

1. Names and dates in modern science

So you wanted some names after all? Well, here are a few, with their best-known accomplishments, in chronological order.

1543	Nicolaus Copernicus (Germany) proposes heliocentric theory of universe (just before his death, so avoiding the church's (f)ire)
c. 1570-1600	Tycho Brahe (Denmark) makes astronomical measurements which will be used by his assistant, Johannes Kepler.
1605	Johannes Kepler (Germany) shows that planets move around the Sun in elliptical orbits
1609	Galileo Galilei (Italy) observes moons of Jupiter, studied law of motion
1665	Robert Hooke (England) coins the term "cell"
c. 1670	Antonie Philips van Leeuwenhoek (Netherlands) first observes microorganisms with his handcrafted microscope
1687	Isaac Newton (England) publishes Principia Mathematica, containing his laws of motion and the law of universal gravitation
1735	Carl Linnaeus (Sweden) publishes <i>Systema naturae</i> , founding the science of taxonomy.
1783	John Mitchell (England) proposes the idea of "dark stars" from which light cannot escape; Laplace has same idea indepenantly.
1785	James Hutton (Scotland) proposes geological cycles
1791	Luigi Galvani (Italy) discovers bioelectricity
1799	Pierre Simon Laplace (France) develops the nebular origin of the solar system
1803 (c.)	John Dalton (England) publishes first version of modern atomic theory, based on varying masses and complexity of matter particles.
1808	John Dalton (England) publishes atomic theory of matter.
1824	Nicolas Léonard Sadi Carnot (France) founds the science of thermodynamics with his studies on heat engines
1839	Theodor Schwann (Germany) states the cell theory, that all living things are composed of cells.
1859	Charles Darwin (England)) publishes "On the origin of species", proposing evolution by natural selection
1861	James Clark Maxwell (Scotland) publishes the equations of electromagnetism; later, