Biographies
- Historical timeline
- Glossary
- References

Historical timeline
- Pre 19th Century
- 19th Century
- Early 20th Century
- Late 20th Century
- 21st Century
- References

2000: The Paleobiology Database, an authoritative online resource for information on the distribution and classification of fossil animals, plants, and microorganisms founded

.

2000: Toby White's Vertebrate Notes established. In 2002 this would be merged with MAK's paleo pages at Kheper net to become Palaeos com (more).

2001: Astrophysicist and science educator Eric Chaisson, the author of Cosmic Evolution: Rise of Complexity in Nature, (Harvard Univ. Press, 2001) and *Epic of Evolution: Seven Ages of the Cosmos*, (Columbia Univ. Press, 2006). Chaisson's account of Cosmic Evolution is based on evolutionary directionality,, and he divides this into 'Seven Ages of the Cosmos': Particulate, Galactic, Stellar, Planetary, Chemical, Biological and Cultural, with evolution continuing into the future. (Wikipedia) More

2001: Mikko's Phylogeny Archive established. This site would become the largest interlinked dendrogram.

2002: Chased by Dinosaurs is a BBC program featuring features wildlife presenter and naturalist Nigel Marven as a time-traveller who encounters dinosaurs in the wild. The two-part series, a sequel to *Walking with Dinosaurs*. A three part sequel, *Sea Monsters*, was later broadcast in 2003. In 2006 the similar series Prehistoric Park, a six-part mockumentary *Prehistoric Park* was produced by ITV. It features Marven going through a time portal to various geological periods to bring back live specimens for a breeding program; special effects by the Walking with Dinosaurs team, Features fairly realistic animals and introduced some scientific speculation. Cancelled in favour of Primeval.

2002: launch of Palaeos com (due to difficulties in maintaining it, the site would later go off line in 2006 and again 2009-2010)

2004: Discovery of the Devonian fish-amphibian "missing link" *Tiktaalik* on Ellesmere Island in Nunavut, Canada. The species was described scientificxally two years later.

2005: Although Wikipedia first came online in 2001 it was only by about 2005 that it began to include a reasonable amount of articles on Paleo subjects, although most were very stubby or of poor quality (during this time the one of us contributed a number of entries). As of 2011 Wikipedia contains a large amunt of good quality articles (and even more stubby ones) and is easily the largest single reference of paleo topics (however it is not the largest Paleo only website as it is, obviiously, devoted to many other topics). With information now flowing the other way, it is also now (late 2011) an invaluable resource for padding out incomplete entries here on Palaeos MAK111205

2005: *Walking with Dinosaurs* the prequel *Walking with Monsters*, set primarily in the Paleozoic era, and showing various invertebrates, fish, amphbians, and early reptiles.(MAK, Wikipedia)

2006: Eric Chaisson's *Epic of Evolution: Seven Ages of the Cosmos*, provides a unifying cosmic-evolutionary worldview of the Universe and our sense of place in it More

2007: British science fiction television series *Primeval*, tells of a team of scientists investigating the appearance of temporal anomalies through which prehistoric and futuristic creatures enter the present. Created by Adrian Hodges and Tim Haines, who previously created the Walking with Dinosaurs/Beatss/Monsters documentary series.

2007: Pope Benedict XVI publishes Creation and Evolution, where he writes "This clash (between evolution and Creationism) is an absurdity because on one hand there is much scientific proof in favor of evolution, which appears as a reality that we must see and which enriches our understanding of life and being as such." (Wikipedia)

2008: Dinosauricon defunct

2009: Fossils of *Titanoboa* are unearthed in the coal mines of Cerrejón in La Guajira, Colombia. This large snake gives a hint that Earth was warmer than 90°F (30°C). (Wikipedia - Timeline of Paleontology)

2009: Description and publicity around "Ida" (*Darwinius masillae*) a genus of basal primate (Adapiformes) from the Eocene of Germany. The original fossil was discovered in 1983. The genus was named in commemoration of the bicentenary of the birth of Charles Darwin. The creature appeared superficially similar to a modern lemur. Wikipedia - more

2010: Greg Paul publishes *The Princeton Field Guide to Dinosaurs* (published in the UK as *Dinosaurs: a Field Guide*). Updates *Predatory Dinosaurs of the World* with new discoveries, and illustrations of other dinosaurs as well as theropods. Covers 735 species with over six hundred of Paul's illustrations. However, each species is given less consideration than in the previous work.

Late 2010: Mikko's Phylogeny Archive no longer updated.

2011: *Xiaotingia zhengi* an *Archaeopteryx*-like animal from early Late Jurassic of western Liaoning, China described; affirms dromaeosaur relationships of *Archaeopteryx* and other transitional dino-birds.

2011: re-launch of revised Palaeos com (though still under construction)

References

Science
- Biographies
- Historical timeline
- Glossary
- References

Historical timeline
- Pre 19th Century
- 19th Century
- Early 20th Century
- Late 20th Century
- 21st Century
- References

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Timeline - Avicenna

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Timeline - Avicenna


>

Biographies

Biographies Main Page | Biographies - Introduction

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
References

Page under construction

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

Page Back: Science | Unit Home (You are here) | Page Top | Page Next: Scientists

images not loading? | error messages? | broken links? | suggestions? | criticism?

contact us

page uploaded MAK111005

Biographies - A

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
A
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

A.

Agassiz, Louis Swiss anatomist, geologist, paleontologist and ceaseless critic of Darwinian evolution. He studied under Cuvier in Paris, and later taught at Harvard. In 1861, the very year Archaeopteryx was discovered, Agassiz cited the reptile/bird gap as one which evolutionary theory could never surmount, a claim which Thomas Huxley effectively put to rest. Agassiz also described the first fossils attributable to ostracoderms, which would later be formally described as a taxon by E. D. Cope, and described the first fossils of coelacanths (and named them so). Agassiz was the first to recognize the Ice Ages. He was one of the earliest to study and recognize the extent of glacier advance in both Europe and North America. Glacial Lake Agassiz, the Pleistocene precursor to Lake Winnipeg, was named to honor his work in glaciology in North America. (EvoWiki)

Anaximander (c.610 b.c.e. - c. 546 b.c.e.) pre-socratic philosopher of Ionia. Develop a theory of abiogenesis and proto-evolutionary naturalism: he believed that humans and other animals developed from a fish-like organism and that life formed from mist. He described his theories in his book *On Nature*, but his book has been lost and most of our information on his theories come from second-hand quotes found in other books. Anaximander also believed there are multiple planets in the universe that harbor life. (from EvoWiki)

Anning, Mary (1799-1847) English fossil collector who made a number of dramatic discoveries in the Early Jurassic marine fossil beds at Lyme Regis, which shapef the Victorian (and hence the scientific) understanding of prehistoric life and the history of the earth. The tongue twister "she sells seashells on the seashore" is based on her. Wikipedia

Aristotle: (384-322 b.c.e.), student of Plato, ancient Greek polymath, who wrote on Logic, Physics, Astronomy, Biology, Psychology, Metaphysics, Ethics, Politics, Rhetoric, and Poetics. In biology, he made numerous very detailed observations, including many dissections; some of his observations have proved

remarkably accurate. He also produced the first detailed taxonomy, dividing animals into blooded and bloodless ones, and from there into further subcategories, see *Scala Naturae*. His view of the history of life was non-evolutionary and non-creationist; he believed that the Universe is eternal, being pretty much the same for all time. Species don't evolve, but they had always been in existence. He also believed that living things have three types of vital force: the vegetable soul, that all living things have, the animal soul, that all animals have, and the rational soul, that only humanity has. (EvoWiki)

Biographies : B

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
B
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

B.

Bakker, Robert T.: popular figure in dinosaur paleontology, largely credited with the "dinosaur renaissance" of the late 1960s and 1970s. Bakker was influential in asserting the (now accepted as standard) monophyly of Dinosauria, with Peter Galton in 1974, as well as the (now generally rejected) theory that dinosaurs were fully endothermic, like birds and mammals (the current paradigm tends towards fast-growing and endothermic young becoming slower metabolic gigantothermic adults, although even here there is no consensus). His easily readable and highly informative *The Dinosaur Heresies* published in 1986, presented for the first time to the public a synopsis of the new view of dinosaurs. An accomplished illustrator, his drawings were among the first to present dinosaurs as intelligent, active, bird and mammal-like animals, rather than the hulking dim-witted sluggards of popular imagination. Bakker is also a Pentecostal preacher who admires the early Catholoic theologian Augustine and finds no contradiction between religion and evolution (compare non-overlapping magisteria). One of Bakker's students, Greg Paul, is perhaps the single most influential paleo artist around today, and also maintains the endothermic dinosaur theory (Douq (Dmill96), tk at EvoWiki, MAK)

Benton, Michael J. : British paleontologist, professor of vertebrate palaeontology in the Department of Earth Sciences at the University of Bristol. and author of many papers and several popular science books, as well as the palaeontology text book *Vertebrate Palaeontology*. He has also advised on many media productions including BBC's Walking with Dinosaurs. His research interests include: diversification of life, quality of the fossil record, shapes of phylogenies, age-clade congruence, mass extinctions, Triassic ecosystem evolution, basal diapsid phylogeny, basal archosaurs, and the origin of the dinosaurs. He has worked on diapsid phylogeny (being with Gauthier and others among the pioneers in the application of cladistics to paleontology), the integration of paleontology and molecular clocks, biotic diversity based on supra-specific taxa, and the fossil record near and at the Permo-Triassic boundary. His college entry level textbook *Vertebrate Palaeontology* replaces Colbert's *Evolution of the Vertebrates*, and integrates the earlier evolution trees (spindle diagrams or Romerograms) and Linnaean ranking evolutionary taxonomies of earlier workers like Romer, Colbert, and Carroll with cladistic methodologies. He is also one of many critics of the phylocode approach.

Bertalanffy, Karl Ludwig von (1901-1972) Austrian-born biologist and one of the founders of general systems theory, an interdisciplinary practice that describes systems with interacting components, applicable to biology, cybernetics, and other fields. Bertalanffy proposed that the laws of thermodynamics applied to closed systems, but not necessarily to "open systems," such as living things. His mathematical model of an organism's growth over time, published in 1934, is still in use today. (Wikipedia)

Broom, Robert South Africa's most prestigious paleontologist, and though his work spanned a variety of taxa his most important contributions to the science of avian phylogeny and origins, was his specific elaboration of a "pseudosuchian" hypothesis whereby basal Archosauria gave rise to birds, and theropods merely converged with Aves. Broom advanced Euparkeria capensis, a marvelous reptile from the Early Triassic beds of South Africa, which he described in 1913, as precisely the sort of "pseudosuchian" progenitor of birds one should expect. Broom's work was profoundly influential and largely led Heilmann to author the most eloquent and definitive account of what has commonly been called the "thecodont" hypothesis for bird origins, in his 1926 tome.

Broom is also widely regarded for his discovery of the first robust australopithecine specimen in 1938, and, in 1947, a partial skeleton instrumental in establishing bipedality in *Australopithecus africanus*. (EvoWiki)

Buckland, William (1784-1856) English geologist, palaeontologist and Dean of Westminster, who wrote the first full account of a fossil dinosaur, which he named Megalosaurus. His work proving that Kirkdale Cave had been a prehistoric hyaena den was widely praised as an example of how detailed scientific analysis could be used to understand geohistory by reconstructing events from deep time. Early in his career Buckland believed that he had found geologic evidence of the biblical flood, but later became convinced that the glaciation theory of Louis Agassiz provided a better explanation, and he played an important role in promoting that theory in Great Britain. (Wikipedia)

Burian, Zdenek (1905-1981) Czech painter and book illustrator whose work played a central role in the development of palaeontological reconstructions during a remarkable career spanning five decades. He illustrated over 500 books (including natural history and numerous classic novels such as Robinson Crusoe, Tarzan, Plutonia) and some 600 book covers; total works are estimated to number between 15,000 and 20,000 paintings and drawings. Since the late 1950s and early 1960s when Burian's work became known in the west through a series of large-format books released by the Artia publishing house, numerous scholarly and popular books on prehistoric life have featured his work, either as originals or as art based closely on them. Worked in initial cooperation with university palaeontologist Josef Augusta from 1938/39 (during World War II all universities in Czechoslovakia were closed due to the German occupation) and subsequently (following Augusta's death in 1968) with Zdenek Spinar. Close to 500 prehistoric images were painted by him between the early 1930s and the late 1970s, featuring everything from the earliest invertebrates to a vast array of fish, amphibians, reptiles, mammals and birds, as well as panoramic vistas of the landscapes in which they lived. Earlier palaeo works depicting North American species were inspired by the pioneering American palaeo-artist Charles R. Knight. Previous palaeo-artists had often produced speculative works reflecting 19th century views of large dinosaurs as lethargic reptiles akin to giant lizards with sprawling limbs, but Burian convincingly painted them as active animals with parasagittal (mammal or bird-like) limb-movement and musculature. (Wikipedia) link with many artworks illustrated bio, exhibition and short bio

Figure, right. *Tyrannosaurus rex* charges the "duck billed" herbivore *Trachodon* (later renamed *Anatotitan* and *Edmontosaurus*). Whilst the erect gait and portrayal of dinosaurs as highly active animals modern, in other respects this pre-dinosaur renaissance image is outdated, and perhaps based on the Charles Knight material (the tail of *T rex* is too long, duckbills didn't have a "duck bill", the body of both species was held more horizontally) it is full of colour and movement. Burian's work, like Knight's, was immensely inspiring to me during my childhood days; these two artists pretty much shaping my idea of what the prehistoric world was like. (MAK)


>

Page Back | Unit Up: Science | Page Next
Unit Back: Science | References | Unit Next Timeline

Biographies : C

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
C
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

C.

Carroll, Robert L. (b. 1938) American vertebrate paleontologist who specialises in Paleozoic amphibians and basal amniotes (reptiles and proto-reptiles). Went to Harvard University where he studied biology and paleontology under Alfred Sherwood Romer. Author or co-author of a large number of scientific papers and monographs and several books, including *Vertebrate Paleontology and Evolution* (1988), an update to Romers classic *Vertebrate Paleontology*, and the last major textbook on the subject which uses evolutionary rather than cladistic systematics.

Cavalier-Smith, Thomas: (b. 1942) Canadian microbiologist, revolutionary and controversial thinker, published extensively on the classification and evolution of protists. "(In 1981 Cavalier-Smith) introduced the kingdom Chromista, defined then as now on both ultrastructural and molecular grounds. This kingdom is now widely accepted, including by the Catalogue of Life, although the scope and content of the Chromista are still being refined. Cavalier-Smith (1987) circumscribed and raised a putatively basal protozoan group, Archaezoa, to kingdom rank, at the same time raising both Eubacteria and Archaebacteria to kingdom rank, effectively creating an eight-kingdom scheme. Subsequently it was discovered that the "Archaezoa" were not, as thought, primitively amitochondriate, their condition being derived, and this kingdom was abandoned. Cavalier-Smith currently treats Bacteria as a single prokaryote kingdom and his system remains at six kingdoms (Cavalier-Smith 2004)." (Towards a management hierarchy (classification) for the catalogue of life - Draft Discussion Document), these being Bacteria, Protozoa, Chromista, Plantae (including red and green algae), Fungi, and Animalia. Proposed and described many new taxa, including Amoebozoa, Archaeplastida, Chromalveolata, Excavata, Opisthokonta, and Rhizaria. Published prodigiously on issues such as the origin of various cellular organelles (including the nucleus, mitochondria), genome size evolution, and endosymbiosis. Many of his strongest claims have not gained widespread acceptance in the scientific community to date. Advocates evolutionary systematics over Hennigian (cladistic) phylogeny. Rejects the current three domain paradigm and instead argues for a recent (Neoproterozoic) origin of the Archaea, coined the term Neomura and argues for its origin in the Actinobacteria (a Eubacterial clade). (modified from Wikipedia)

Chambers, Robert: (1802 - 1871) Scottish editor, publisher, geologist, evolutionary thinker, and author of *Vestiges*

of the Natural History of Creation. This book was first published anonymously in England in 1844, which incorporated or integrated themes from Naturphilosophie and contemporary scientific theories to propose the progressive transmutation of species on the cosmological and biological level. While not a theory of evolution in the Darwinian sense, Chamber's work was very popular and paved the way for the reception of Darwin's ideas.

Colbert, Edwin H.: (1905-2001), American vertebrate paleontologist, made an important study of the early theropod dinosaur *Coelophysis*; his highly readable books influenced a generation of paleo-enthusiasts (including yours truly) in the 60s through to the 80s. (MAK)

Conway Morris, Simon: (b. 1951) English paleontologist who following a detailed study of the Burgess Shale fossils presented an opposite hypothesis to that argued by Stephen Jay Gould in *Wonderful Life* . In his own book on the subject, *The Crucible of Creation* and elsewhere he argues that the previously enigmatic Cambrian organisms were actually related to modern phyla. A Christian and admirer of Teilhard de Chardin, he is also actively involved in various science and religion debates, and is critical of creationism and intelligent design on the one hand and materialism and reductionism on the other. In his book *Life's Solution: Inevitable humans in a Lonely Universe*, he argues that evolutionary convergence repeatedly tends towards the same solutions, so a humanoid form of life would be inevitable. "The evolutionary routes are many, but the destinations are limited." (*Life's Solution: Inevitable Humans in a Lonely Universe*, 2003, p. 145, cited at Fossils and other living things blog). (MAK, also Wikipedia)

Cope, Edward Drinker: (1840 - 1897) important American paleontologist and comparative anatomist, whose competition with Othniel Charles Marsh for the discovery of new fossils became known as the "Bone Wars". Cope was born in Philadelphia to Quaker parents. At an early age he became interested in natural history, and in 1859 communicated a paper on the Salamandridae to the Academy of Natural Sciences at Philadelphia. In 1865 he was appointed curator to the Academy of Natural Sciences, a post which he held till 1873. From 1864 to 1867 he was professor of natural science in Haverford College, and in 1889 he was appointed professor of geology and paleontology by the University of Pennsylvania. From 1871 to 1877 he carried on explorations in the Cretaceous strata of Kansas, the Tertiary of Wyoming and Colorado; and in course of time he made known at least 1,000 species and many genera of extinct vertebrata new to science. Among these were some of the oldest known mammalia, obtained in New Mexico. He served on the U.S. Geological Survey in 1874 in New Mexico, in 1875 in Montana, and in 1877 in Oregon and Texas. He was also one of the editors of the *American Naturalist*. (EvoWiki)

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>

Biographies : D

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
D
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

D.

Dart, Raymond: influential anatomist and paleoanthropologist at South Africa's University of Witwatersrand. In 1925 he described *Australopithecus africanus*, the "Taung child", in the journal Nature. Despite the initial skepticism of his claim that Australopithecus was a hominid (with the exception of Robert Broom, who remained a strong supporter) in light of the discrepancies between his specimen and "Piltdown man", described shortly before, Dart eventually won the academic concensus in the 1940's after a series of additional discoveries. (EvoWiki)

Darwin, Charles: 19th-century naturalist considered the father of the science of evolution. His landmark work, *On the Origin of Species*, published in 1859, presented a wealth of facts supporting the idea of evolution and proposed a viable theory for how evolution occurs, via the mechanism he called "natural selection" (as a natural process analogous to artificial selection) Also published important works on coral reefs and on the geology of the Andes, and a popular travelogue of his five-year voyage aboard HMS Beagle, and a comprehensive scientific stupy of barnacles. (adapted from PBS evolution Glossary)

Darwin's theory of evolution through natural selection can be summarised by means of three principles:

1. *Principle of variation*. Among individuals within any population, there is variation in morphology, physiology, and behavior.
2. *Principle of heredity*. Offspring resemble their parents more than they resemble unrelated individuals.
3. *Principle of selection*. Some forms are more successful at surviving and reproducing than other forms in a given environment

(Griffiths AJF, Miller JH, Suzuki DT, et al. "Introduction", in *An Introduction to Genetic Analysis*. 7th edition. New York: W. H. Freeman; 2000)

More

Dawkins, Richard: English evolutionary biologist who has taught zoology and is the author of several books on evolution and science, including *The Selfish Gene* (1976) and *The Blind Watchmaker* (1986). He is known for his popularization of Darwinian ideas, as well as for original thinking on evolutionary theory. A committed atheist, he strongly argues for metaphysical naturalism. (PBS evolution Glossary, MAK)

Dennett, Daniel Clemont: (b. 1942) philosopher and cognitive scientist, author of many popular science and philosophy books, focusing primarily on philosophy of mind, elucidating an functionalist theory he calls "Multiple Drafts". The idea, he says, is that consciousness is commonly thought to occur in a single place in the brain, a "Cartesian Theater", where we sit and witness its goings-on. He believes that it is more accurately modeled as a multitude of information states, like the multiple drafts (hence the name) of a paper. He is also known for his insightful and wide reaching looks at evolutionary biology. Dennett has strongly criticised theories of group selection, repeatedly leveled arguments against Stephen Jay Gould, and staunchly defended gene selection. Dennett was a student of Willard van Orman Quine and is a close friend of Richard Dawkins and Edward Wilson. He is a proponent of atheism and philosophical naturalism (The belief that the supernatural does not exist and all that exists is matter and energy). His influential and controversial 1995 book *Darwin's Dangerous Idea* explains why he believes natural selection to be the single most brilliant and Earth-shattering idea ever conceived. Dennett argues that Darwinian evolution, as it can occur wherever there are imperfect replicators which display some kind of phenotype-like effect, applies to far more than the origin of species, such as with the idea of memetics and neural Darwinism. (from EvoWiki)

Dodson, Peter: American paleontologist who has published many papers and written and collaborated on books about dinosaurs. An authority on Ceratopsians, he has also authored several papers and textbooks on hadrosaurs and sauropods., Dodson described *Avaceratops* in 1986; *Suuwassea* in 2004, and many others, while his students have named *Paralititan* and *Auroraceratop*s. He has conducted field research in Canada, the United States, India, Madagascar, Egypt, Argentina, and China. A professor of vertebrate paleontology and of veterinary anatomy at the University of Pennsylvania, Dodson has also taught courses in geology, history, history and sociology of science, and religious studies. Describing himself as a "deeply committed Christian," Dodson subscribes to theistic evolution and has argued that there is no real conflict between religion and science. (Wikipedia)

Hans Driesch (1867–1941). German biologist and philosopher. He is most noted for his early experimental work in embryology and for his neo-vitalist philosophy of entelechy. Under the influence of his teacher Haeckel, Driesch had tested the mechanistic embryological theories of another of Haeckel's students, Wilhelm Roux. In 1894, after publishing papers on his experiments on sea urchin eggs, Driesch wrote a theoretical essay entitled *Analytische Theorie der organischen Entwicklung*, in which he declared that his studies in developmental biology pointed to a "blueprint" or teleology, an Aristotlean *entelechy*, a scientific demonstration of Immanuel Kant's notion that the organism develops as if it has a purposeful intelligence. Driesch's experiments on the sea urchin embryo suggested that it was possible to remove large pieces from eggs, shuffle the blastomeres and interfere in many ways without affecting the resulting embryo. It appeared that any single monad in the original egg cell was capable of forming any part of the completed embryo. This important refutation of both preformation and the mosaic theory of Wilhelm Roux was to be subject to much discussion in the ensuing years, and caused friction among Driesch, Roux and Haeckel.

Like other teleologists, Driesch was a strong anti-Darwinian. His reputation as an experimental biologist deteriorated as a result of his vitalistic theories. He moved to Heidelberg and became a Professor of Natural Philosophy. In 1933 he was removed from his Leipzig chair by the Nazi administration, the first non-Jewish academic to be thus expelled, because of his pacifism and open hostility to Nazism (Wikipedia)

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Charles Darwin

Charles Darwin

Charles Darwin as a young man (circa 1840)

> ***"It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us."***
>
> Charles Darwin

One of the greatest thinkers of nineteenth century science, and a man whose legacy of ideas has so shaped the understanding of the world in which we live, Darwin replacing the static Judeo-Christian cosmos with a dynamic scientific-materialistic one.

A wide-ranging thinker, Darwin made contributions to human knowledge not only in his theory of evolution (surely one of the greatest ideas ever formulated), but also in geology, soil science, experimental botany and the study of animal behavior.

Darwin's ideas can be traced to his experience with domesticated animals (Darwin had bred domestic pigeons) and his familiarity with the work of the geologist Lyell and with Malthus' ideas about populations. Darwin devoted years of study

to collecting information about problems within various species. Furthermore, he developed explanations and mechanisms for what he considered the "transmutation of species." In his famous voyage aboard the *Beagle*, he became aware of geographic variation within species, and kept notes on the natural history and geology of the countries he visited.

Of especial significance was his visit to the Galapagos Islands. This is a group of volcanic islands in the Pacific Ocean on the equator and 600 miles west of Ecuador. The land animals and plants that were able to colonize there in isolation have developed into new species. Many unique species evolved here, such as giant tortoises (many of which have sadly been driven to extinction by the predation of sailors, who used them as source of fresh meat), iguanas, and finches. Not only are these species different from nearby continents, but they also exhibit differences among the various islands.

The finches are particularly important; these small birds lived on different islands in a complex, inter-related group of species now called "Darwin's Finches."

Darwin and his finches

One of a series of Royal Mail Mint Stamps issued in Darwin's honor
reproduced from Stamp One
click on graphic for finch birdsong

Darwin's study of characteristics of species on isolated islands such as these Galapagos finches, and of fossil animals, led him to conclude that evolution had occurred. The mechanism for this that he hit upon was termed natural selection. He coined the term because he knew that humans had long taken advantage of natural variation to select for breeds (artificial selection). When this occurs as a process in nature therefore it is "Natural Selection". Contrary to popular belief, Darwin himself never used the word "evolution".

On November 4, 1859 his classic work, *Origin of Species* (full title: *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*). was published. This work was a great success. The initial printing sold out on the first day of publication, but Darwin's theory eventually lost some of its original popularity. Although field naturalists preserved Darwin's emphasis on the role of geographical factors on evolution, many were tempted by the theory of Lamarckism. It was some time before the mechanism of variation and inheritance (genetics) was discovered (by Mendel).

There is a rumor - propagated by Christian Creationists, that Darwin renounced his theory on his deathbed. This rumor, like so many others, is completely false.

Links

EFF "Evolution" Archive - includes Darwin's *Origin of the Species* and *Decent of Man* and Wallace's *On New*

Species and *On the Tendency of Variations to Depart Indefinitely from the Original Type* papers (in simple ASCII format)

Charles Darwin by Adrian Desmond - a very interesting essay on Darwin in the context of the tensions of 19th century English society - part of Darwin - the man and his legacy

THE DARWIN PAGE - Biography - Bibliography - Information - Links - Dr Robert A. Hatch - assorted links and material

Charles Darwin - the Truth?

"what were the true origins of The Origins? Was it all Darwin's own work, or were there other influences in play? Why did it take Charles Darwin more than 20 years to publish his ideas on evolution? And what really motivated him to finally write his magnum opus? This is the story of not one but four men - Charles Darwin, Edward Blyth, Charles Lyell and Alfred Wallace. Each of them played a crucial role in the development and eventual publication of The Origin, but maybe not the ones we are familiar with."

What really happened with Galileo and Darwin? - John Polkinghorne debunks some of the popular myths about Galileo and Darwin.

Home	evolution	Lamarck	Darwin	Darwinism	Creation vs. Evolution	Glossary

Page Back	Unit Home	Evolution Glossary	Top of Page	Page Next

---

images not loading? | error messages? | broken links? | suggestions? | criticism?
contact me

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Biographies : E

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
E
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

E.

Elzanowski, Andrzej Polish paleornithologist. Elzanowski has carried out marvelous work on the phylogeny of basal Avialae, including reviews of the phylogenetic significance of Enantiornithes (Elzanowski 1981). Elzanowski also reviewed and described the astounding embryonic and egg fossils referred to *Gobipteryx* which were collected by the Polish-Mongolian Expedition to Late Cretaceous deposits in Mongolia (see Elzanowski 1974, 1976, 1977, 1981). More recently, Elzanowski co-authored along with Peter Wellnhofer an eclectic hypothesis whereby Avialae, spinosaurs, and troodonts formed a holophyletic clade (Elzanowski & Wellnhofer 1995), a view which has been unilaterally rejected. Elzanowski has also authored recently an extensive review of the osteology, paleobiology, and phylogeny of *Archaeopteryx*. (JGK - EvoWiki)

Empedocles: Greek pre-Socratic philosopher who developed a cyclic cosmology based on the four classical elements and the polarity of primal powers called Love and Strife, which bring about the mixture and the separation of the elements respectively. Was among the first to speculate on a natural theory of evolution . (from Wikipedia)

Page Back | Unit Up: Science | Page Next
Unit Back: Science | References | Unit Next Timeline

Biographies : G

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
G
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

G.

Galton, Francis: A cousin of Charles Darwin, Galton was a British explorer and anthropologist. He was known for his studies of human intelligence and later for his work in eugenics (a term he coined), the "science" of improving human heredity characteristics. Known for his efforts at various sorts of measurement (he developed fingerprinting and was a pioneer in statistics), he was knighted in 1909. (PBS evolution Glossary)

Gauthier, Jacques: American vertebrate paleontologist, comparative morphologist, and systematist, and one of the founders of the use of cladistics in biology and paleontology. His paper on the origin of birds from theropod dinosaurs (Gauthier 1986) was the first detailed cladistic analysis of the theropods, and initiated a revolution in dinosaur phylogenetics, in which cladistics replaced the Linnaean system in the classification and phylogenetic understanding of the dinosaurs. In this way an obscure *neontological* system came to be the fundamental orientating paradigm of paleo geeks everywhere. i.e. paleo geeks love big charismatic animals like dinosaurs, so anything that helps understand dinosaurs or provides an easy and logical way to map their eveolutionary relationships will be enthusiastically embraced, and then applied not just with dinosaurs but with all tetrapods and eventually all organisms. Gauthier co-authered 1988 amniote paper (Gauthier et al 1998) is also frequently cited to demonstrate the importance of taxon sampling in phylogenetic analysis, in particular the importance of sampling rare or fossil taxa that can break long branches along which convergence can occur. More recently, Gauthier has, together with Kevin de Queiroz, argued for replacing Linnaean taxonomy with the PhyloCode. (MAK, Wikipedia)

Gehring, Walter J.: Dr. Gehring and his research group discovered the homeobox, a DNA segment characteristic for homeotic genes which is not only present in arthropods and their ancestors, but also in vertebrates up to humans. Their work on the "master control gene" for eye development sheds light on how the mechanism for building eyes may have evolved long ago in the ancestor of what are now very different types of organisms. (PBS evolution Glossary)

Geoffroy Saint-Hilaire, ?tienne (1772 ? 1844) French naturalist who established the principle of "unity of composition". Although a friend and coworker with Georges Cuvier, Geoffroy also supported and developed

Lamarck's evolutionary theories. Unlike Lamarck's naturalist explanations, Geoffroy advocated an idealist position similar to those of the German Naturphilosophie morphologists like Lorenz Oken. Held that organisms were based on a basic archetype. He believed in the underlying unity of organismal design, and the possibility of the transmutation of species in time, amassing evidence for his claims through research in comparative anatomy, paleontology, and embryology. (Wikipedia)

Gould, Stephen Jay: (1941-2002) American paleontologist, evolutionary biologist, historian of science, and popular science writer who spent most of his career at Harvard University. With Niles Eldredge he formulated the theory of punctuated equilibrium in 1972. Gould was very critical of the idea of evolutionary ascent, arguing that this is a misinterpretaion of Darwinism. In *Ever Since Darwin*, he explains that Darwinian selection means is that no organism becomes better fitted to survival in its environment. A nematode parasite is just as valid an example of evolution as a graceful gazelle; in other words, Darwinism is not about progress. In *Wonderful Life* he argued that the Cambrian explosion involved a large number of organisms totally unrelated to extant phyla, and hence that evolution does not have any direction, and that the rise of intelligence on Earth was purely accidental. Based on his interpretation of the Burgess Shale and the many anatomical designs he saw arise there only to then die out, he felt "amazement . . . at the fact that humans ever evolved at all. . . . Replay the tape a million times from a Burgess beginning, and I doubt that anything like Homo sapiens would ever evolve again. It is, indeed, a wonderful life." (*Wonderful Life: the Burgess Shale and the Nature of History* (1989) p. 289, cited at Fossils and other living things blog). Some of his paleontological interpretations here have since been refuted, as taxa such as *Hallucogenia* have been slotted in or related to current phyla. Gould and Dawkins were the major players in the "Darwin wars", a longrunning disagreement about the details of sociobiology, adaptationism and whether evolution took place more on the level of genes or organisms; Gould opposed strict selectionism, sociobiology as applied to humans, and evolutionary psychology. Gould tirelessly campaigned against creationism and proposed that science and religion should be considered two distinct fields, or "magisteria", whose authorities do not overlap. Contrast with Evolution (Systems Theory), Simon Conway Morris. Links: The Unofficial Stephen Jay Gould Archive, World of Dawkins: The Gould Files, Darwinian Fundamentalism by Stephen Jay Gould (MAK, Wikipedia, EvoWiki)

new page MAK111204

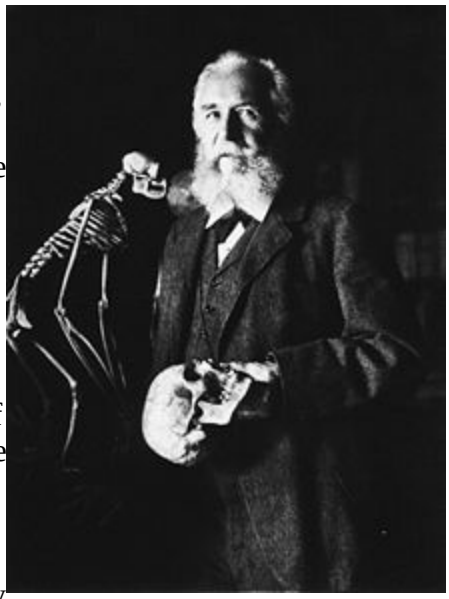
Biographies : H

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
H
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

H.



Haeckel, Ernst: (1834-1919) eminent German zoologist, naturalist, philosopher, physician, professor of comparative anatomy and artist who discovered, described and named thousands of new species, mapped a genealogical tree relating all life forms, and coined many terms in biology, including anthropogeny, ecology, phylum, phylogeny, and the kingdom Protista. His chief interests lay in evolution and life development processes in general, including development of nonrandom form.

Haeckel promoted and popularized Charles Darwin's work in Germany (Darwin's *On the Origin of Species* made a powerful impression on Haeckel when he read it in 1864,). His massive and ambitious *Generelle Morphologie*, published in 1866, presenting a revolutionary new synthesis of Darwin's ideas with the German tradition of Naturphilosophie going back to Goethe and with the progressive evolutionism of Lamarck in what he called Darwinismus. He used morphology to reconstruct the evolutionary history of life, in the absence of fossil evidence using embryology as evidence of ancestral relationships. He invented new terms, including ontogeny and phylogeny, to present his evolutionised recapitulation theory that "ontogeny recapitulated phylogeny". The two massive volumes sold poorly, and were heavy going: with his limited understanding of German, Darwin found them impossible to read. Haeckel's publisher turned down a proposal for a "strictly scholarly and objective" second edition.

Haeckel was an accomplished artist and illustrator, his published artwork of Haeckel includes over 100 detailed, multi-colour illustrations of animals and sea creatures (entitled *Kunstformen der Natur*, "Art Forms of Nature"). He was also one of the first to consider psychology as a branch of physiology. A flamboyant figure, he sometimes took great (and non-scientific) leaps from available evidence. For example, at the time that Darwin first published *On the Origin of Species* (1859), no remains of human ancestors had yet been found. Haeckel postulated that evidence of

human evolution would be found in the Dutch East Indies (now Indonesia), and described these theoretical remains in great detail. He even named the as-of-yet unfound species, *Pithecanthropus alalus*. Eventually a young Dutchman named Eugene Dubois went to the East Indies and dug up the remains of Java Man, the first human ancestral remains ever found. These remains originally carried Haeckel's Pithecanthropus label, though they were later reclassified as *Homo erectus* (Wikipedia)

Hennig, Willi (1913 - 1976) German entomologist and taxonomist; founder of phylogenetic systematics (later known as cladistics). He specialised in the taxonomy of dipterans (flies and mosquitoes). In 1950, he proposed a method for determining phylogenetic trees by classifying organisms according to their shared derived morphological characters, which are called synapomorphies (Hennig 1966). He developed cladistics as a way to compensate for the very scrappy fossil record of insects when trying to construct the evolutionary history. In his 1950 opus *Grundz*  *ge einer Theorie der phylogenetischen Systematik* ("Basic outline of a theory of phylogenetic systematics"), republished in English as *Phylogenetic Systematics* he proposed a rigorously logical protocol based on evolutionary branching or cladogenesis as a phylogenetic methodology. The term *cladist*, for an adherent of Hennig's school, was coined by Mayr in 1965; Hennig himself referring to his own approach as *phylogenetic systematics*. The term Phylogenetic Systematics is here used to refer to the classic form of cladistics proposed by Hennig, in opposition to rival and less succesful interpretations such as Pattern Cladism. During his life Hennig's methodology remained a minority approach to classification, but in the 1980s and 1990s his work resulted in a paradigm shift which replaced the then current Modern Synthesis' methodology of evolutionary systematics with the current phylogenetic approach. Phylogenetic systematics is now almost universal in paleontology and molecular phylogeny, but has much less influence in botany, due to the latter's heritage of Linnaean taxonomy. (MAK, Wikipedia). Link - pdf essay: Willi Hemiig and the Rise of Cladistics; The Willi Hennig Society

Hitchcock, Edward (1793 -1864) American geologist who surveyed much of New England; he also published papers on fossilized tracks in the Connecticut Valley, including *Eubrontes* and *Otozoum*, which he believed were made by gigantic prehistoric birds (they are now known to be dinosaur tracks, but cladistically speaking, birds are dinosaurs, so he was right after all MAK111205 (Wikipedia)

Holtz, Thomas R., Jr., : vertebrate palaeontologist and senior lecturer at the University of Maryland's Department of Geology, published extensively on the phylogeny, morphology, ecomorphology, and locomotion of terrestrial predators, especially theropod dinosaurs. (Wikipedia

Hutton, James: (1726-1797) Scottish farmer and geologist. In his travels around Britain, he made observations which suggested to him that the geologic processes that shaped the ancient Earth could be seen operating all the time, an idea which would later form the basis of Lyell's uniformitarianism. Hutton used his observations and hypothesis to argue that the Earth must be extremely old. (UCMP Understanding Evolution Glossary) Link: James Hutton

Hyatt, Alpheus: (18381902) American zoologist and palaeontologist. Studied under Louis Agassiz; along with Edward Drinker Cope was the most prominent American neo-Lamarckian. Advocated a theory of "racial senility" based on the analogy of ontogeny with phylogeny, which became the foundation of orthogenetic theories in the U.S.; his followers included C. Beecher at Yale. Founder and first editor of the *American Naturalist*; first president of Woods Hole laboratory. (John Alroy - Lefalophodon, Wikipedia,)

Biographies : J

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
J
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

J.

Jantsch, Erich: (1929-1980) Austrian astrophysicist whose 1979 lectures in System Science at the University of California in Berkely became the basis for his book *The Self-Organizing Universe: Scientific and Human Implications of the Emerging Paradigm of Evolution* (Pergamon Press, 1980). This now long out of print work deals with self-organization as a unifying evolutionary paradigm that incorporates cosmology, biology, sociology, psychology, and consciousness. Jantsch is inspired by and draws on the work of Ilya Prigogine concerning dissipative structures and nonequilibrium states. (Wikipedia) Although superseded by more recent developments in system science, this book exerted a very strong influence on me (MAK) when I read it in the early 1980s, and still inspired because of the author's elegant presentation of a big picture "integral" worldview (MAK)

Janvier, Philippe: Philippe Janvier is a paleontologist at the *Museum National de l'Histoire Naturelle* in Paris. He is a specialist in Palaeozoic vertebrates, and has written a number of scientific papers on the subject, as well as a definitive book, Early Vertebrates. Janvier has also contributed to the Tree of Life phylogeny project. MAK061003

Select bibliography

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Janvier, Philippe. 1996. The dawn of the vertebrates: Characters versus common ascent in the rise of current vertebrate phylogenies. *Palaeontology*. 39:259-287.
Janvier, Philippe. 1996. *Early Vertebrates*. Oxford Monographs on Geology and Geophysics, v. 33, Oxford University Press, Oxford, England, ISBN 0-19-854047-7 392 pp. - a comprehensive review of the phylogyny and technical characteristics of Paleozoic fish
Forey, P. L., and Janvier, P. (1993). Agnathans and the origin of jawed vertebrates. *Nature*, 361, 129-134.
Forey, P. L., and Janvier, P. (1994). Evolution of the early vertebrates. *American Scientist*, 82, 554-565.
McBirney, Alex and Philippe Janvier, 2005, *The Trilobite Affair*, Libri Terrarum, ISBN 0-9772425-44 ; 350 pages - on French geologist Jacques Deprat, who was accused of falsifying his data by using spurious fossils. Janvier, who has worked in the same regions where Deprat worked in Vietnam and has a personal familiarity with much of the background of this famous case. This book argues that Deprat was the victim of a vicious conspiracy.

new page MAK111204

>

Biographies : K

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
K
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

K.

Laelops

Knight, Charles R. (1874-1953) American artist best known for his highly influential paintings of dinosaurs and other prehistoric animals. His works have been reproduced in many books and are currently on display at several major museums in the United States. Examples of his work frequently appeared in dinosaur and paleontology books published in the US during the first half of the twentieth century. While some of his works depticted the dinosaurs as slow and sluggish, such as the iconic Brontosaurus grazing in a swamp, others, such as the *Laelops* featured here prefigure the later dinosaur renaissance (although perhaps going to the opposite extreme, as Bakker's and Paul's fully endothermic dinosaurs also do). Knight was most active during the 1890s-1940s, and his work exerted a strong influence on popular culture, including both toys and movies such as the stop motion dinosaurs in Harry Hoyt's *The Lost World* (1925) and Ray Harryhausen's magnificent special effects (*One Million Years B.C.* (1966), *The Valley of Gwangi* (1969)) (MAK, Wikipedia)

Biographies : L

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
L
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

L.

Lamarck, Jean Baptiste: (1744-1829), French naturalist, coined the word "zoology", the first to seriously study invertebrates, also developed the first well thought out theory of organic evolution. Applied the "Great Chain of Being" in a dynamic manner, to describe evolution. He recognized that organisms change in their environment, but he did not accept the concept of extinction. Lamarck argued that species evolved through time by passing on traits they acquired to their offspring; the "inheritance of acquired characteristics". This predecessor and rival theory to Darwin's descent through natural selection remained popular, especially in France and (in modified form) Soviet Russia well into the early 20th century. More

Lyell, Charles: A 19th-century scientist, principal architect of uniformitarianism and a founding father of modern geology, helping to transform the discipline into an empirical, testable science. Lyell argued that the geology of Earth is shaped by gradual processes, such as erosion and sedimentation, and further developed Hutton's theories. Lyell's notion was that Earth has been shaped by the same forces and processes that operate today, acting continuously over very long periods of time, was a major breakthrough in a world that still widely believed in a literal genesis. His landmark work, *Principles of Geology*, greatly influenced the young Charles Darwin. Darwin and Lyell later became close friends. Despite claims that he hated religion, was in fact deeply troubled by Darwin's work and forced to reconcile his view of special creation with evolution Hhe came to accept evolution after Darwin published *On the Origin of Species*. (PBS evolution Glossary; EvoWiki)


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Jean Baptist de Lamarck

(1744-1829)
Jean Baptist de Lamarck

Lamarck was a French naturalist who published *Zoological Philosophy* in 1809. He was the first thinker to come up with a reasonable theory of organic evolution. He believed that species could change through time by passing on traits acquired during an individual's life to their offspring - the so-called "acquired characteristics".

In Lamarck's view organic beings constituted a ladder of life from simplest to complex animals, with humans at the top rung. In this way all variation now and in the past were united by a "Great Chain of Being". This was the Scala Naturae in motion. Lamarck did not really explain the origin of this ladder, nor did he acknowledge the possibility of a species becoming extinct. But he did offer an explanation for how organisms change over time, thus turning the ladder into what we might call an escalator of being.

The theory of Lamarckian inheritance, or the inheritance of acquired characteristics, remained influential and popular until the late nineteenth century. The belief that characteristics acquired by organisms in response to the conditions of life or as a result of their own habits could be inherited by their descendents, was shared by both Lamarck and Darwin. The theory fell out of favor with the rise of knowledge of hereditary and genetic science. One version, known as Lysenkoism, was popular in Stalinist Russia, it put Soviet agriculture back several decades relative to the West.

Interestingly modern advances in DNA sequencing and other aspects of molecular biology reveal that certain acquired structures of the immune system may be transferred from parent to child, defying commonly held evolutionary beliefs and recalling Lamarck assertion of the inheritance of acquired characteristics resulting from environmental factors. - see the book *Lamarck's Signature*, by Edward J. Steele, Robyn A. Lindley, and Robert V. Blanden (Perseus Books, 1998)

Links

- Jean-Baptiste Lamarck (1744-1829)
- Lamarck and His Theory of Evolution
- Chevalier de Lamarck

Page Back | Unit Home | Evolution Glossary | Page Next

---

images not loading? | error messages? | broken links? | suggestions? | criticism?
contact me

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Biographies : M

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
M
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

M.

Malthus, Thomas: (1766-1834) English political economist and demographer concerned about the poverty he saw in London. His *Essay on the Principle of Population* (1798) observes that as as populations increase at a geometric rate, but food production only arithmetically, people will always outrun the food supply . Poverty, disease, war, and famine were all outcomes of increasing population that kept populations from increasing. His theory was in opposition to the utopians of the 18th century. Malthus' insights were incorporated by Darwin who combined his idea with variation and natural selection: since more young are born than grow to adulthood, it follows that only those best fitted would be survive, and hence give rise to new offspring (natural slection). (adapted from PBS evolution Glossary)

Mantell, Gideon Algernon (1790-1852) English obstetrician, geologist and palaeontologist. in 1822 he was responsible for the discovery (and the eventual identification) of the first fossil teeth, and later much of the skeleton, of *Iguanodon*, which began the scientific study of dinosaurs. Wikipedia

Margulis, Lynn: A biologist who developed the serial endosymbiosis theory of origin of the eukaryotic cell. Although now accepted as a plausible theory, both she and her theory were ridiculed by mainstream biologists for a number of years. (PBS evolution Glossary)

Marsh, Othniel C.: (1831-1899), of Yale University, was perhaps the single most influential American vertebrate paleontologist of the 19th Century. His credentials were sterling, and his accomplishments, astounding both in their volume and import. Marsh came from humble beginnings, born on a farm in Lockport, New York in 1831. Marsh was intelligent, and productive as a scientist, though in both of these regards it is questionable if he was a match for the truly gifted E.D. Cope of Philadelphia, with whom Marsh would have a life-long rivalry. Marsh, unlike Cope, was a superb politician, and equipped with a great deal of social acumen, such that he was far more skilled at gaining goverment grants from the USGS, and his list of administrative posts throughout his career further underscores these points: president of the NAS from 1883-1895, Vertebrate Paleontologist of the USGS from 1882-1892, and honoray Curator of Vertebrate Paleontology of the Smithsonian, a title granted in 1886. Some of Marsh's most noteworthy

scientific accomplishments include naming and describing Triceratops, the quintessential dinosaur with which all children are fascinated, naming Ceratopsia, describing Theropoda, and recovering and describing the marvelous remains of *Hesperornis regalis* and *Ichthyornis dispar* from the Late Cretaceous Niobrara chalk beds of Kansas (published in a gorgeous monograph in 1880). Marsh was also an early defender of the theropod origin of birds (see Marsh 1877), and had a penchant for Mesozoic mammals. He is still rightly regarded as something of a legend in vertebrate paleontology. (EvoWiki)

Maryanska, Teresa: one of the foremost Polish paleontologists, and moreover, one of the few women to rise to prominence in what is unfortunately, a still very male-dominated field. Maryanska is truly brilliant, and her work includes influential revisions of the phylogeny of Ceratopsia, with particular emphasis on the description and classification of the vast amount of protoceratopsid and psittacosaurid material to emerge from central Asia in the past half-century (and in particular, Mongolia). See esp. Maryanska & Osmolska (1975). (JGK - EvoWiki)

Mayr, Ernst Walter: (1904 – 2005) One of the 20th century's leading evolutionary biologists. He was a renowned taxonomist, tropical explorer, ornithologist, historian of science, and naturalist. His work contributed to the conceptual revolution that led to the modern evolutionary synthesis of Mendelian genetics, systematics, and Darwinian evolution, and to the development of the biological species concept. With George Simpson he was one of the authors of evolutionary systematics. His theory of peripatric speciation (a more precise form of allopatric speciation which he advanced), based on his work on birds, is still considered a leading mode of speciation, and was the theoretical underpinning for the theory of punctuated equilibrium, proposed by Niles Eldredge and Stephen Jay Gould. Mayr is sometimes credited with inventing modern philosophy of biology, particularly the part related to evolutionary biology, which he distinguished from physics due to its introduction of (natural) history into science. In many of his writings, Mayr rejected reductionism in evolutionary biology, arguing that evolutionary pressures act on the whole organism, not on single genes, and that genes can have different effects depending on the other genes present. He advocated a study of the whole genome rather than of isolated genes only. Mayr was quite critical of molecular evolutionary studies such as those of Carl Woese, as well as of replacing current taxonomy with cladistic classification. (Wikipedia)

Mendel, Gregor Johann : (1822-1884) Austrian monk whose study of the inheritance of certain traits in pea plants, led to insights into the mechanisms of heredity that are the foundation of genetics today. Mendel showed that the inheritance of these traits follows particular laws, which were later named after him. His work was ignored in his lifetime and only rediscovered in 1900. The independent rediscovery of these laws formed the foundation of the modern science of genetics.See Mendelian inheritance. (PBS evolution Glossary, Wikipedia)

Moore, Raymond C. (1892–1974) American paleontologist, co-author (with Lalicker and Fischer) of *Invertebrate Fossils* (1952) and founder and first editor of the multi-volume *Treatise on invertebrate paleontology* (1953-ongoing). He was also a talented artiost who illustrated the book *Invertebrate Fossils* (MAK)

Page Back | Unit Up: Science | Page Next
Unit Back: Science | References | Unit Next Timeline

Biographies : O

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
O
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

O.

Osborn, Henry Fairfield, Sr. (1857–1935) American geologist, paleontologist, and scientific administrator, president of the American Museum of Natural History (AMNH) in New York City. He assembled a great team of fossil hunters and preparators, which included Roy Chapman Andrews, considered the inspiration for the fictional archeologist Indiana Jones, and Charles R. Knight, who made murals of dinosaurs in their habitats and sculptures of the living creatures. A student of Edward Drinker Cope, he held the now rejected theory of orthogenesis, and is responsible for influential illustrations such as the evolution of the horse from tiny eohippus to the modern horse. Wrote a detailed mongraph on the Brontotheriidae (Titanotheres), which includes a similar illustration (evolution of the brontotheres). Discovered *Tyrannosaurus rex* and believed it stood upright, which is now known not to be the case. (MAK, Wikipedia)

Osmolska, Halszka, one of the most influential of paleontologists, she, likeTeresa Maryanska, is an enterprising Pole whose work on dinosaurs extends back to the days of the "iron curtain." Osmolska's contributions to the field are extensive, and include recognizing the ceratopsian affinity of Psittacosauridae (with Maryanska, 1975), reviewing the osteology and phylogeny of the enigmatic troodonts (in Dodson et al 1990) and co-authoring *The Dinosauria* in 1990. Osmolska has furthermore contributed significantly to our understanding of both the morphology and evolution of the oviraptorosaurs. (EvoWiki)

Ostrom, John H., of Yale, was one of the most influential figures in 20th Century dinosaur paleontology. It is no exaggeration to say that he single-handedly resurrected the theropod origin of birds with his 1964 discovery of *Deinonychus antirrhopus* from the Early Cretaceous Cloverly Formation of Wyoming in 1964, and the subsequent description of this marvelous predator in a truly gorgeous 1969 monograph. Ostrom carried out the most extensive review of the *Archaeopteryx* material that perhaps has ever been executed, and was intimately involved with the discovery of two previously misidentified urvogel remains. It is Ostrom's work that the post-modernist consensus on theropod phylogeny and avian origins, is largely indebted to, a fact reflected in the 1999 symposium on those very subjects, held in honor of Ostrom. Moreover, Ostrom had a crucial influence on a generation of dinosaur

paleontologists, including most notably, his former student Robert Bakker. In addition, Ostrom is largely responsible for the primacy of paleobiological thought in modern dinosaur paleontology. (EvoWiki)

Owen, Richard: (1804-1892) English biologist, anatomist and palaeontologist, best remembered today for coining the word *Dinosauria* (meaning "Terrible Reptile" or "Fearfully Great Reptile"). Owen was a student of Cuvier, and shared with him a strong opposition to Darwin's theory of evolution by natural selection. He reconstructed the skeletons of many extinct animals, even working on some of Darwin's specimens. He argued that God created new species by modifying a basic anatomical idea or archetype. Later he modified his own views to accept a kind of "divine" evolution. Owen is also known for overstating the differences between the human brain and those of other apes in his struggle to keep humans above the rest of the animal kingdom. In other respects though, Owen's approach to evolution anticipated the issues that have gained greater attention with evolutionary developmental biology. He was the driving force behind the establishment, in 1881, of the British Museum of Natural History in London. Bill Bryson argues that, "by making the Natural History Museum an institution for everyone, Owen transformed our expectations of what museums are for". (UCMP Understanding Evolution Glossary, Wikipedia)

images not loading? | error messages? | broken links? | suggestions? | criticism?

contact us

new page MAK111204

>

Biographies - P

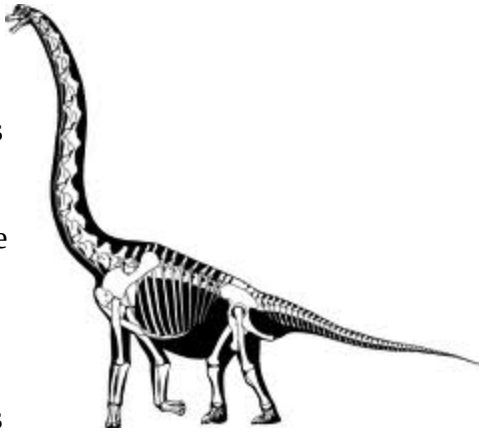
Science
Biographies
Timeline
Glossary
References

Biographies A-Z
P
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

P.

Padian, Kevin:, of the University of California, Berkeley, is a dinosaur paleontologist. He studied pterosaur phylogeny under Ostrom, and in 1983 presented a significant body of research which largely revolutionized our understanding of Pterosauria. Padian's 1983 work argued for a terrestrial origin of flight amongst pterosaurs, although more recent data contradicts Padian's initial conclusions, and recent discoveries of a flat-footed *Dimorphodon*, quadrupedal trackways and uropatagial membrances clearly falsify the hypothesis. Padian is furthermore one of the principal researchers of theropod phylogenetics, reviewing in 1999 the phylogeny of Theropoda introduced by Sereno (1997, 1998) in an effort to more rigorously define the major theropod clades. Padian, as is the case with most dinosaur paleontologists, has staunchly defended a theropod origin of birds, and in conjunction with Jensen, of Brigham Young University, presented some of the first fossil data arguing a Jurassic derivation of Maniraptora (Padian & Jensen 1989). (EvoWiki)



Paul, Gregory S.: freelance researcher, author and paleo artist, and supporter of Robert Bakker's theory that dinosaurs had mammal and bird grade endothermy (from 1977 to 1984, Paul was an informal research associate and illustrator for Robert Bakker in the Earth and Planetary Sciences department at Johns Hopkins University in Baltimore). His superb but unfortunately now dated *Predatory Dinosaurs of the World* (1988), and meticulous dinosaur skeletal drawings with black silhouette as well as life reconstructions, inspired and shaped an entire generation of paleo geeks. Later works include *Dinosaurs of the Air* (2002) and *The Princeton Field Guide to Dinosaurs* (2010), (published in the UK as *Dinosaurs: A Field Guide*) continue and update this ground-breaking presentation. The Field Guides tends to a very evocative approach to classification, a sort of biological equivalent of "armoured vehicles of World War II", with silhouettes and various statistics, include adult weight estimates (rarely given in other books). I have to say that my own presentation of paleo life has been strongly shaped by the style of Greg Paul's work. Paul argues that some theropods, such as *Velociraptor*

and other coelurosaurs, were actually flightless descendents of early birds like *Archaeopteryx*, an intriguing thesis that has not really caught on in the wider scientific and paleo geek community, mau\inly because it goes against the dominant cladistic model of dinosaur to bird transition. More recently Paul has written on the sociology of religion, controversially arguing that religiosity is not universal to human populations, and is actually inversely related to socio-economic development (i.e. the greater the level of education, standard of living, and democracy, the less religious belief) (MAK, Wikipedia) Website

Brachiosaurus brancai (since renamed *Giraffatitan*), skeletal reconstruction in left lateral view. The style and format immortalised by Greg Paul. From Paul 1988 fig. 1, larger image at Sauropod Vertebra Picture of the Week

images not loading? | error messages? | broken links? | suggestions? | criticism?

contact us

new page MAK111204

Biographies : R

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
R
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

R.

Romer, Alfred Sherwood: (1894-1973), director of the Museum of Comparative Zoology at Harvard University until his retirement in 1961, was one the singularly most influential vertebrate paleontologists of the 20th Century. His work ranged over virtually every conceivable subject within that field, although it was the osteology and taxonomy of the therapsids and other proto-mammals which was nearest his heart. In addition to this work, Romer was acutely interested in the origin and initial adaptive radiation of tetrapods, and his work became the basis for a theory of tetrapod origins which was canon until the description of *Acanthostega gunnari* by Clack & Coates in the 1990s. Romer was ahead of his time in his defense of monophyly of Dinosauria (1966) (though he did feel that Theropoda was not ancestral to birds). Perhaps Romer's most notable gift to scientific posterity, were his three seminal publications: *Osteology of the Reptiles* (1956), *Vertebrate Paleontology* (1966), and *The Vertebrate Body* (1977)--immortal tomes which still adorn the shelves of any self-respecting student of vertebrate paleontology and evolution. See Bakker (1986) for a particularly heartfelt tribute to the Dean of vertebrate paleontology. (EvoWiki)

Biographies : S

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
S
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

S.

Simpson, George Gaylord: One of the most influential paleontologists of the 20th century and a leading developer of the modern synthesis. He wrote hundreds of technical papers in addition to many widely read popular books and textbooks, and was a leading expert on Mesozoic, Paleocene, and South American mammals. (PBS evolution Glossary)

Smith, John Maynard: An eminent evolutionary biologist and author of many books on evolution, both for scientists and the general public. A professor emeritus at the University of Sussex, his research interests include evolution of human mitochondrial DNA sequences and investigation of evidence for extensive recombination. (PBS evolution Glossary)

Biographies : T

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
T
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

T.

Teilhard de Chardin, Pierre: (1881-1955) French philosopher and Jesuit priest who trained as a paleontologist and geologist and took part in the discovery of both Piltdown Man and Peking Man. Teilhard conceived the idea of the Omega Point and developed the concept of Noosphere. He came into conflict with the Catholic Church, and several of his books were censured. His primary work *The Phenomenon of Man*, set forth a sweeping account of the unfolding of the cosmos. He saw no contradiction between Darwinism and Theism, rejected traditional interpretations of a supernatural creator and creation in the Book of Genesis in favor of a panentheistic teleology. Teilhard envisaged the "within" (consciousness) and the "without" (matter) as complementary, each subject to its own evolutionary principle, which he called radial and tangential energy respectively. The former corresponds to the ascent of consciousness and evolution to divinity, the latter to evolution as described by Darwinian science. To this day, Teilhard remains one of the very few individuals whose work seamlessly integrates both evolutionary science and theistic religion, not in a dualistic supernatural context of theistic evolution, but in a holistic and pantheistic manner.

Although the two never met, and neither knew of the other's work, Teilhard's ideas have some intriguing parallels with those of Sri Aurobindo (although in terms of W.C. Snow's "Two Cultures", Teilhard arrives at spirituality from the perspective of the sciences, Aurobindo from the humanities). His ideas are also very similar to those of A. N. Whitehead, both beings trongly influenced by Henri Bergson. Seems to have been one of the very few who integrated the "Two Cultures". Teilhard's cosmology, but not his strict anthropocentrism, have been strongly influential in the New Age movement, Transhumanism, the Universe Story, Integral Theory, and other contemporary advocates of evolution of consciousness, while his term complexification has been adopted by contemporary systems science.

Teilhard's work has been strongly criticised by Stephen Jay Gould. For Teilhard, evolution tends to greater complexity and consciousness; for Gould, there is no such thing as ascent or progress, only random natural selection. While Teilhard's strong teleological approach is anathema to mainstream naturalist science (with a few exceptions such as Conway Morris) Gould's equally extreme but diametrically opposite blanket denial that evolution results in the emergence of greater complexity hasn't fared much better; it is mostly also rejected even by other evolutionists. (MAK)

new page MAK111204

>

Biographies : V

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
V
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

V.

Vernadsky, Vladimir Ivanovich: (1863–1945) Ukrainian interdisciplinary scientist; the father of Russian ecology. He ehlped establish the fields of geochemistry, biogeochemistry, and of radiogeology. His ideas of noosphere were an important contribution to Russian cosmism. His 1926 book *The Biosphere* developed Eduard Suess' earlier 1885 concept of the biosphere into the idea of life as a geological force, similar to James Lovelock's Gaia theory. Note that this is very different to the watered down biosphere of popular thought, a mere envelope clinging to the surface of the planet. He also developed the idea of the noosphere, which he interpreted as the third stage in the earth's development, mind as a geological force; here we see obvious parallels with transhumanism. Vernadsky influenced Teilhard de Chardin and no doubt vice-versa, when they met in Paris when he Vernadsky was lecturing at the Sorbonne in Paris, although Vernadsky's theory of Earth evolution was purely materialistic, in contrast to Teilhard's Panentheism. (MAK, Wikipedia)

Vermeij, Geerat J. Evolutionary biologist and paleontologist who studies marine molluscs both as fossils and as living organisms. Developed the escalation hypothesis in the 1980s.

von Baer, Karl Ernst : (1792-1876) Baltic German naturalist of Russian Empire, a biologist, geologist, meteorologist, geographer, a founding father of embryology, explorer of European Russia and Scandinavia, a member of the Russian Academy of Sciences, a co-founder of the Russian Geographical Society and the first President of the Russian Entomological Society. He formulated what would later be called *Baer's laws of embryology*:

1. General characteristics of the group to which an embryo belongs develop before special characteristics.
2. General structural relations are likewise formed before the most specific appear.
3. The form of any given embryo does not converge upon other definite forms but, on the contrary, separates itself from them.
4. Fundamentally, the embryo of a higher animal form never resembles the adult of another animal form, such as one less evolved, but only its embryo.

(Wikipedia) Baer's laws refuted and replaced Haeckel's Recapitulation theory

images not loading? | error messages? | broken links? | suggestions? | criticism?

contact us

new page MAK111204

>

Biographies : W

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
W
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

W.

Waddington, Conrad Hal: (1905-1975), British zoologist, developmental biologist, paleontologist, geneticist, embryologist and philosopher who laid the foundations for systems biology. He had wide interests that included poetry and painting, as well as left-wing political leanings.

Waddington's epigenetic landscape is a metaphor for how gene regulation modulates development. One is asked to imagine a number of marbles rolling down a hill towards a wall. The marbles will compete for the grooves on the slope, and come to rest at the lowest points. These points represent the eventual cell fates, that is, tissue types. Waddington coined the term *Chreode* to represent this cellular developmental process. This idea was actually based on experiment: Waddington found that one effect of mutation (which could modulate the epigenetic landscape) was to affect how cells differentiated. He also showed how mutation could affect the landscape and used this metaphor in his discussions on evolution; he was the first person to emphasise that evolution mainly occurred through mutations that affected developmental anatomy. (Wikipedia)

Alfred Russel Wallace (1823–1913) British naturalist, explorer, geographer, anthropologist and biologist. He is best known for independently proposing a theory of evolution due to natural selection that prompted Charles Darwin to publish his own theory. Wallace did extensive fieldwork, first in the Amazon River basin and then in the Malay Archipelago, where he identified the *Wallace Line* that divides the Indonesian archipelago into two distinct parts, one in which animals closely related to those of Australia are common, and one in which the species are largely of Asian origin. He was considered the 19th century's leading expert on the geographical distribution of animal species and is sometimes called the "father of biogeography".

He believed qualitative novelties could arise through the process of evolution, in particular the phenomena of life and mind, in a vitalistic manner. His advocacy of Spiritualism and his belief in a non-material origin for the higher mental faculties of humans strained his relationship with the scientific establishment, especially with other early proponents of evolution. In addition to his scientific work, he was a social activist who was critical of what he considered to be

an unjust social and economic system in 19th-century Britain. (Wikipedia)

Ward, Peter Douglas: Professor of geological sciences at the University of Washington in Seattle, where he is also adjunct professor of zoology and of astronomy. Author of several books on biodiversity and the fossil record, including Rivers in Time: The Search for Clues to Earth's Mass Extinctions and Rare Earth: Why Complex Life is Uncommon in the Universe (with Donald Brownlee). He is the principal investigator for the University of Washington's portion of the NASA Astrobiology Institute. (PBS evolution Glossary)

Wegener, Alfred: A German climatologist and geophysicist whose book, *The Origins of Continents and Oceans*, was the first to propose the concept of continental drift (the forerunner to the theory of plate tectonics), as well as to suggest a supercontinent called Pangaea, which Wegener suggested had fragmented into the continents as we know them today. His ideas remained controversial until the 1960s, when they became widely accepted as new evidence led to the development of the concept of plate tectonics. (PBS evolution Glossary)

Weismann, August (1834-1914), German zoologist, cytologist and evolutionary theorist, considered by Ernst Mayr the second most notable evolutionary theorist of the 19th century, after Charles Darwin. Developed germ plasm theory, according to which inheritance only takes place by means of the germ cells (the gametes such as egg cells and sperm cells). Sexual reproduction (recombination) creates in every generation a new, variable population of individuals, which then acts on this variation and determines the course of evolutionary change. Genetic information cannot pass from soma (the rest of the cells) to germ plasm (the Weismann barrier). This refutes out Lamarck's theory of inheritance of acquired characteristics. The idea of the Weismann barrier is central to Neo-Darwinism and the Modern evolutionary synthesis (Wikipedia, Kutschera & Niklas 2004, p.260)

Wilson, Edward Osborne: (b. 1929) American biologist and professor at Harvard University, researcher (sociobiology, biodiversity), theorist (consilience, biophilia), naturalist, conservationist, and author. His biological specialty is myrmecology, the study of ants. Wilson has won two Pulitzer Prizes for his books On Human Nature and The Ants, and has received numerous honors for his research and conservation efforts. (Wikipedia; (PBS evolution Glossary))

Woese, Carl Richard : (b. 1928) American microbiologist and physicist who brought about a paradigm revolution in our understanding of the tree of life. In 1977, Carl Woese proposed that Archaea are different from normal bacteria and constitute a new super-kingdom Archaebacteria. His three-domain system, based upon genetic relationships rather than obvious morphological similarities, divided life into 23 main divisions, all incorporated within three domains: Bacteria, Archaea, and Eucarya. This was based on phylogenetic taxonomy of 16S ribosomal RNA, a technique pioneered by Woese and which is now standard practice. Despite being published in a top scientific journal (PNAS), his publication was not read widely. Furthermore, it was not greeted with enthusiasm by the scientific community, especially by Salvador Luria, Nobel Prize winner in Medicine, and later by others. As a consequence, he was not invited to conferences to speak about his work or defend it. His three domain model was not rejected because of the data, but because it violated the central dogma of prokaryote-eukaryote dichotomy. In contrast to the Darwinian idea of a Common Descent of all life, Woese argued that there is not a single ancestor or root of the tree of life, but a network of organisms life forms that horizontally exchanged genetic material. Even evolutionary biologist Ernst Mayr (1904-2005), an icon of evolutionary biology, was one of a number of scientists who vigorously opposed Woese's (and Norman Pace's) suggestion that the catch-all term prokaryote be rejected. In 1990 Woese adopted the term 'domain' for the three branches of life and shortened the name Archaebacteria to Archaea. Textbooks teach the third domain now as a matter of fact, but omit the initial hostile reaction to Woese's ideas.

Woese's work is also significant in terms of its implications for the search for life on other planets. Prior to Woese, Archaea were thought to be extreme organisms that had evolved from the organisms that are more familiar to us. Many scientists now believe they are ancient, and may have robust evolutionary connections to the first organisms to live on Earth. Organisms similar to those Archaea that exist in extreme environments may have found a foothold on other planets, some of which are known to harbor conditions conducive to extremophile life. Woese was also the originator of the RNA world hypothesis, although not by that name. (Carl Woese: from scientific dissident to textbook orthodoxy ,Wikipedia)

Wright, Sewall: (1889–1988) American geneticist known for his influential work on evolutionary theory and also for his work on path analysis. With R. A. Fisher and J.B.S. Haldane, he was a founder of theoretical population genetics. (Wikipedia)

new page MAK111204

>

Biographies : Y

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
Y
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

Y.

C. C. Young is the anglicized name of Yang Zhong Jian, perhaps the most famous student of Chinese Dinosauria of the 20th Century and certainly the most famous Chinese paleontologist. Young was intimately involved in the discovery and description of dinosaurs from China for over 50 years, beginning a series of publications in 1930 which did not cease until 1982. His accomplishments include describing two new species of the marvelous *Psittacosaurus*, in 1931. (JGK - EvoWiki)

Biographies - Z

Science
Biographies
Timeline
Glossary
References

Biographies A-Z
Z
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

Z.

Zallinger, Rudolph F. (1919 - 1995) Russian-born American paleo artist, notable for two immesely influential represnetations of evolution: the *The Age of Reptiles* mural (1947) (his *The Age of Mammals* follows a similar theme) and the popular illustration known as *March of Progress* (1965), one of the world's most recognizable scientific images. (Wikipedia)

A.

Abiogenesis: The development of life from non-living systems via natural mechanisms. cf. creation. (W. R. Elsberry talk.origins via W.J. Hudson)

Agnostic: Someone who defers belief or non-belief in a god until the evidence is in. Usually accompanied by the assertion that the evidence is not in. cf. unbelief (W. R. Elsberry talk.origins via W.J. Hudson)

Analysis: Step Six in the Scientific Method. Experimental results are gathered. The experiment should be repeated (replicated) several times to avoid chance error. The results are subjected to statistical analysis. Statistical analysis is designed to help minimize false positives and false negatives. In most statistical procedures in biology, a 5% error rate is allowed to occur and still consider the results viable. This much error is accepted as "due to chance alone." (W. R. Elsberry talk.origins via W.J. Hudson)

Archetype: Platonic forms or Ideas, which in Neoplatonic emanationism became one of the intermediate stages between the absolute reality and the material world. In the late 18th and 19th centuries the concept of an ideal primitive plan ("Bauplan") on which organisms, such as plants or vertebrates, are based became a central theme in German Idealism and Naturphilosophie. Called by Richard Owen the "primal pattern" and "divine idea." See also Idealism. (modified from M. W. Strickberger).

Argument from Design: An argument most notably forwarded by the Reverend Paley which brought us the "watchmaker" analogy. At basis, this argues that the complexity and good design seen in natural systems could only be attributed to a superlative designer. Centuries ago, David Hume argued that one can only separate designed from non-designed entities via experiential comparison and contrast. Hence, since we only have one universe, we have no point of reference to argue that the universe is designed (or not designed). More recently, Richard Dawkins has written an excellent summary of at least one way in which good design does not imply the existence and action of a designer. (W. R. Elsberry - talk.origins). See also intelligent design; irreducible complexity, teleology

Aristotle: (384-322 b.c.e.), student of Plato, ancient Greek polymath, who wrote on Logic, Physics, Astronomy, Biology, Psychology, Metaphysics, Ethics, Politics, Rhetoric, and Poetics. In biology, he made numerous very detailed observations, including many dissections; some of his observations have proved remarkably accurate. He also produced the first detailed taxonomy, dividing animals into blooded and bloodless ones, and from there into further subcategories, see *Scala Naturae*. His view of the history of life was non-evolutionary and non-creationist; he believed that the Universe is eternal, being pretty much the same for all time. Species don't evolve, but they had always been in existence. He also believed that living things have three types of vital force: the vegetable soul, that all living things have, the animal soul, that all animals have, and the rational soul, that only humanity has. (EvoWiki)

Atheist: Someone who either states a disbelief in a god or gods ('strong' or 'positive' atheism), or an unbelief in a god or gods ('weak', 'negative' or 'passive' atheism). cf. agnostic. (W.J. Hudson)

B.

Belief: The position of affirming the truth of a proposition. Belief, if asserted as true in a debate, bears a burden of proof (as does disbelief). See also: unbelief. (W.J. Hudson)

Burden of Proof: Also known (especially in legal terminology) as the *onus probandi*. The burden of proof is something shouldered by anyone who makes an assertion regarding a proposition -- a requirement that they support/substantiate their assertions, if they expect anyone else to accept them. It is important to note, however, that simply having a belief or disbelief on a subject does not require the burden of proof -- one must actually assert that one's position is true. cf. unbelief. (W.J. Hudson)

C.

C-decay: Young Earth Creationist assertion that the speed of light has undergone a measurable slowing in recorded history, forwarded by Barry Setterfield. Setterfield further claims that the decay of the speed of light follows an exponential, such that light speed was infinite a few thousand years ago. The talk.origins FAQ deals with the questionable data handling and analysis which Setterfield had to use to obtain his pre-ordained results, and the wholesale rejection of data points which would have lessened the confidence levels which Setterfield claimed. (W. R. Elsberry - talk.origins)

Catastrophism: the theory that the Earth's geological landscape is the result of violent cataclysmic events. Advocates of this theory usually believe that there have been a number of wide-spread violent and sudden natural catastrophes that have destroyed most living things. It was used by George Cuvier to explain the extinction of species. Contrast with uniformitarianism; the two opposed each other during the late 18th and 19th centuries. Young Earth Creationism uses a modified from of Catastrophism, employing the Biblical Flood to explain the fossil record

The Clergy Letter Project: project that gained signatures from over 10,000 members of clergy for An Open Letter Concerning Religion and Science. This letter contains the basic statement: "We the undersigned, Christian clergy from many different traditions, believe that the timeless truths of the Bible and the discoveries of modern science may comfortably coexist. We believe that the theory of evolution is a foundational scientific truth, one that has stood up to rigorous scrutiny and upon which much of human knowledge and achievement rests." (EvoWiki, Wikipedia) Compare with Non-overlapping magisteria

Cognitive science: interdisciplinary scientific study of minds as information processors. It includes research on how information is processed (in faculties such as perception, language, reasoning, and emotion), represented, and transformed in a (human or other animal) nervous system or machine (e.g., computer). Cognitive science consists of multiple research disciplines, including psychology, artificial intelligence, philosophy, neuroscience, linguistics, anthropology, sociology, and education. It spans many levels of analysis, from low-level learning and decision mechanisms to high-level logic and planning; from neural circuitry to modular brain organization. The term was coined by Christopher Longuet-Higgins in his 1973 commentary on the Lighthill report, which concerned the then-current state of Artificial Intelligence research (Wikipedia)

Common ancestor: The ancestral species that gave rise to two or more descendant lineages, and thus represents the ancestor they have in common. The idea of a common ancestor is central to evolutionary thinking from Darwin onwards. In the Modern Synthesis' Evolutionary Systematics the common ancestor is usually shown as the most suitable fossil form at the base of a lineage, where it may or (more likely given the small number of species known from those which actually lived in past ages) or may not be an actual ancestor, more often it is a sort of grand-uncle rather than grandfather). Nevertheless, some idea of a general common ancestor can be had. In an attempt to establish greater rigour and precision, Cladistic phylogeny defines the *most recent common ancestor* as the originator of a clade; in other words the first species or organism to possess the unique attributes of that clade. Contrary to popular opinion, cladograms do not actually show the common ancestor; in this context, see basal taxon, hypothetical common_ancestor. See also non-missing link. (MAK)

Consilience: as defined by Edward O. Wilson in his 1998 book *Consilience: The Unity of Knowledge*, an attempt to bridge the culture gap between the sciences and the humanities that was the subject of C. P. Snow's book on *The Two Cultures*. Wilson's assertion was that the sciences, humanities, and arts have a common goal: to give a purpose to understanding the details, to lend to all inquirers "a conviction, far deeper than a mere working proposition, that the world is orderly and can be explained by a small number of natural laws." (Wikipedia) Compare Integral Theory (a very different attempt to likewise create a unifying synthesis of human knowledge)

Consciousness: pertaining to subjective or "inner" experience and existence, awareness, sense of selfhood, and including as its contents the relationship between the mind and the world with which it interacts. Equivalent to "mind" in the mind-body problem of philosophy. Reductionists and metaphysical naturalists tend to reduce consciousness to matter, idealists the reverse. Cognitive science studies the workings of consciousness in relation to neural funcdtioning. The evolutionary philosopher Teilhard de Chardin used the trem complexification to refer to the relation between "outer" complexity and "inner" consciousness. In physicalism (a form of materialistic monism), consciousness is identified with physical functions such as neural functioning, in dualism it is considered distinct from matter, and in some forms of Eastern Philosophy (another form of monism) it is identified with the absolute reality (MAK).

Creation: The bringing forth of matter from nothing, or the development of life from non-living systems. cf. abiogenesis. (W. R. Elsberry talk.origins via W.J. Hudson)

Creation-Evolution debate: situation that has developed in Western society as a result of the clash between religious traditionalists who advocate a supernatural worldview, and the scientific community which uses empirical method and tends to agnosticism and naturalism. A highly polarised society with a strong religious demographic like America has a larger proportion of creationists than a more secular society like Britain or Australia. Alternative solutions include more science education, non-overlapping magisteria, universe story, theistic evolution, and pantheism. (MAK)

Creation out of nothing: The Judaeo-Christian doctrine that God created the cosmos out of nothing (*ex nihilo* in the famous latin phrase). Rejected by both emanationism and naturalism (MAK)

Creation Science: see Scientific creationism

Creationism: The belief in creation as having a supernatural agent, but usually without limiting the range of mechanisms used by that agent. Variations include Young Earth and Old Earth creationism and religious forms of Intelligent Design. May or may not claim scientific credentials. Creationists generally accept microevolution but not macroeveolution. (W. R. Elsberry talk.origins via W.J. Hudson, MAK)

Cyclic: most premodern cosmologies posited a cyclic universe, in which the same stages occur in the same sequence again and again. The originbal inspiration here seems to have have been the movement of the celestial bodies and the regularity of the seasons. The only non-cyclic cosmologies were those associated with Semitic monotheistic religion, in which case the universe is created by God out of nothing six thousand years ago and will end soon in a day of judgment. Eastern philosophy today holds to a cyclic cosmology, Creationism to a religious linear cosmology, and Theosophy and the New Age combine cycles and evolution to give a spiral cosmology (MAK)

D.

Darwin fish: parody of the Christian *ichthys* (fish) symbol with feet, legs and Darwin written inside the fish to symbolise Darwin's Theory of evolution by natural selection which is seen in contrast with Biblical creationism which is based on christian fundamentalism (hence the legs and feet attached to it). It is often associated with another parody of the ichthys fish known as the Evolve fish which is depicted as having legs, the word evolve written on it and carrying a wrench. (EvoWiki, from Wikipedia)

Darwin fish

Darwinian: Of or pertaining to natural selection, or Darwin's theory of evolution in general. Sometimnes taken to mean natural selection with gradualist assumptions, although it is now considerd doubtful that Darwin was a uniformitarian to this degree. (modified from W. R. Elsberry - talk.origins)

Darwinism: In 1859 Charles Darwin supplied a mechanism, namely natural selection, that could explain how evolution occurs. Darwin's theory of natural selection helped to convince most people that life has evolved and this point has not been seriously challenged in the past one hundred and forty years. It is important to note that Darwin's book "The Origin of

Species by Means of Natural Selection" did two things. It summarized all of the evidence in favor of the idea that all organisms have descended with modification from a common ancestor, and thus built a strong case for evolution. In addition Darwin advocated natural selection as a mechanism of evolution. Biologists no longer question whether evolution has occurred or is occurring. That part of Darwin's book is now considered to be so overwhelmingly demonstrated that is is often referred to as the *fact* of evolution. However, the *mechanism* of evolution is still debated. cf. Modern Synthesis. More (W.J. Hudson).

Decision: Step Seven in the Scientific Method: The estimate of error and the allowance for error are analyzed, and the hypothesis is either "rejected" or "not rejected" Please notice that the hypothesis is not 'proven'! The end result of the process is a theory. A theory is what a hypothesis becomes after it has accumulated supporting experimental data. (W.J. Hudson)

Deism: 18th century theology, stemming from the Age of Enlightenment, according to which God, the divine clockmaker, created the universe at the beginning, but did not interfere in any way since. (MAK)

Denialism: any psychological attitude that involves denying empirically verifiable historical or scientific facts, in order to avoid facing the uncomfortable truth such evidence or research reveals. Climate Skepticism (which rejects findings of climate science) and Creation Science (which denies evolutionary theory) are probably the two most influentual forms of denialism today. Denialists of one type of denialism need not agree with those of another; e.g. geologist Ian Plimer, a climate denialist and author of the best-selling *Heaven and Earth*, is also an evolutionist who has vigorously criticised creationists. Denialists may be free thinkers, sincerely concerned about the way established paradigms dominate a particular field of science and unconventional views are rejected. Or they may be deliberate advocates of religious, ideological, or corporate pressure groups or vested interests. (MAK, Wikipedia. Ref: *New Scientist* - Special report, Age of Denial, 15 May 2010, vol 206, no. 2760 (preview, full view for subscribers))

Disbelief: A position which asserts that a proposition is false. This is technically a "positive" position on any matter, and, like belief, must shoulder a burden of proof if it is to be proven. cf. unbelief. (W.J. Hudson)

Dualism: the belief or philosophical argument that claims that mind or spirit and matter or physical reality are two fundamentally different and irriducible realities. The standard metaphysical form is *substance dualism*, argued by Descartes, who claimed that there are two fundamental kinds of substance: mental and material. The mental does not extend in space, and material cannot think. *Supernaturalism* would constitute another form of dualism, as it places a supernatural reality consisting of God and other religious entities apart from the natural material world. Dualism is now out of favour with contemporary philosophy. Compare theistic evolution. Contrast monism and materialism. Emanation, emergence, and holism represent various alternatives to both Dualism and Monism (MAK, Wikipedia glossary)

E.

Eastern philosophy: philosophical and spiritual (as opposed to religious) aspects of Buddhism, Jainism, Hinduism, Taoism, and similar worldviews, which teach the goal of existence is the realisation of the absolute reality. Influential in Transpersonal Psychology and the New Age/New Paradigm, and Integral movements. Assumes endless cycles of existence but accommodates evolution without any problem. Tends to reject creationism and supernaturalism in favour of monism and emanation. See also individual evolution, conscious evolution (MAK)

Empiricism: understanding the natural world by means of verifiable observation via the senses and scientific instruments; an essential component of scientific method and naturalism in general. Also refers to a school of 18th century philosophy which argued that knowledge is only derived through the senses, in contrast to rationalism (knowledge can be derived through pure reasoning; e.g. Cartesian realism). Empiricism can be used to argue for both positivist realism and pragmatist neo-kanteanism. In late 20th century systematics, neo-pragmatist *radical empiricist* methodologies, such as Phenetics and Pattern Cladism, sought to arrive at a perfectly "objective" science (or hypotheses) devoid of any subjectivity, evolutionary narrative, and "intuition"; such attempts fail because any assesment, e.g. weighting, is itself the result of subjective opinion and "intuition" (MAK)

Evolution (Biology): A change in the gene pool of a population over time. The process of evolution can be summarized in three sentences: Genes mutate. Individuals are selected. Populations evolve. (W.J. Hudson) A subset of Evolution (Systems Theory). See also Darwinism, Modern Synthesis . **more**

Evolutionary Theory: (or **Evolutionary Mechanism Theory**) Any one of several theories in biology dealing explicitly with some aspect of evolution or cumulative evolution. Examples include Sewall Wright's "shifting-balance theory",

Eldredge and Gould's "punctuated equilibrium theory", the theory of common descent, Darwin's "descent with modification", Henry Fairfield Osborn's "orthogenesis", and "Gene Flow". While "evolutionary theory" is equivalent, the point that mechanisms are proposed and tested in evolutionary mechanism theories is worthy of stress and repetition. Some mechanisms increase genetic variation (cf. mutation, recombination, gene flow) and some decrease genetic variation (cf. natural selection, genetic drift) (W. R. Elsberry talk.origins via W.J. Hudson)

Evolutionism: Conditional acceptance of one or more Evolutionary Theories based upon the overwhelming evidence found for such; philosophy of inevitable development. (W. R. Elsberry - talk.origins). Consititutes an *evolutionary narrative*, which is accepted by mainstream science but rejected by both radical empiricism and neo-pragmatism. Evolutionism can be naturalistic, acknowledging only natural selection and mutation or rearrangements of genetic material that allowing successive generations of living beings adapted to changing environments, or it can also include teleological factors such as theistic evolution, conscious evolution and/or a pantheistic/panentheistic Godhead. The opposite of Creationism. (MAK)

Experiment: Step five in the Scientific Method. The system is manipulated and the results are compared against a control setting and the prediction. (W.J. Hudson)

F.

Fact: in science, an observation that has been repeatedly confirmed and for all practical purposes is accepted as "true." Truth in science, however, is never final, and what is accepted as a fact today may be modified or even discarded tomorrow.

Fundamentalism: the belief in a literal and inerrant interpretation of the Bible. The term developed in the American Protestant community of the United States in the early part of the 20th century, and that had its roots in the Fundamentalist-Modernist Controversy of that time. It was popularized by a series of books called *The Fundamentals*, published in 1910 and funded by Milton and Lyman Stewart, referring to those tenets considered fundamental to Christian belief. More recently it has come to be applied to religious extremism and literalist belief in religious scripture in any faith. Almost all Young Earth Creationists are of this persuasion, in contrast to Old Earth Creationists, Theistic Evolutionists,Deists, and Pantheists, who all adopt a more allegorical approach to the Bible. (MAK, Wikipedia)

G.

God: the supreme being of supernatural religions (note that Buddhism is an atheistic religion and so does not believe in a supreme deity). In a broader sense, any mystical or ultimate theistic reality (may be personal or impersonal). Contrast with absolute reality, emanation, naturalism (MAK)

Gosse Assertion, The: The belief that a creator created the universe and life by fiat, but with the "appearance of age". Rightly rejected by most theologically astute persons as libelous or blasphemous. Gosse was the author of "Omphalos" (navel), where this assertion was given its fullest treatment. (W. R. Elsberry - talk.origins)

Gradualism or **Phyletic gradualism**: evolutionary mechanism theory, based on the premise that evolutionary change takes place through the gradual change of populations and not by the sudden (saltational) production of new individuals that represent a new type. Nnew species evolve through the steady and gradual transformation of the entire population. The standard evolutionary paradigm prior to the early 1970s, as shown by the diagram (right) from Moore, Lalicker, & Fischer 1952. This view is usually attributed to Darwin because of his being influenced by uniformitarian geology by Eldredge and Gould, who instead argued for Punctuated Equilibria. But Richard Dawkins explained that such constant-rate gradualism is not present in the professional literature, thereby the term only serves as a straw-man for punctuated equilibrium advocates. In his book *The Blind Watchmaker*, Dawkins argues against the idea that Charles Darwin himself was a constant-rate gradualist, as suggested by Niles Eldredge and Stephen Jay Gould- See also comments by John Wilkins and Larry Moran (MAK; W.J. Hudson, Wikipedia)

H.

Holism: A non-reductionist descriptive and investigative strategy for generating explanatory principles of whole systems. Attention is focused on the emergent properties of the whole rather than on the reductionist behavior of the isolated parts. The approach typically involves and generates empathetic, experiential, and intuitive understanding, not merely analytic understanding, since by the definition of the approach, these forms are not truly separable. (Wikipedia glossary)

Hypothesis: The third step in the scientific method. A tentative statement about the natural world leading to deductions that can be tested, It provides explanatory and predictive power, and is conditionally held on review of further observations and experiment. If the deductions are verified, it becomes more probable that the hypothesis is correct. If the deductions are incorrect, the original hypothesis can be abandoned or modified. Hypotheses can be used to build more complex inferences and explanations. cf. theory. (W. R. Elsberry talk.origins via W.J. Hudson, modified)

I.

Idealism: in metaphysics (as opposed to colloquial or political definitions), the premise that the visible, material world of phenomena is secondary to fundamental non-material ideas, plans, archetypes, forms, or consciousness underlying the phenomena we observe in nature. It has been historically influential in 18th and 19th century pre- and non-Darwinian biological and evolutionary thought. See also German Idealism, Naturphilosophie, Teleology. (MAK)

Intelligent Design: is the proposition that "certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection." Usually it a form of creationism restated in non-religious terms, retaining the idea of deity while seeking to embrace scientific method. In this form it is a contemporary adaptation of the traditional teleological argument for the existence of God, but one which deliberately avoids specifying the nature or identity of the intelligent designer. Its leading proponents are associated with the Discovery Institute, a politically conservative religious fundamentalist think tank who believe the designer to be the Christian God. There are however other, non-religious, interpretations of Intelligent Design, such as emanation, panspermia, link: consciousness and quantum physics), universal field, and emanation. Link: EvoWiki

J.

"Just so" story: Sarcastic term used by some neo-pragmatist critics of empirical realism when describing accounts of the evolution of life. According to pheneticists and many early cladists (especially of the Pattern / Transformed orientation), phylogeny such as is described by evolutionary systematicists has no more validity than a Rudyar Kipling fable of how the elephant got its trunk. While pheneticists and cladists did acknowledge the reality of evolution (unlike creationism for example), they rejected any empirical or literalist interpretations, and argue that all phenetics and cladistics does is characterise and analyse patterns, these patterns may or may not correspond to actual evolution and phylogeny, but even if they do, it is impossible to prove this for certain, still less to analyse the underlying causes that generate these patterns (Eldredge, 1993, p.34). Remarkably similar to certain anti-empirical and anti-realist trends in postmodernist philosophy, such as Derridean deconstruction and Wilfred Sellars "myth of the given". Rightly criticised by Richard Dawkins and others. Note that modern Phylogenetic Systematics (currently the mainstream phylogenetic paradigm) rejects this approach and returns to phylogenetic realism. (MAK)

K.

L.

Law: A descriptive generalization about how some aspect of the natural world behaves under stated circumstances.

M.

Macroevolution: Evolution at or above the species level. The boundary between macro- and micro- is fuzzy, as some researchers prefer to include speciation in micro- and others reson that the only macro- process that gives distinctive events is speciation. Speciation events are thus, to many scientists, examples of macroevolution. Another definition is evolution too imperceptible to be observed within the lifetime of one researcher . (W. R. Elsberry talk.origins via W.J. Hudson) link: Macroevolution Its Definition, Philosophy and History by John Wilkins

Materialism: the philosophical view that the only thing that can truly be said to 'exist' is matter; that fundamentally, all things are composed of 'material' and all phenomena are the result of material interactions. (note: matter could include energy or other phenomena known to science, in this context materialism and metaphysical naturalism are synonymous). There are a large number of different schools and interpretations, e.g. dialectical materialism (Marxism), eliminative materialism (consciousness is simply brain functioning and doesn't exist in itself), emergent materialism (just the opposite, mind is an irreducible existent, and the study of mental phenomena is independent of other sciences), reductive materialism, and so on (from Wikipedia glossary)

Meme: controversial concept proposed by Richard Dawkins. A meme is a "a unit of cultural inheritance, hypothesized as analogous to the particulate gene and as naturally selected by virtue of its 'phenotypic' consequences on its own survival and replication in the cultural environment." A meme can be an idea, skill, story, or custom, which is passed from one person to another by imitation or teaching. Some theorists argue that memes are the cultural equivalent of genes, and reproduce, mutate, are selected, and evolve in a similar way. The study of memes is called *memetics*. (Mavericks of the Mind; PBS evolution Glossary)

Metaphysics: branch of philosophy concerned with explaining the nature of being and the world, and which seeks to clarify the fundamental questions of nature of existence, including existence, properties, space, time, causality, and the nature of being (ontology), God (theology), consciousness, the Mind-Body problem, and the nature of the universe (cosmology).

Microevolution: Evolution within the species level, or a change in allele frequency in a population over time. Note that this connotation is equivalent to evolution. All "Scientific Creationists" so far admit that microevolution is observed. Some Theistic Anti-Evolutionists may not. (W. R. Elsberry talk.origins via W.J. Hudson)

Mind-Body problem: branch of metaphysics that deals with the relationship between consciousness and the body, more specifically with the brain and nervous system. Generally, reductionistic, materialistic, and naturalistic worldviews and methodologies support the reduction of the former to the latter, citing developments in neuroscience, neurotheology and cognitive science, whereas idealistic and dualistic philosophies, tend to be sceptical in considering that scientific methodologies can deliver the complete picture. According to mind-body philosopher David Chalmers, such approaches do not deal with the "hard problem" of how objective physiological impulses are transformed into subjective qualia (elements of consciousness). (MAK)

Missing link: see Non-missing link

Modern Synthesis: theory of evolution, representing the synthesis of Mendelian inheritence and Darwinian natural selection, and moving the emphasis from individual organisms to genes, phenotypes, and populations. Essentially proposes that macroevolution is only quantatively, but not qualitatively, different from microevolution. **More**

Monism: philosophical premise which holds that there is ultimately only type of substance in the universe, or alternatively that reality is ultimately unitary. Some of the (sometimes overlapping) variants include Nonduality, an eastern philosophy which says that reality is ineffable, and all that can be said is that it is not dualistic; Pantheism asserts that everything is God; phenomenalism, or mentalistic monism (and Idealism in part), which holds that only mind or spirit is real; *Neutral monism*, which holds that both the mental and the physical can be reduced to some sort of third substance, or energy; and *Physicalism* or *materialism*, which holds that only the physical is real, and that the mental or spiritual can be reduced to the physical. Contrast with dualism. (MAK, Wikipedia)

N.

Natural selection: The differential reproduction and, thereby, transmission of alleles between generations, of individuals in a population, due to heritable variation in a trait or traits which they possess. This is one mechanism by which evolution can occur. (W. R. Elsberry talk.origins via W.J. Hudson). Conceived independently and then jointly published by Darwin and Wallace, and substantially elaborated upon in the early part of the twentieth century with the rediscovery of Mendelian genetics and then advances in population genetics (Kutschera & Niklas 2004, p.256)

Naturalism: any of several philosophical stances, typically those descended from materialism and pragmatism, that do not distinguish the supernatural (including strange entities like non-natural values, and universals as they are commonly conceived) from nature. Naturalism does not necessarily claim that phenomena or hypotheses commonly labeled as supernatural do not exist or are wrong (in fact it remains agnostic about non-physical things), but insists that all phenomena and hypotheses can be studied by the same methods and therefore anything considered supernatural is either nonexistent, unknowable, or not inherently different from natural phenomena or hypotheses. (Wikipedia glossary). Naturalism is the methodology of science, as opposed to philosophy, religion, idealism, etc. Naturalistic (theories of) evolution explain biological evolution without requiring supernatural or teleological factors. Can however tend to *Metaphysical naturalism* (and thus rejection of theism and theistic evolution), as championed by British evolutionary biologist Richard Dawkins This is the belief that nothing exists but objects, forces, and causes of the kind studied by the natural sciences, and that consciousness, mind, etc can be reduced to physical causes. A metaphysical, rather than a scientific, premise that rejects the existence of supernatural entities (including spirits and souls, non-natural values, and universals as they are commonly

conceived) as well as any form of teleology. In practice, metaphysical naturalism tends to reduce to the more specific ontological view of scientific naturalism (scientism), according to which reality consists only of what the concepts of the natural sciences (and especially physics) investigate. Physicalism, reductionism, and atheism are similar and often (putting aside philosophical hair-splitting) synonymous. MAK

Neo-Darwinism: Originallky referred to the incorporation of Weismann's ideas on heredity into Darwin's theory of natural selection. Now, a synonym for Modern Synthesis, or even any modern approach to evolutionary theory

Neo-Kantean: sceptical approach to empiricism, derived from the German Transcendental idealist philosopher Immanuel Kant. Reacting to the excessively naive realism of the French rationalist philosopher Descartes (who, following a thought experiment (the original "brain in the vat" experiment) rejected radical doubt and argued not only for the existence of the material world of spatial extension, but also the God of his religion) Kant denied that it was possible to know anything about reality in itself (noumena), all one could know, he argued, are the subjective phenomena we experience. Kant's hyper-agnostic worldview became lmost influential following the decline of Hegellian metaphysics, and as a reaction to the excessive logical positivism and empiricism of the early 20th century. Neo-Kantean idealism is central to the pluralistic and anti-foundationalist worldview of some representatives of pragmatist and "postmodernist" philosophy. Especially influential here is Wilfred Sellar's Neo-Kantean critique of empiricism (Sellars, 1956/1997), which is both a development of positivism and a rejection of naturalistic realism (so these two tendencies need not be opposed), denies the positivist premise that empirical methodology describes a real world "out there" (Sellars refers to the belief in a pre-given objective reality as the "myth of the given"). Instead, all that science, or philosophy, can do, is examine the linguistic and socio-cultural premises behind such beliefs, or test empirical evidence as hypothetical or historical reconstructions, or as patterns or diagrams thrown up by various methodologies which do not provide proof or factual representation of the objective world. In evolutionary science, examples of neo-kantean theorising can be found in phenetics and Pattern cladism (see "just so" story); ironically these are methodologies that tried to totally eliminate subjectivism in favour of extreme empiricism, and hence one would expect them to be the opposite of postmodernism. More recently, philosopher of science Karl Popper however has refuted such arguments as examples of the "myth of the framework (the belief that socio-cultural factors determine everything we can know about reality). (MAK)

Neuroscience, Neurobiology: a branch of cognitive science, scientific study of the nervous system. Traditionally, neuroscience has been seen as a branch of biology. However, it is currently an interdisciplinary science that collaborates with other fields such as chemistry, computer science, engineering, mathematics, medicine, philosophy, physics, and psychology. The term neurobiology is usually used interchangeably with the term neuroscience, although the former refers specifically to the biology of the nervous system, whereas the latter refers to the entire science of the nervous system (Wikipedia). See also, paleoneurobiology

Neurotheology: branch of Neuroscience, involves the study of correlations of neural phenomena with subjective experiences of spirituality and non-ordinary and mystical states of consciousness, and hypotheses to explain these phenomena. Proponents of neurotheology say there is a neurological and evolutionary basis for subjective experiences traditionally categorized as spiritual or religious. (Wikipedia).

New Age: Describes a broad movement of late twentieth century and contemporary Western culture characterised by an individual eclectic approach to spiritual exploration. It has some attributes of a new, emerging religion but is currently a loose network of spiritual seekers, teachers, healers and other participants. The name "New Age" also refers to the market segment in which goods and services are sold to people in the movement. (Wikipedia). New Age teachings tend to reject both materialism and creationist literal religion on the other, and favour holism, non-religious intelligent design, pantheism, and spiritual evolution. *New Paradigm* refers to a somewhat more intellectual rigorous approach to these themes, drawing from transpersonal psychology, systems theory, and other fields, the term itself is based on an appropriation of Thomas Kuhn's paradigm theory. "New Paradigm" is rarely used nowadays. Another, more recent, term is *New Consciousness*. Despite the eastern elements, New Paradigm and New Consciousness are based on popularist science (holographic universe, Gaia theory, etc) that seeks justification in scientific naturalism. Have a friendly approach to Darwinian-derived evolutionary theory and empirical/positivist realism, rejecting only excessive reductionism and metaphysical naturalism. Considered pseudoscience by many scientists and sceptics. See also Universe Story, Integral Theory. (MAK)

Non-missing link: Although creationists often claim that no transitional forms are known in the fossil record, in fact the reverse is the case. (see Link). As it would be oxymoronic to refer to these intermediate species by their popular moniker as "missing link" (e.g. link link) I have coined the informal term "non-missing link". See also anagenesis, ancestor, common ancestor, basal taxon, stem group. Note that even though, in view of the vagaries of the fossil record, the non-missing link may not necessarily be the actual, literal, common ancestor of all later species in that lineage (although in some cases where stratigraphic preservation is very good it might), but it would certainly be a closely related form (MAK)

Non-overlapping magisteria: is the view advocated by Stephen Jay Gould as the solution to the supposed conflict between science and religion. His idea of Non-Overlapping Magisteria (NOMA) states that science and religion are compatible and each magistrate(or layer) occupies a separate realm of human understanding. Essentially, this is an appeal to the separation of Church and State; or in this instance Church and Science. Gould's position here has been criticised on a number of grounds by Richard Dawkins (see Wikipedia link for more) who argues instead for the atheistic position. Compare with Clergy Letter Project as similarily supporting the non-conflict between science and religion. Contrast with integral theory, pantheism, and Teilhard de Chardin as examples of unified framework integrating science and religion in a single undividivded worldview (rather than two distinct magisteria). (MAK, Wikipedia, EvoWiki)

O.

Observation: This is the first step in the scientific method. The scientific method is founded upon direct observation of the world around us. A scientist looks critically and attempts to avoid all sources of bias in this observation. But more than looking, a scientist measures to quantify the observations; this helps in avoiding bias. (W.J. Hudson)

Old Earth creationism: Old Earth creationism holds that the physical universe was created by God, but that the creation event of Genesis is not to be taken strictly literally. This group generally believes that the age of the Universe and the age of the Earth are as described by astronomers and geologists, but that details of the evolutionary theory are questionable. Old Earth creationists interpret the Genesis creation narrative in a number of ways, that each differ from the six, consecutive, 24-hour day creation of the Young Earth Creationist view. Gap creationism, Day-Age Creationism, and Progressive creationism are related or variant forms.

P.

Panspermia: the hypothesis that life did not originate on Earth but was seeded from elsewhere in the universe. There are several forms:

- *Naturalistic Panspermia* asserts that life evolved on another planet, and was ejected and transferred to Earth by meteorites, or else it originated in deep space from complex molocules found in nebula or comets; the genetic material is then carried to Earth by comets (Fred Hoyle and Chandra Wickramasinghe).
- *Directed Panspermia* is the premise that intelligent extra-terrestrials intentionally seeded other planets with genetic material, even if they didn't travel there themselves. Directed Panspermia was first proposed by Francis Crick, co-discoverer of DNA
- *Ancient Astronaut hypothesis* is the belief that extra-terrestrial astronauts visted Earth in past ages and created the human race through genetic engineering. These aliens were believed to be gods and became the gods of mythology. Popular proponents include Erich von Danniken and Zecharia Sitchin. Does not say anything about the origin or evolution of the rest of life on Earth. Arthur C Clarke and Stanley Kubrick's 2001: A Space Odyssey provides another take on this, and doesn't pretend to be anything other than science fiction.

Directed and Ancient Astronaut Panspermia are clearly variations on the Intelligent Design approach which attempt to circumvent supernatural explanations. The problem with panspermia though, even naturalistic interpretations, is that it still doesn't explain how life appeared in the first place. Even if life or intelligence didn't evolve first on Earth, it still had to evolve somewhere else in the universe. Links: Panspermia (large web site, naturalistic approach); Problems with Panspermia or Extraterrestrial Origin of Life Scenarios

Pantheism, Panentheism: *Pantheism* is a form of monism that asserts that God is the same as the cosmos, and vice versa. Hence divine laws and natural laws are the same. Einstein famously advocated this position; he was inspired by the philosophy of Spinoza. Pantheism allows both science and spirituality and metaphysics to co-exist. Also popular in the New Age movement. *Panentheism* is similar except that it asserts that God is not only the same as the cosmos and everything in it (pantheism), but also transcends the cosmos. Panentheism tends to be preferred by mystics, amd ties in also with emanation. (MAK)

Paradigm: as defined by historian of science Thomas Kuhn as the set of practices that define a scientific discipline at any particular period of time. In his landmark book in *The Structure of Scientific Revolutions*, Kuhn defines a scientific paradigm as:

- what is to be observed and scrutinized
- the kind of questions that are supposed to be asked and probed for answers in relation to this subject

- how these questions are to be structured
- how the results of scientific investigations should be interpreted

Within *normal science*, the paradigm is the set of exemplary experiments that are likely to be copied or emulated. In this scientific context, the prevailing paradigm often represents a more specific way of viewing reality, or limitations on acceptable programs for future research, than the more general scientific method.

When one paradigm is replaced or overthrown by another, that is called a *Paradigm Shift*. Kuhn considered that transition from one paradigm to another via revolution is the usual developmental pattern of mature science. Hence paradigm shifts tend to be most dramatic in sciences that appear to be stable and mature, as in physics, where around the turn of the 20th century, classical netwonian physics was replaced by relativity and quantum mechanics. The mid-19th century transition from a more static biology to a Darwinian-derived evolutionary one would be another example. Evolutionary Theory itself underwent a number of paradigm shifts, such as Darwinism, Neo-Darwinism, Modern Synthesis, and now more recent ideas incorporating molecular phylogeny, evo-devo, cladistics, systems theory, and so on. In terms of mapping out the history of life there was a qute dramatic paradigm shift in the 1980s, from evolutionary systematics to phylogenetic systematics (two other paradigms, phenetics and pattern cladistics, played a much more minor role), more recently there has been a further shift from morphology based cladistics to molecular phylogeny

Advocates of specific paradigms tend to be feircely passionate about their own preferred paradigm, extolling its strengths and virtues and minimising its weaknesses, while at the same time being uncompromisingly critical, dismissing, and ridiculing their oponents' paradigms. In this way, a paradigm becomes like a religion or a political ideology, something that may indeed have good qualities, but which is held to with irrational fervour. In the current iteration of Palaeos I have tried to balance and include many paradigms, not just dominant ones, while acknowledging that inevitavbly, whatever paradigms are used will be supplemanted or supplanted in the future by paradigms which we have no conception of now, and even if we did, would probably not believe. (Wikipedia, MAK)

Parsimony: Also known as Occam's Razor (after the medieval theologian William of Ockham (c. 1285–1349), who rejected the idea of universals) is the principle that recommends when choosing between two competing hypotheses, that the simplest explanation of the evidence or observation is to be preferred, when the hypotheses are equal in other respects

Philosophy of biology: subfield of philosophy of science, which deals with epistemological, metaphysical, and ethical issues in the biological and biomedical sciences. Although philosophers of science and philosophers generally have long been interested in biology (e.g., Aristotle, Descartes, and even Kant), philosophy of biology only emerged as an independent field of philosophy in the 1960s and 1970s. Philosophers of science then began paying increasing attention to biology, from the rise of Neodarwinism in the 1930s and 1940s to the discovery of the structure of DNA in 1953 to more recent advances in genetic engineering. Other key ideas include the reduction of all life processes to biochemical reactions, and the incorporation of psychology into a broader neuroscience. (Wikipedia)

Piltdown Man: famous 1912 hoax of early fossil man, consiting of a human skull, ape jaw, and filed down teeth. Had a significant detrimental impact on early research on human evolution: discoveries of Australopithecine fossils found in the 1920s in South Africa were ignored and instead the popular (but erroneous) theory argued that the human brain expanded in size before the jaw adapted to new types of food. rather than the reverse. Definitively exposed as a forgery by scientists back in 1953 (MAK, Wikipedia)

Platonism: the school of philosophy founded by Plato. Often used to refer to Platonic idealism, the belief that the entities of the phenomenal world are imperfect reflections of an ideal truth. In metaphysics sometimes used to mean the claim that universals exist independent of particulars. Quite distinct from *Aristotleanism*, with its more naturalist approach. The synthesis of Platonism, Aristotelianism, and Stoicism culminated in *Neoplatonism* was a school of philosophy that took shape in the 3rd century c.e. under Plotinus. The school was characterized by a systematization of Platonic metaphysics along with a pursuit of mystical union with the divine. Platonic, Aristotelian, and Neoplatonic ideas led to the Great Chain of Being, and ideas like teleology (Aristotle) and archetypes (Plato, Neoplatonism), which remained influential well into the 19th century. (MAK, Wikipedia glossary)

Positivism: philosophical position that the only authentic knowledge is scientific knowledge (see naturalism). It is an approach to the philosophy of science, deriving from Enlightenment thinkers like Pierre-Simon Laplace and Auguste Compte. **Logical positivism** is a school of philosophy that combines empiricism - the idea that observational evidence is indispensable for knowledge of the world - with a version of rationalism incorporating mathematical and logico-linguistic constructs and deductions in epistemology. It grew from the discussions of a group of philosophers called the "Vienna Circle" which gathered at the Caf– Central, a coffeehouse in Vienna frequented by intellectuals, in the years immediately

preceeding and following World War I. (MAK, Wikipedia glossary)

Pragmatism: American philosophical tradition centered around the linking of practice and theory. It describes a process where theory is extracted from practice, and applied back to practice to form what is called *intelligent practice*. Important positions characteristic of pragmatism include instrumentalism (the view that a scientific theory is a useful instrument in understanding the world, and should be evaluated by how effectively it explains and predicts phenomena, not how accurately it describes objective reality as such), radical empiricism, verificationism, conceptual relativity and a denial of the fact-value distinction (overlaps with postmodernism), a high regard for science, and fallibilism (the philosophical principle that human beings could be wrong about their beliefs, expectations, or their understanding of the world; the position of the natural sciences. Originally established by Charles Sanders Peirce, and further developed by William James, John Dewey and George Santayana. W. V. O. Quine and Wilfrid Sellars used a revised pragmatism to criticize logical positivism in the 1960s. Another brand of pragmatism, known sometimes as *neopragmatism*, gained influence through Richard Rorty, the most influential of the late 20th-century pragmatists (Wikipedia) However I would also use neo-pragmatism to include any anti-realist and radical empiricist approach, in contrast to the less nihilistic pragmatism of Pierce and James. (MAK)

Prediction: Step four in the scientific method. The prediction is a formal way to put a hypothesis to a test. If you have carefully designed your hypothesis to be sure it is falsifiable, then you know precisely what to predict. The prediction has three parts: 1. If my hypothesis is true... 2. Then _____ should happen ... 3. When _____ is manipulated. The manipulation is what you knew would likely falsify your hypothesis. (W.J. Hudson)

Preformationism: historical and obsolete 17th and 18th century scientific theory that all living beings were created at the same time, and that succeeding generations grow from homunculi, animalcules, or other fully formed but miniature versions of themselves that have existed since the beginning of creation. Hence the entire human race, down to the last individuals prior to the Day of Judgment, pre-exist in the ovaries of Eve, or the testes of Adam, depending on where one locates the miniature homunculi. Although Preformationism sounds (and is) ridiculous to us todauy, it made sense to the logic of pre-evolutionary Christendom, according to which the entire lifespan of the universe from beginning to end would be no more than six or seven thousand years. Moreover, after the invention of the microscope and the discovery of microscopic organisms, but before modern cell theory, there was no reason not to assume that "big fleas have little fleas to bite 'em", and so on ad infinitum. (MAK)
Link: Each Sperm Cell has a Fully Formed Human Waiting Inside; graphic Preformation, drawn by N. Hartsoecker 1695

Proposition: A statement which can be either true or false, as opposed to interrogative, exclamatory, or imperative sentences. See also: belief, unbelief, disbelief. (W.J. Hudson)

Punctuated Equilibria, Punctuated evolution: evolutionary theory that argues that new species evolve suddenly and in geographically isolated areas. Hence speciation is rarely found in the fossil record, because established, populous and widespread species (the sort that are most likely simply through greater numbers to leave fossil remains) usually change slowly, if at all, during their time of residence. See punctuated equilibria FAQ on the talk.origins archive site. (W. R. Elsberry talk.origins via W.J. Hudson, modified).

Q.

Question: The second step in the scientific method is to formulate a question. The question must be answerable. "Why am I here?" is not a question that is answerable by science; it is, to use the colloquialism: "metaphysics rather than physics". (W.J. Hudson, modified)

Quote mining. The intellectually dishonest art of deliberately selection of quotes, normally out of context, to refute the original author's point. This tactic is widely used among Young Earth Creationists to attempt to discredit evolution. Quote mining - RationalWiki

R.

Random: Unpredictable in some way. Mutations are "random" in the sense that the sort of mutation that occurs cannot generally be predicted based upon the needs of the organism. However, this does not imply that all mutations are equally likely to occur or that mutations happen without any physical cause. Indeed, some regions of the genome are more likely to

sustain mutations than others, and various physical causes (e.g., radiation) are known to cause particular types of mutations. (UCMP Understanding Evolution Glossary)

Realism: philosophical premise that reality ontologically independent of individual conception, perception, etc. Objects have certain properties regardless of any thought to the contrary. As pertains to a scientific or contemporary philosophical understanding of the world, a distinction can be made between *na&#65533;ve realism*, the common view of the world including the claims that it is as it is perceived, that objects have the properties attributed to them, and that they maintain these properties when not being perceived, and *critical realism*, the view that certain types of sense data accurately represent a mind-independent reality while other types do not, for example the primary/secondary quality distinction. Na&#65533;ve realism is now universally rejected, whereas critical realism represents the current accepted paradigm. Contrast with pragmatism. (MAK, Wikipedia glossary).

Reductionism: in Philosophy, a number of related, contentious theories that hold, very roughly, that the nature of complex things can always be reduced to (be explained by) simpler or more fundamental things. This is said of objects, phenomena, explanations, theories, and meanings. In short, it is philosophical materialism taken to its logical consequences. *Ontological reductionism* is the idea that everything that exists is made from a small number of basic substances that behave in regular ways. Compare to monism, contrast with holism, emergence. *Methodological reductionism*: the idea that explanations of things, such as scientific explanations, ought to be continually reduced to the very simplest entities possible (but no simpler). Occam's Razor forms the basis of this type of reductionism. Compare with scepticism. *Scientific reductionism*: has been used to describe all of the above ideas as they relate to science, but is most often used to describe the idea that all phenomena can be reduced to scientific explanations. Also known as *Scientism*. Compare with naturalism and materialism, contrast with idealism. (from Wikipedia glossary). In Systems Theory, one kind of scientific orientation that seeks to understand phenomena by a) breaking them down into their smallest possible parts: a process known as *analytic reductionism*, or conversely b) conflating them to a one-dimensional totality: a process known as *holistic reductionism*. (Wikipedia glossary).

S.

Scepticism: generally refers to any questioning attitude of knowledge, facts, opinions, or beliefs stated as facts, or doubt regarding claims that are taken for granted elsewhere. A sceptical attitude is central to scientific method (MAK, Wikipedia)

Scala Naturae "Natural ladder", is a sort of proto-taxonomy first developed by Aristotle, according to which the natural world can be arranged in a single linear series from inanimate matter through plants, invertebrates, higher vertebrates, and finally man. Along with Plato's Principle of Plenitude it led to the idea of the Great chain of being. Scala Naturae and Great Chain of Being remained central ideas in natural philosophy until the mid 19th century.

Scientific Creationism: The belief that scientific evidence supports the literal factuality of the first eleven or so chapters of the book of Genesis in the bible, in contradiction to evolutionary mechanism theories. This is derived from early sources of the term; later ones try to dissociate "scientific creationism" from "biblical creationism" by the expedient course of not actually mentioning the Bible when discussing "scientific creationism". "Scientific Creationists" are distinguished by two features from the theistic anti-evolutionists: "Scientific Creationism" is associated only with literal inerrantist interpretations of Genesis, and "scientific creationists" take a proactive stance on pushing their conjectures into secondary school science classrooms as science alongside or in replacement of evolutionary mechanism theories. (W. R. Elsberry talk.origins via W.J. Hudson) As with other forms of denialism, claim their own approach is more scientific than that of the consensus scientific or academic community. See also creationism (MAK)

Scientific Method: Science can be defined as "a methodical approach to the acquisition of knowledge." This distinguishes how a scientist works from how other people learn about the world. Science is an approach that is methodical, and that approach helps acquire knowledge. Science is not the knowledge gained through the approach. Knowledge can be gained through a variety of ways, but science acquires knowledge methodically. The scientific method can be described as having seven steps: 1. Observation; 2. Question; 3. Hypothesis; 4. Prediction; 5. Experiment; 6. Analysis; 7. Decision. The end result of the scientific method is either a rejected hypothesis, or a supported hypothesis. A hypothesis that has gathered enough supporting observations and experimental results is a theory. (W.J. Hudson)

Separate creation: The theory that species, or higher taxa of an indeterminate rank, have separate origins (being created by God as separate and distinct "kinds"), there is no evolutionary relationship between them, and they never change after their origin, or only change at the microevolutionary level. A central premise of creationism, which was falling out of favour even before Darwin (see Naturphilosophie and Lamarck) (MAK)

Social Darwinism: a 19th century political philosophy which attempted to explain differences in social status (particularly class and racial differences) on the basis of evolutionary fitness. Based on the misinterpretation of Darwinian theory, Social Darwinism is generally considered unscientific by modern philosophers of science. (Wikipedia glossary)

Sociobiology: scientific study based on the assumption that social behavior has resulted from and attempts to explain and examine social behavior within an evolutionary that context. Often considered a branch of biology and sociology, it also draws from ethology, anthropology, evolution, zoology, archaeology, population genetics, and other disciplines. Sociobiology investigates social behaviors, such as mating patterns, territorial fights, pack hunting, and the hive society of social insects. It argues that just as selection pressure led to animals evolving useful ways of interacting with the natural environment, it led to the genetic evolution of advantageous social behavior. Popularised in 1975 with the publication of Edward O. Wilson's book, *Sociobiology: The New Synthesis*. The new field quickly became the subject of heated controversy. Criticism, most notably made by Richard Lewontin and Stephen Jay Gould, centered on sociobiology's contention that genes play an ultimate role in human behavior and that traits such as aggressiveness can be explained by biology rather than a person's social environment. Sociobiologists generally responded to the criticism by pointing to the complex relationship between nature and nurture. In response to some of the potentially fractious implications sociobiology had on human biodiversity, anthropologist John Tooby and psychologist Leda Cosmides founded the field evolutionary psychology. (Wikipedia)

Spirituality: broadly defined, the inner impetus to transcendence, and appreciation of a greater reality beyond the individual ego. Religionists and idealists associate it with transcendent reality, whereas naturalists may seek to explain it in terms of Neurotheology and Neuroscience. Spirituality can also be distinguished from normative (institutional) religion; for example Einstein's pantheistic "sense of wonder" at the universe is an example of spirituality that is not religious (because he rejects a supernatural God) but naturalistic. In contrast to some (more literalist) forms of religion, a strong sense of spirituality does not require a rejection of empirical science, as their is nothing in the findings or methods of science or naturalistic evolution that conflicts with spirituality. (MAK)

Supernatural, Supra-physical: over and apart from the natural or physical world, and hence tending to imply a dualistic worldview. May refer to theological ideas (God, souls, etc) or pop-culture (vampires, ghosts etc). Generally tends to imply incomprehensibility, fantastical elements, and tital non-connection with the material world. For all these reasons an alternative and less religious term like *Supra-physical* would be preferable. This is the premise, advocated by most mystical, esotericist, and occult philosophies and teachings, that there exist realities that cannot be defined in terms of, or reduced to material or natural causes. In contrast to the "supernatural", with its fantastical and illogical aspects, supra-physical realities are considered to relate to the external or material universe in a knowable and meaningful way, the whole forming a unified cosmology. See also archetype, emanation, idealism, teleology. Some metaphysical philosophies, such as Theosophy, have attempted to integrate supra-physical and evolutionary ideas. (MAK)

the less sensationalist term supra-physical is preferable (MAK).

System: a set of interacting or interdependent system components forming an integrated whole. The scientific research field which is engaged in the study of the general properties of systems include systems theory, cybernetics, dynamical systems, thermodynamics and complex systems. They investigate the abstract properties of the matter and organization, searching concepts and principles which are independent of the specific domain, substance, type, or temporal scales of existence. Most systems share common characteristics, including:

- Systems have structure, defined by components and their composition;
- Systems have behavior, which involves inputs, processing and outputs of material, energy, information, or data;
- Systems have interconnectivity: the various parts of a system have functional as well as structural relationships between each other.
- Systems may have some functions or groups of functions

(Wikipedia)

Systems theory: the transdisciplinary study of systems in general, with the goal of elucidating principles that can be applied to all types of systems in all fields of research. The term does not yet have a well-established, precise meaning, but systems theory can reasonably be considered a specialization of systems thinking and a generalization of systems science. The term originates from Ludwig von Bertalanffy's General System Theory (GST). In this context the word "systems" is used to refer specifically to self-regulating systems, i.e. that are self-correcting through feedback. Self-regulating systems are found in nature, including the physiological systems of our body, in local and global ecosystems, and in climate. See also complex system, emergence. (Wikipedia)

T.

TalkOrigins Archive: website that presents a comprehesive scientific critique of claims by young-earth, old-earth, and intelligent design creationists, and useful introduction to various evolution science topics. Uses material from the talk.origins newsgroup, collected by Brett J. Vickers in 1994 and posted as a website in 1995. Still the most comprehensive and easily accessible anti-creationism website around. Some of the material in this glossary is originally from TalkOrigins (MAK) Website

Teleology: the philosophical supposition that there is design, purpose, directive principle, or final causes in the works and processes of nature, and therefore that either design and purpose analogous to that found in human actions are inherent also in the rest of nature, or that evolution is being pulled to a final goal or consumation. Teleology was explored by Plato and especially Aristotle, by Saint Anselm, and Immanuel Kant (*Critique of Judgment*). Philosophers and thinkers like Hegel, Marx and Engels, Henri Bergson (Creative Evolution), Teilhard de Chardin (evolutionary theology), and Ken Wilber (Integral Theory), are among the many who have in different ways have advocated a teleological theory of evolution. Both philosophical naturalism and teleology investigate the existence or non-existence of an organizing principle behind those natural laws and phenomena investigated by science. Philosophical naturalism asserts that there are no such principles, whereas teleology asserts that there are (see archetype, vitalism). Teleology is rejected by both metaphysical naturalism (e.g. Richard Dawkins), neo-pragmatism, and postmodern philosophy (as an example of a "grand narrative"). (MAK, and Wikipedia glossary)

Theism: Refers to the position of belief in a God or gods. Some more narrowly-construed versions of belief in God include: monotheism (belief in one God), polytheism (belief in many gods), pantheism (belief that God is everything), and deism (belief in a God which created the universe, but does not "interfere" with it). contrast with atheism, agnosticism (W. R. Elsberry talk.origins via W.J. Hudson, modified)

Theistic Anti-Evolutionist: Any person who expresses opposition to evolutionary mechanism theories when motivated by religious doctrine, as contrasted with those who propose alternative hypotheses and theories within the framework of the scientific method. The theistic anti-evolutionist tends to confuse evolution and evolutionary mechanism theories, which typically results in the theistic anti-evolutionist making specific criticisms of a particular evolutionary mechanism theory while asserting that all evolutionary mechanism theories are affected. (W. R. Elsberry talk.origins via W.J. Hudson). Basically synonymous with Creationism

Theistic evolution: the view that some or all classical religious teachings about God and creation are compatible with some or all of modern scientific theory, including, specifically, evolution. It generally views evolution as a tool used by a creator god, who is both the first cause and immanent sustainer/upholder of the universe; it is therefore well accepted by people of strong theistic (as opposed to deistic) convictions. Most adherents consider that the first chapters of Genesis should not be interpreted as a "literal" description, but rather as a literary framework or allegory. Theistic evolutionists have frequently been prominent in opposing creationism

There is a continuum between theistic evolution (*sensu stricta*) and evolutionary creationism, the belief that things evolve but that God intervenes and directs evolution towards a goal (i.e. Humanity). The term *deistic evolution* has also been proposed to describe the model in which God started creation, but do not interfere in any way. Famous theistic evolutionists included Asa Gray, Darwin's correspondent, and Henry Drummond, whose *Ascent of Man* was a popular apologetic work of the 1890s. An alternative, non-supernaturalist approach is evolutionary pan(en)theism (e.g. Teilhard de Chardin) (MAK, Wikipedia, EvoWiki)

Theory: In science, a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses. It proposes a natural mechanism for a phenomenon, where the mechanism is amenable to test, provides explanatory and predictive power, is conditionally held on review of further observations and experiment, and has accumulated supporting observations and experimental results. cf. hypothesis, scientific method. (W. R. Elsberry talk.origins via W.J. Hudson)

Theosophy: 19th century occult philosophy and cosmology which describes planes of being and the evolution of consciousness, and attempted to integrate these with Victorian evolutionism and popular Darwinism and deep time (via a convergence of 19th century geology and the cyclic cosmology of eastern philosophy. Advocates an emantionist worldview, rejects creationism and the idea of a supernatural God. Hugely influential on the modern New Age movement. Some theosophists have attempted to reconcile the theory of root races and lost continents with 20th century scientific discoveries of earth evolution and continental drift (so, for example, Lemuria becomes Gondwana). (MAK) **more**

Transitional form, or transitional fossil: A fossil or group of organisms that are intermediate and a link between a more primitive or ancestral group and a more advanced or specialised one, possessing characteristics or traits of both (see Mosaic evolution). Generally any evolutionary lineage constitutes a series of transitional forms; for example in the evolution of birds from dinosaurs, or whales from terrestrial ancestors, there are a number of intermediate forms or non-missing links.An important aspect of evolutionary systematics, see also anagenesis. Note that strict application of cladistics rejects the possibility of identifying transitional forms (it dossn't deny the reality of evolution of course, just that it is possible to know for sure which fossils represent transitional forms) (Paraphyly Watch blog - Transitional Fossils, Microbes & Patrocladistics). An alternative approach (given in Wikipedia) would be to make a distinction between "transitional" and "intermediate". *Transitional* forms do not have a significant number of unique derived traits, so it is morphologically close to the actual common ancestor it shares with its more derived relative (see also basal taxon and stem group). *Intermediate* can be used for those forms with a larger number of uniquely derived traits. According to this definition, *Archaeopteryx* is transitional whereas the platypus (an specialised egg laying mammal, decsended from very primitive mammals) is intermediate. But rather than multiply terminology, it would be better to retain intermediate in the informal but more grammatically correct sense of meaning the same as "transitional". Some intermediate/transitional forms linking major groups of vertebrates include the fish/amphibian sequence from *Eusthenopteron* (fish) to *Panderichthys* to *Tiktaalik* to *Acanthostega* to fully developed amphibians (Devonian period), transitional reptile/mammal forms such as the cynodont *Thrinaxodon* and other mammal-like reptiles that show a blend of mammalian and reptilian characteristics (Triassic), *Velociraptor* and relatives, and even more so *Microraptor*, a four-winged gliding dromaeosaurid, and even more advanced forms such as *Anchiornis* and *Scansoriopteryx*, representing an intermediate stage between the flightless theropods and primitive birds such as Archaeopteryx (Jurassic); *Pezosiren*, an intermediate form of a primitive seacow with both terrestrial (land mammal) and aquatic adaptations (Eocene); *Pakicetus, Ambulocetus, Rodhocetus* and similar forms constitute links between amphibious and terrestrial artiodacyl (even-toed) ungulates and aquatic whales (Eocene); and *Sahelanthropus*, indicating it is close to the common ancestor of chimpanzees and modern humans) the most basal ape-like African hominid. mosaic of primitive (chimpanzee-like) and derived hominid features (Miocene) See Transitional vertebrate fossils FAQ, at the TalkOrigins Archive, and Wikipedia - List of transitional fossils for a much more detailed lists. (MAK; Kutschera & Niklas 2004, p.259).

Two Cultures (C.P. Snow): *The Two Cultures* is the title of an influential 1959 Rede Lecture by British scientist and novelist C. P. Snow. Its thesis was that the breakdown of communication between the "two cultures" of modern society – the sciences and the humanities – was a major hindrance to solving the world's problems. As a trained scientist who was also a successful novelist, Snow was well placed to articulate this thesis. (from Wikipedia). In my studies of evolutionary science on the one hand, and philosophy and metaphysics on the other, it seems to me that these two fields (and sciences and humanities in general) represent not just two radically different forms of academic study and methodology, but totally different way of thinking and interpreting and understanding the world. Science is concerned with facts, humanities with meaning. Two very different attempts to intregrate the two in a larger framework are Conscilience and Integral Theory. (MAK)

U.

Unbelief: The position of not believing a proposition. This is distinct from disbelief in that it does not assert that the proposition is false; rather, it merely states that there is no good reason to assert that it is true or false. Unbelief is, in essence, a position of suspension of judgment on a matter, and as such does not bear any burden of proof. cf. belief (W.J. Hudson)

Uniformitarianism: Assumption that processes acting in the past are the same as those acting in the present. proposed the late 18th century theory of James Hutton that the natural forces now changing the shape of the earth's surface have been operating in the past much in the same way. The most important implication is that the earth is very old (deep time) and that the present is the key to understanding the past. Developed by Charles Lyell in the 19th century, who in turn influenced Darwin. Contrast with catastrophism, punctuated equilibrium.

Universe Story: understanding of the emergent evolution of the universe and life and intelligence as not simply a quantitative fact but a sacred or meaningful story (and alternative to the supernaturalism of traditional mythic-literalist religion), proposed by ecotheologian Thomas Berry and cosmologist Brian Swimme, both influenced by Teilhard de Chardin but rejecting the excessive anthropocentrism of the latter's writings. See also big history, deep time, pantheism

V.

Vitalism: metaphysical doctrine common to most cultures that explains life by means of a non-material but organisational

vital principle, such as ch'i, prana, entelechy, *élan vital*, etc. In classical times, physicians and healers such as Galen used this to explain the functioning of the human body. Dualists associate the vital principle with the "soul", whereas emanationist, occultist, and theosophical metaphysics tends to postulate a series of gross and subtle bodies, levels of self, or "vehicles of consciousness", in which case the vital principle is the body or self level immediately beyond or behind the physical, or intermediate between body and soul, or body and mind. Vitalism was influential and respected alternative to mechanism during the 18th and 19th centuries, and can also be fo8und in the popular "animal magnetism" theories of Franz Anton Mesmer. It was also important in the thinking of later teleologists such as Hans Driesch, where it was associated with anti-Darwinism; as Darwin's theory of evolution denied the existence of any cosmic teleology, the vitalists saw Darwin's theories as too materialistic to explain the complexity of life. The demise of vitalism was brought about by increasing advances in empirical science and evolutionary and developmental theories. However, the vitalistic worldview reappeared with New Age/New Paradigm/New Consciousness movement with its emphasis on new approaches such as holism , organicism, and emergent evolution, and the rising popularity of alternative or complementary medicine. Compare with Idealism. (Wikipedia)

W.

X.

Y.

Young Earth creationism: the belief that the Earth along with the entire cosmos was created by God within the last 10,000 years, or even 6000 or so years ago (for example the Jewish calender and the Ussher chronology) as described literally in Genesis, within the approximate timeframe of biblical genealogies. Generally Young Earth Creationists interpret the Bible literally , including not just the special, separate creation of human beings and all other species, but the historicity of Noah's flood, and attempts by some creationist thinkers to give the universe an age consistent with the Ussher chronology and other Young-Earth timeframes, e.g. C-decay.

Z.

Biographies : References

Science
Biographies
Timeline
Glossary
References

Biographies
References

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

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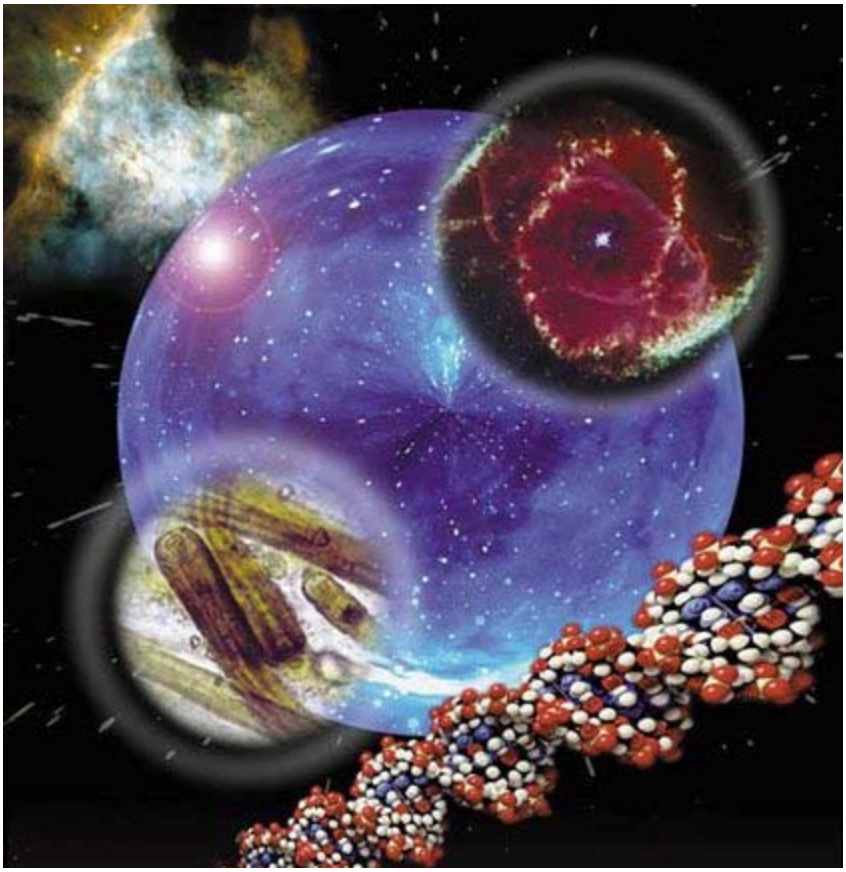
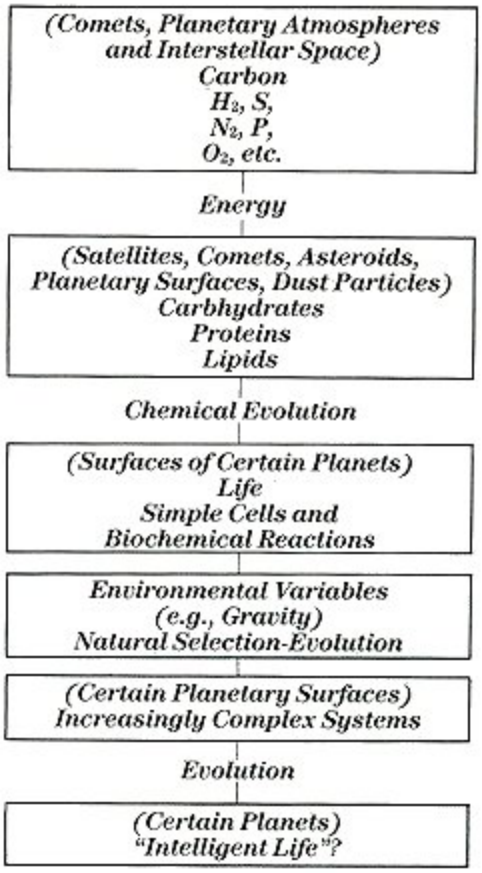
Astrobiology

Life
- Taxonomy
- Paleontology
- Evolution
- Phylogeny
- Ecology
- Astrobiology
- Life on Earth

Astrobiology Main Page



Astrobiology, graphic from Universe Today



Sequence of cosmic evolution. This scheme places the theory of the chemical origin of life on Earth into the broader context that similar events may occur elsewhere in the universe. Graphic and caption from A Meeting with the Universe, Chapter 6-2, Life in the Solar System

Page Back | Unit Home (You are here) | Page Top | Page Next

images not loading? | error messages? | broken links? | suggestions? | criticism?

contact us

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Ecology

Life
Evolution
Paleontology
Systematics
Ecology

Astrobiology
Life on Earth

Biomes
Biota
Trophic Levels & Groups
Guilds
Glossary
References

Ecology

Status

The coverage of the Ecology section is currently shallow. Most of the subsections are one-page summaries, which is frequently cited in course materials which use this site.

The section is organized along lines which reflect our interest in ecology as one aspect of evolutionary change. It is not intended to cover the much broader implications of the science of ecology as a whole.

Index

Ecology: this introductory page

Biomes: major terrestrial assemblages

Biota: ecological communities as assemblages of organisms

Trophic Levels & Groups: biota as groups of organisms with similar food sources

Guilds: trophic groups as organisms with similar life styles

Radiations: sudden increases in range or diversity

Extinction: disappearance of a phylogenetic group

The study of the relationship of organisms with one another and with their environment.

This also means the distribution and abundance of organisms, and their co-evolution and even past history (paleoecology). Ecology is a multidisciplinary study, incorporating all the biological disciplines: botany, zoology, microbiology, marine biology, physiology, genetics, morphology, etc, and even non-biological fields like meteorology, geology, chemistry, and physics

Because life's interaction is like a series of boxes one within the other, ecological studies are organized in hierarchical levels.

organismal ecology, the organism's interaction with it's environmental

population ecology, factors which affect size an composition of a population of organisms.

community ecology, interactions of populations of different organisms (different species) within a particular area

ecosystem ecology, includes the community and all abiotic factors. An ecosystem regulates the flow of energy, derived ultimately from the sun, and the cycling of essential nutrients on which the lives of its constituent plants, animals, and microorganisms depend. The ecosystem is the largest unit in the study of ecology. Any selected part of the physical environment, together with the animals and plants in it, constitutes an ecosystem. An ecosystem therefore may be as large as the Earth or as small as a garden pond.

One important factor in the evolution of species is the relative ability of different individuals to survive and reproduce within a common ecosystem. An important component of the ecosystem is, of course, the other species that inhabit it. Thus, to some extent, groups of organisms co-evolve as a result of the selective pressures generated by one species on another. A faster predator may confers a selective advantage on faster members of the prey species. Tougher seeds may select for birds with stronger beaks. Accordingly, in an evolutionary context we may wish to look -- not just at species -- but at the whole evolutionary biota which characterizes a particular era or location.

Links:

Ecology - Ken's Bio-web references

Ecology: Distribution and Adaptation of Organisms - short but useful list of headings (lecture notes) - gives bare summary definition

Environmental Biology - Ecosystems - really excellent page, includes
Overview
Roles of Organisms
Energy Flow Through Ecosystems
Food Chains and Webs - Pyramids - Biological Magnification
Human vs. Natural Food Chains
BioGeoChemical Cycles - The Water Cycle - Carbon Cycle - Oxygen Cycle - Nitrogen Cycle -Phosphorous Cycle

BIODIVERSITY and CONSERVATION - A Hypertext Book by Peter J. Bryant - covers the origin, nature and value of biological diversity, the threats to its continued existence, and approaches to preserving what is left

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images not loading? | error messages? | broken links? | suggestions? | criticism?

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photo of tree frog (top of page) from Columbia University Department of Earth and Environmental Sciences front page
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Ecology: Biomes

Life
Evolution
Paleontology
Systematics
Ecology

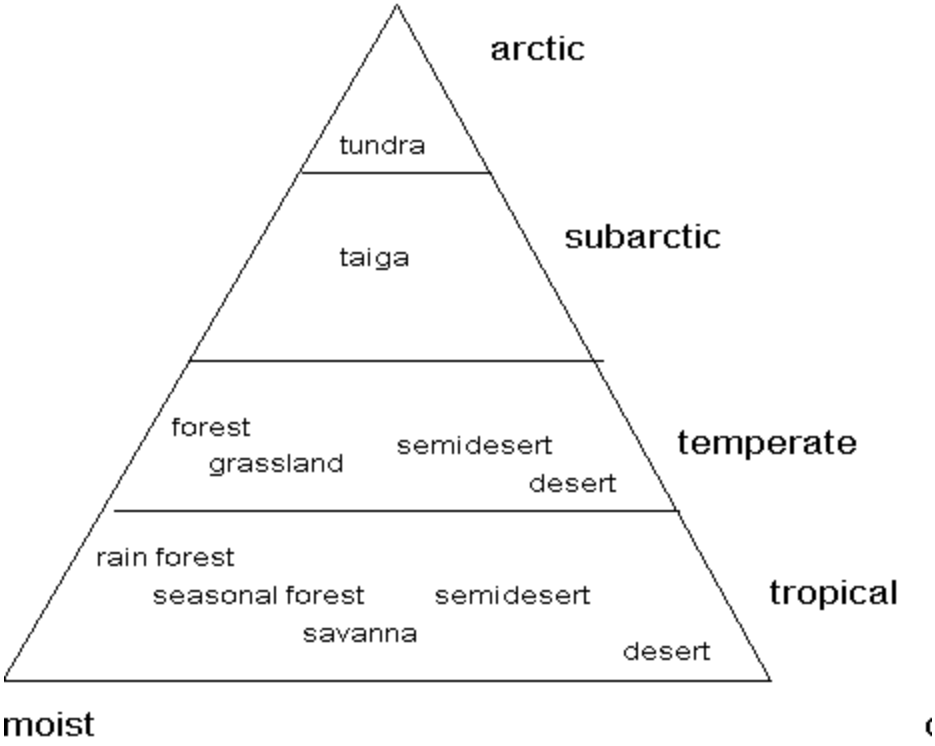
Astrobiology
Life on Earth

Biomes
Biota
Trophic Levels & Groups
Guilds
Glossary
References

Biomes

The biome is a major terrestrial assemblage of plants, animals, and microorganisms that has a characteristic appearance and occurs over large geographical areas on the earth's surface.

Biomes are largely determined by combination of temperature (in term determined by latitude) and rainfall, as indicated by the following diagram:



Biome diagram from Environmental Biology - Grasslands page

for a geographical representation see the Holdridge Life-Zone map at the NPP Database

Biomes can be divided up in several ways, but it is most usual to list six or seven: (from tropical to polar): tropical rainforest, savanna, desert, grassland. temperate deciduous forest, taiga (boreal forest), tundra. These ecosystems differ dramatically from one another, largely because of climatic factors.

climate	very dry	dry	moist
Very cold	tundra		
Cold	desert	taiga (boreal forest)	
Temperate		grassland	temperate deciduous forest Mediterranean/chaparral
Tropical		savanna	tropical rainforest

The ocean can be considered an eighth biome, or even a succession of biomes, determined by depth and proximity to the continental shelf. Sometimes freshwater ecosystems are also considered biomes.

The biomes mentioned above are those currently in existence on earth. However, some of them have not always been around. The first forests appeared during the late Devonian, modern deciduous trees in the Cretaceous, and grasslands only in the Miocene epoch. Biomes during the Jurassic, the Permian or the Carboniferous were very different. Fern savannas for example seem have served as vast prairies which provided food for herds of grazing sauropod dinosaurs.

During the Holocene biomes have changed radically. Two artificial biomes could be added, the agricultural and the urban landscapes, as environments modified by man.

Links

World Wide Biome project

Biome Basics

Biome Resources

Biomes - annotated list of links

Biomes - huge list of links

Biomes - list of links

Modern Ecosystems - has material on Biomes

maps Global land environments since the last interglacial by Jonathan Adams

Page Back: Overview | Page Top | Unit Home | Page Next: Biota

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MAK 12 May 1999, last revised 21 November 1999

Ecology: Evolutionary Biota

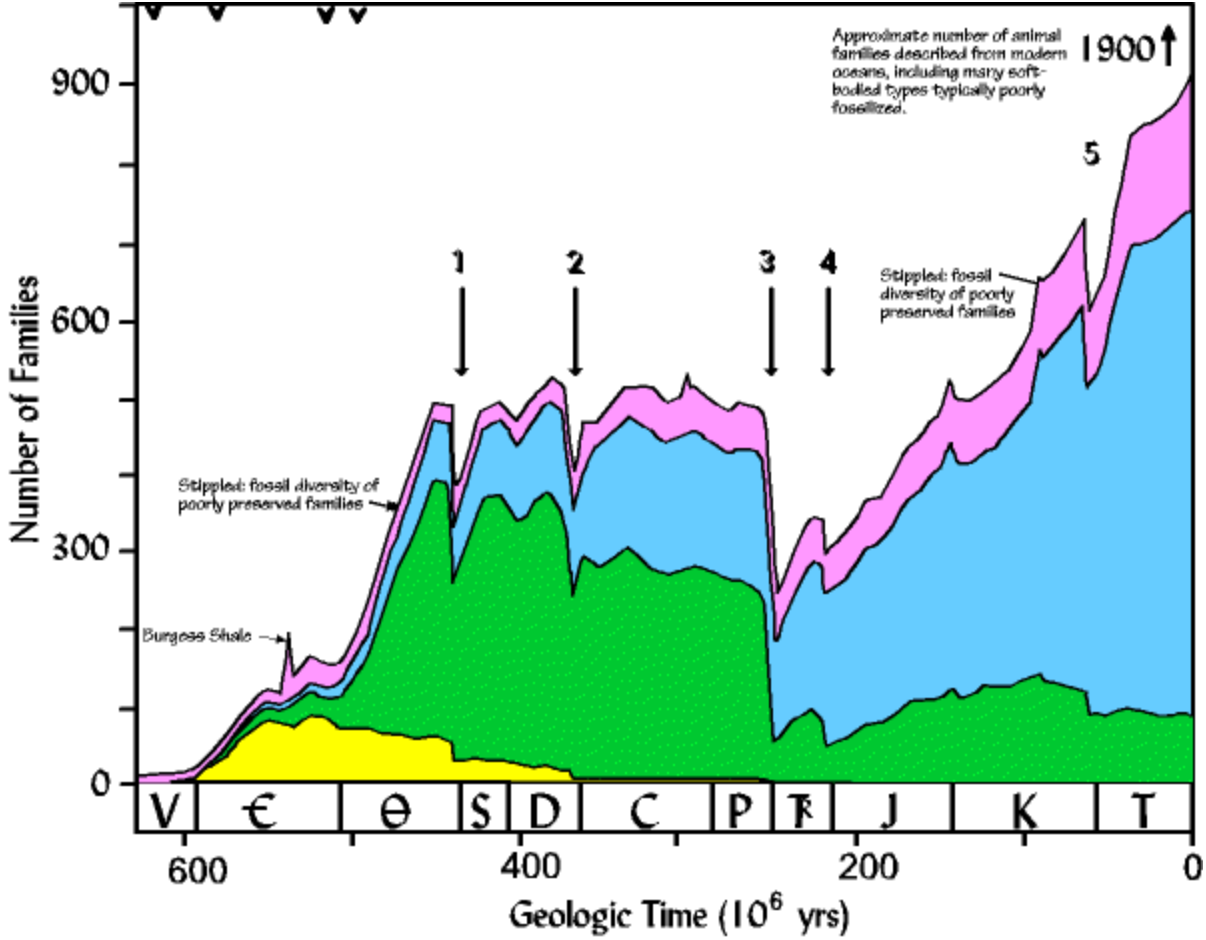
Life
Evolution
Paleontology
Systematics
Ecology

Astrobiology
Life on Earth

Biomes
Biota
Trophic Levels & Groups
Guilds
Glossary
References

The Succession of Life in the Sea

On the basis of statistical analysis of shelly marine fauna (which tend to be easily fossilized) Jack Sepkoski has found that marine mostly invertebrate communities can be broken down into three separate evolutionary faunas. These are shown in the following diagram (Sepkoski's original having been reproduced a number of times) in which each taxon is measured in terms of diversity (number of families):



The three skeletonized evolutionary faunas of Phanerozoic marine invertebrate taxa,
Redrawn from Sepkoski, J.J. Jr, 1984, "A kinetic model of Phanerozoic taxonomic diversity, III. Post Paleozoic families and mass extinctions" *Paleobiology* **10:** 246-267; - © (original url by Lynn S. Fichter and Steve J. Baedke)

In this diagram, the **Cambrian fauna** (or **Trilobite fauna**) is shown in yellow, the **Paleozoic fauna** (or **Brachiopod fauna**) in green, and the **Modern fauna** (or **Bivalve-Gastropod fauna**), in blue. The purple field indicates soft bodied organisms, and not representative of total diversity (because these creatures are only very rarely fossilized, the famous Burgess Shale lagerstätten is shown here as a "spike"; other lagerstätten like Chengjiang and Sirius Passet have only more recently been discovered.

The terms *Cambrian*, *Paleozoic* and *Modern* are in a sense misleading, because representatives of all three categories already existed in the Cambrian, and each persist until the present day (although some or many of the species and clades may have become extinct. However, these biotas can be grouped together because they tend to be common or rare at the same time. For example at the end of the Cambrian, the Cambrian fauna (yellow) begins to slowly decline, while the Paleozoic fauna (green) undergoes an evolutionary radiation, increasing greatly in abundance and diversity during the early Ordovician.

The five numbered arrows each represent a mass-extinction event, the effect of which can be seen in a sharp decline in the diversity of the various faunas. Note that several Cambrian and early Ordovician mass extinctions are not shown here.

In their book on palaeoecology, Benchley and Harper 1998 suggest three additional evolutionary biotas before the Cambrian. These they call the *Pre-Vendian*, the *Vendian*, and the *Tommotian*. All of which gives us the following:

The Pre-Vendian biota consists mostly of microorganisms and extends almost the entire span of the Precambrian.

The Vendian evolutionary biota includes the enigmatic Ediacaran fauna, which seems to be a combination of organisms (the so-called Vendobiota) unrelated to any living Metazoa, along with possible metazoan ancestors. Elements of the Vendian biota survived into the Cambrian.

The Tommotian evolutionary biota is made up of "coat of mail" animals that left behind small shelly fossils, as well as archaeocyaths and other early groups. This diverse and often paraphyletic (ancestral) assemblage of early metazoans includes a number of elements that survived into the mid or even late Paleozoic

The Cambrian evolutionary biota includes such representative taxa include trilobites, hyoliths, monoplacophorans, inarticulate brachiopods, and primitive echinoderms. A recent "living fossil" representing this fauna is the brachiopod *Lingula*, barely changed in 500 million years.

The Paleozoic evolutionary biota includes organisms that flourished from the Ordovician to the Permian, but are now relatively rare. Representative taxa include articulate brachiopods, stony and lacy bryozoans, stromatoporoids, cephalopods, crinoids and blastoids, starfish, and graptolites

Finally, the Modern evolutionary biota emerged in the wake of the end-Permian mass extinction, and is still rapidly diversifying. Examples include bivalves, gastropods, vertebrates, echinoids, crustaceans, and gymnolaemate bryozoans. As Benchley & Harper have observed: "The Modern evolutionary marine biota radiated after the end Permian extinction event with mobile detritus-feeders both epifaunal and infaunal dominating the seascapes previously occupied by the sessile suspension-feeding benthos. The Mesozoic marine revolution was apparently driven by an arms race (Vermeij, 1987). Thicker shells and the ability to burrow deeper were matched by a variety of improved predatorial skills including the evolution of more advanced jaw mechanisms in groups such as the crustaceans. Moreover specific adaptations such as the evolution of cementation have been related to the appearance of molluscivorous predators."

Page Back: Biota | Page Top | Unit Home | Page Next: Trophic Levels

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Ecology: Trophic Levels and Groups

Life
  Evolution
  Paleontology
  Systematics
  Ecology

  Astrobiology
  Life on Earth

  Biomes
  Biota
  Trophic Levels and Groups
    Trophic Levels
    Trophic Groups
  Guilds
  Glossary
  References

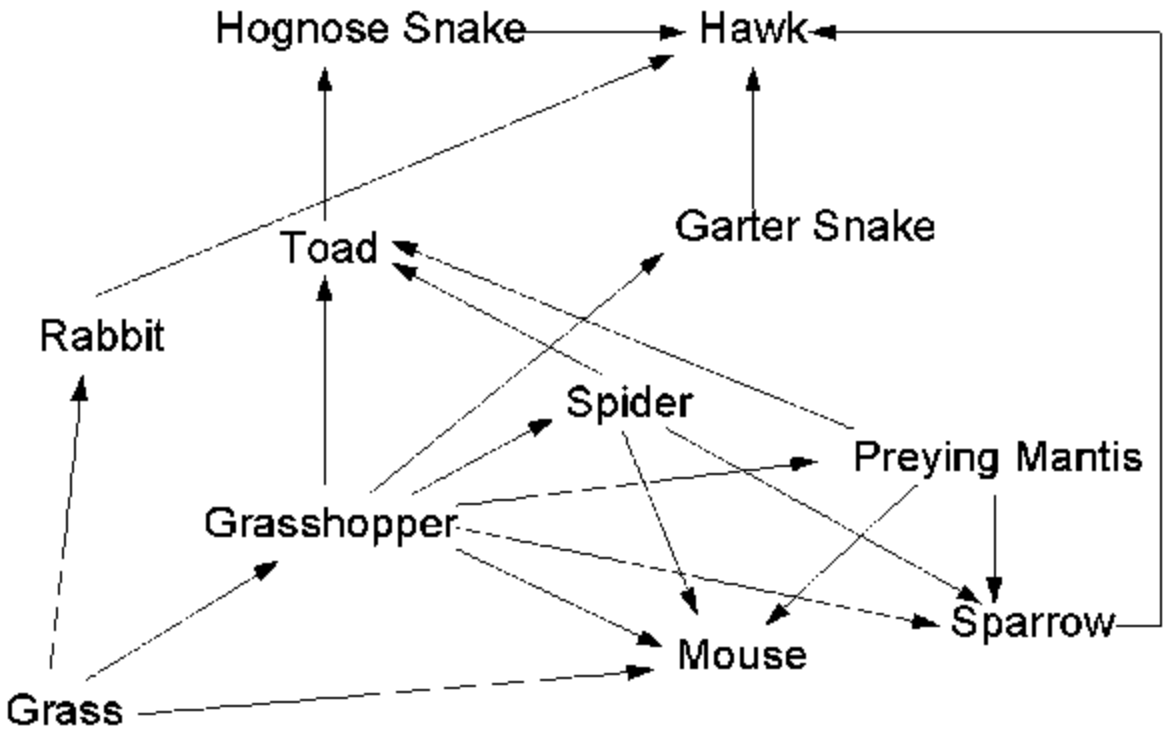
This page briefly covers a few basic concepts about trophic (= feeding) interactions between organisms and lists some typical trophic positions in the food chain.

Trophic Levels: an introduction to food chains and food webs.

Trophic Groups: a list of typical trophic "jobs" in an ecosystem.

Trophic Levels

trophic levels



Trophic means eating. Life is the result of the exchange of energy, which - except for the primary producers, (autotrophs - manufacture own food) has to come from consuming other living or dead organisms or organic matter (heterotrophs - derive food from elsewhere). The result, especially when heterotrophs are preyed upon by other heterotrophs, is a food chain. Energy flows through the system from the primary producers through a chain of consumers. Because energy loss can be anywhere from 20 to 90% per successive link or level in the chain, food chains tend to have relatively few links.

At the bottom of the food chain are humble organisms like green plants and photosynthetic algae (or, during the Archean era, when the atmosphere contained little or no free oxygen, anaerobic prokaryotes). Feeding on them are microscopic and macroscopic herbivores, with carnivores preying on them. At the top of any food-chain is the most charismatic creature, the animal that eats others but is not itself preyed upon, the dominant or top predator, sometimes called the superpredator, the lord of all it surveys. Quaternary examples include in today's world the Great White Shark (*Carcharodon*) and Killer Whale (*Orca*), the big cats and great bears. Today, man is the real superpredator

predator of the Quaternary epoch. In the Mesozoic top predators included the biggest theropod dinosaurs on land, and pliosaurs and mosasaurs in the seas. During the Cambrian period, some 530 million years ago, the top predator was a 60 cm long monster called *Anomalocaris*, that terrorized the seas for millions of years. Life is ever changing.

At each level of the food chain, organisms compete for food and resources. Based on their mode of feeding, they can be referred to one or more of a dozen or so Trophic Groups. Representatives of each group can further be characterized in terms of guilds. MAK990706

Reference: Benchley and Harper 1998

Trophic Groups

Organisms, based on their mode of feeding, can be referred to a small number of trophic groups:

Primary Producers - produce food from sunlight (photosynthesis) or chemical reactions (plants, photosynthetic and chemautotropic bacteria)

Herbivores - feed on living plants. They include

- **browser** (tetrapod) - selectively feeds on leaves
- **grazer** (tetrapod) - unselectively feeds on grass or other vegetation (in the past it may have been ferns)
- **browser** (marine invertebrate) - feeds on leaf-like vegetation (e.g. large algae)
- **grazer** (marine invertebrate) - rasps algae from the surface of the substrate

Frugivore - feeds on fruit only

Nectivore - feeds on nectar or pollen - e.g. hummingbird

Carnivores (Predators) - capture, kill, dismember (usually), and feed on live prey.

Subdivisions include:

- Carnivores (vertebrate) - feed on other tetrapods (e.g. lion)
- **Piscivore** - feeds on fish (e.g. gavial)
- **Insectivore** - eats insects or other terrestrial arthropods (e.g. shrew, gecko, sparrow etc)
- **Molluscivore** - feeds on mollusks (e.g. walrus)

Omnivore - feeds on animals or plants, generally anything it can find

Scavengers - consume dead and/or partially decayed organisms. Most tetrapod predators will also scavenge (generally easier than tackling a live and fighting prey)

Parasites - feed on another (usually larger) organism (whether plant or animal) without (usually) killing it. Two kinds:

> **Ectoparasites** (External parasites) - latch onto target organism and suck the blood or fluid. After it has had its fill it withdraws. Not fatal unless carry disease (e.g. leeches, mosquitoes, ticks)
>
> **Endoparasites** (Internal Parasites) - permanently live inside the body of, and consume the fluids or issues of another organism (called the host organism), generally over a period of time. A badly evolved parasite will kill its host (and hence itself dies, unless it can find a new host).

Filter Feeder or **Suspension Feeder** (aquatic environment only) - collect particulate matter or microorganisms from suspension in the water without need to subdue or dismember the particles. Food may include smaller swimming or floating organisms (nekton and plankton), microorganisms, dissolved organic colloidal molecules, organic detritus, living or dead smaller members of benthic flora and fauna, and/or rich organic grains. Especially among invertebrates,

this is one of the most common trophic groups. While ciliate microorganisms, rotifers, brachiopods, and bivalves use beating cilia, cirra, or lophophore to sweep particles into their mouth, larger animals may have some sort of sieve to select small organisms from the water (e.g. whalebone in baleen whales)

Detritivores - feed on decaying organic matter in the soil - e.g. millipede

Deposit-feeders (marine) - collect particulate matter from the sediment

Decomposer - breaks down decaying organic matter - e.g. fungi, bacteria

Reference: the above list is modified from Benchley and Harper 1998

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Page Back | Unit Home | Page Top | Page Next

---

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Ecology: Guilds

Life
Evolution
Paleontology
Systematics
Ecology

Astrobiology
Life on Earth

Biomes
Biota
Trophic Levels & Groups
Guilds
Glossary
References

Biotic Guilds

A Guild is a group of organisms having a similar morphology, and exploiting the same food resources, living the same life-style and in the same environment, but which are not necessary related. Because no two types of organisms can occupy the same ecological niche (one will inevitably outcompete the other, and push it aside), comparable guilds have to be separated by geographical or chronological distance.

A good example of the same guild is the Crocodilian today, and the phytosaurian thecodont (parasuchia) of the late Triassic. Both are astonishingly similar in size, appearance, and life-style, and indeed modern crocodiles only appeared after the phytosaurs had become extinct. But they are only distantly related (both are archosaurian reptiles, but their common ancestor lived millions of years before the first phytosaur appeared)

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Ecology: Glossary

Life
Evolution
Paleontology
Systematics
Ecology

Astrobiology
Life on Earth

Biomes

Biota

Trophic Levels & Groups

Guilds

Glossary
References

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Glossary of ecology.

Referenced material is from A Glossary of Terms Related to Basic Ecology (Ecology - Wikibooks - the Creative Commons Attribution-ShareAlike License), most other defimnitions from Wikipedia - Glossary of ecology Creative Commons Attribution-ShareAlike License . A few terms have been added or modified.

Abiotic factors: The non-biological environmental influences that affect organisms; for example, temperature, rainfall, and humidity. Wikipedia glossary

Autopoïesis: An organized self contained system whose parts and systems integrate seamlessly in a relationship of form and function.

Autotroph: an organism who makes its own food from inorganic materials.. Wikipedia glossary

Biodiversity: diversity of species in an environment; variety of organisms found within a specified geographical region. Wikipedia glossary

Biogeography: the study of the distribution of organisms and species, past and present, and of diverse processes that underlie their distribution patterns. The patterns of species distribution at this level can usually be explained through a combination of historical factors such as speciation, extinction, continental drift, glaciation (and associated variations in sea level, river routes, and so on), and river capture, in combination with the area and isolation of landmasses (geographic constraints) and available energy supplies. Wikipedia

Biogeochemistry: effect of biota on global chemistry, and the cycles of matter and energy that transport the Earth's chemical components in time and space. Wikipedia glossary

Biogeochemical cycle: the pathway through which a chemical, element, or molecule moves through the atmosphere, hydrosphere, lithosphere, and biosphere. Wikipedia glossary

Biomass: the sum of all living living organisms in an area; a measure of the quantity of living matter in a given unit area or volume. Wikipedia glossary

Biome: The total complex of biotic communities occupying and characterizing a particular area or zone, classified according to its climate and type of vegetation. More Wikipedia glossary

Biological control or biocontrol: 1. In general, the control of the numbers of one organism as a result of natural predation by another or others. Specifically, the human use of natural predators for the control of pests or weeds. Also applied to the introduction of large numbers of sterilized males of the pest species, whose matings result in the laying of infertile eggs (Allaby, 1998). 2. The release of one species to control another (Carlton, 2001). 3. The management of weeds using introduced herbivores (often insects) as biological control agents (Booth et al., 2003). 4. Control method involving a biological control agent that is a natural enemy of a target pest (Heutte and Bella, 2003).

Biological diversity or biodiversity: Used to describe species richness, ecosystem complexity, and genetic variation (Allaby 1998).

Bioregion: A biological subdivision of the earth’s surface delineated by the flora and fauna of the region (Allaby 1998).

Biota: The plants and animals of a specific region or period, or the total aggregation of organisms in the biosphere (Allaby 1998); the total collection of organisms of a geographic region or a time period. More

Biotic factors: The living environmental influences that affect organisms, such as predators, competitors, prey. Wikipedia glossary

Biosphere: The sphere of life; all living organisms on the planet and their interactions, Wikipedia glossary

Community: Any grouping of populations of different organisms that live together in a particular environment (Allaby 1998). A **Biocenose**, or community, is a group of populations of plants, animals, micro-organisms. Each population is the result of procreations between individuals of same species and cohabitation in a given place and for a given time. When a population consists of an insufficient number of individuals, that population is threatened with extinction; the extinction of a species can approach when all biocenoses composed of individuals of the species are in decline. In small populations, consanguinity (inbreeding) can result in reduced genetic diversity that can further weaken the biocenose. Biotic ecological factors also influence biocenose viability; these factors are considered as either intraspecific and interspecific relations.

Disturbance: An event or change in the environment that alters the composition and successional status of a biological community and may deflect succession onto a new trajectory, such as a forest fire or hurricane, glaciation, agriculture, and urbanization (Art 1993).

Ecology: The study of the interactions of organisms with their environment and with each other. Wikipedia glossary

Ecosystem: A discrete unit, or community of organisms and their physical environment (living and non-living parts),

that interact to form a stable system (Allaby 1998).

Endemic: A species or taxonomic group that is restricted to a particular geographic areas because of such factors as isolation or response to soil or climatic conditions; this species is said to be endemic to the place (Allaby 1998) and would be native.

Exotic species: This term is commonly used in publications and literature, and is similar to the terms alien species, foreign species, introduced species, non indigenous species, and non native species (Heutte and Bella 2003). Other definitions include: 1. An introduced, non native species, or a species that is the result of direct or indirect, deliberate or accidental introduction of the species by humans, and for which introduction permitted the species to cross a natural barrier to dispersal (Noss and Cooperrider 1994). 2. In North America, often refers to those species not present in a bioregion before the entry of Europeans in the 16th century, or present in later parts of that region and later introduced to an ecosystem by human-mediated mechanisms (Cohen and Carlton 1988).

Fauna: The animal life of a region or geological period (Allaby 1998)

Fitness: Survival and reproduction ability of an individual Wikipedia glossary

Flora: Plant or bacterial life forms of a region or geological period (Allaby 1998).

Food chain: a group of organisms interrelated by the fact that each member of the group feeds upon on the one below it. Wikipedia glossary

Food web: a set of interconnected food chains by which energy and materials circulate within an ecosystem. Wikipedia glossary

Habitat: 1. The place, including physical and biotic conditions, where a plant or an animal usually occurs (Allaby 1998). 2. The physical conditions that surround a species, or species population, or assemblage of species, or community (Clements and Shelford, 1939).

Host: organism that serves as a habitat for another organism. A host may provide nutrition for a parasite, alternatively with mutualism the host benefits. (from UCMP Understanding Evolution Glossary)

Indigenous: A species that occurs naturally in an area; a synonym for native species (Allaby 1998), although see endemic. Wikipedia glossary

Interspecific relations: interactions between different species—are numerous, and usually described according to their beneficial, detrimental or neutral effect (for example, mutualism (relation ++) or competition (relation --). The most significant relation is the relation of predation (to eat or to be eaten), which leads to the essential concepts in ecology of food chains (for example, the grass is consumed by the herbivore, itself consumed by a carnivore, itself consumed by a carnivore of larger size). A high predator to prey ratio can have a negative influence on both the predator and prey biocenoses in that low availability of food and high death rate prior to sexual maturity can decrease (or prevent the increase of) populations of each, respectively. Selective hunting of species by humans which leads to population decline is one example of a high predator to prey ratio in action. Other interspecific relations include parasitism, infectious disease and competition for limiting resources, which can occur when two species share the same ecological niche.

Intraspecific relations: relations which are established between individuals of the same species, forming a population. They are relations of co-operation or competition, with division of the territory, and sometimes organization in hierarchical societies.

K-selected species: species that produce fewer but stronger offspring and dedicate more care to their upbringing. K-selected species are better suited for, and better able to compete with strong competitors in a crowded environment Wikipedia glossary

Keystone species: keystone species is a species that has a disproportionate effect on its environment relative to its abundance. Such species affect many other organisms in an ecosystem and help to determine the types and numbers of various others species in a community. Wikipedia glossary

Mutualism: A biological interaction between individuals of two different species, where each individual derives a

fitness benefit. It includes relationships which are mutualistic, parasitic or commensal.. Wikipedia glossary

Mimicry: imitative behavior, one species resembling one another, and gaining advantages as a result. For example harmless flies that have the same colouration as bees and wasps. Because preditors know that wasps sting they tend to avoid anything that looks like them. Wikipedia glossary

Native range: The ecosystem that a species inhabits (Booth et al. 2003).

Native species: 1. A synonym for indigenous species 2. A species that occurs naturally in an area, and has not been introduced by humans either intentionally or unintentionally (Allaby 2005). 3. In North America, a species established before the year 500 (Jeschke and Strayer 2005)

Naturalized species: 1. A species that was originally introduced from a different country, a different bioregion, or a different geographical area, but now behaves like a native species in that it maintains itself without further human intervention and now grows and reproduces in native communities (Allaby 1998). 2. A non native species that forms self-sustaining populations but is not necessarily an invasive species (Booth et al. 2003).

Niche: the role the species plays in the functioning of the ecosystem: the "functional status of an organism in its community" (Charles Elton, in Odum, 1959).

Nitrogen cycle: a continuous cycle by which nitrogen from the atmosphere and compounded nitrogen keeps getting exhanged through the soil into substances that can be taken up and used by green plants, what is left returns to the air as a result of denitrification. Wikipedia glossary

Nitrogen fixation: conversion of nitrogen into nitrogen compounds (ex. nitrate and nitrite) that is carried out naturally by certain bacteria and algae. Wikipedia glossary

Paleoecology: the study of the relationships between species in fossil assemblages. More

Population: A group of potentially inter-breeding individuals of the same species found in the same place at the same time (Booth et al. 2003).

Population ecology: major subfield of ecology that deals with the dynamics of species populations and how these populations interact with the environment. The older term, **autecology** refers to the roughly same field of study, coming from the division of ecology into *autecology*—the study of individual species in relation to the environment—and **synecology**—the study of groups of organisms in relation to the environment—or *community ecology*. Odum (1959, p. 8) considered that synecology should be divided into population ecology, community ecology, and *ecosystem ecology*, defining *autecology* as essentially "species ecology." However, biologists have for some time recognized that the more significant level of organization of a species is a population, because at this level the species gene pool is most coherent. In fact, Odum regarded "autecology" as no longer a "present tendency" in ecology (i.e., an archaic term), although included "species ecology"—studies emphasizing life history and behaviour as adaptations to the environment of individual organisms or species—as one of four sub-divisions of ecology. The development of the field of population ecology owes much to the science of demography and the use of actuarial life tables. Population ecology has also played an important role in the development of the field of conservation biology especially in the development of population viability analysis (PVA) which makes it possible to predict the long-term probability of a species persisting in a given habitat patch (e.g., a national park). While essentially a subfield of biology, population ecology provides many interesting problems for mathematicians and statisticians, which work mainly in the study of population dynamics. wikipedia

Population size: a statistic (n) which describes the number of individuals of a species in a particular geographic range. Wikipedia glossary

Predation: the interaction among populations when one organism kills and consumes another one. Wikipedia glossary

Prey: living organisms that predators feed on.

Primary producer: an autotroph that obtains energy directly from the nonliving environment through photosynthesis or less commonly through chemosynthesis. Wikipedia glossary

Primary production: production of organic compounds from carbon through photosynthesis. This effects all life on

Earth either directly or indirectly. Wikipedia glossary

R-selected species: A species that produces a large number of off-spring, each of which receives little care (quantity rather than quality). R-selected species are better suited for variable or unpredictable environments. Wikipedia glossary

Ruderal species: A plant associated with human dwellings, construction, or agriculture, that usually colonizes disturbed or waste ground. Ruderals are often weeds which have high demands for nutrients and are intolerant of competition. See also native weed or invasive native (Allaby 1998).

Species: A group of organisms formally recognized as distinct from other groups; the taxon rank in the hierarchy of biological classification below that of genus; the basic unit of biological classification, usually defined by the reproductive isolation of the group from all other groups of organisms (Allaby 1998). Evolution glossary. Page

Weed: 1. A plant in the wrong place, being one that occurs opportunistically on land or in water that has been disturbed by human activities (see also ruderal species and native weed or invasive native), or on cultivated land, where it competes for nutrients, water, sunlight, or other resources with cultivated plants such as food crops. Under different circumstances the weed plant itself may be cultivated for beneficial purposes (Allaby, 1998). 2. A native or introduced species that has a perceived negative ecological or economic effect on agricultural or natural ecosystems (Booth et al., 2003). 3. A plant growing in an area where it is not wanted (Royer and Dickinson, 1999).

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Trophic Levels & Groups
Guilds
Glossary
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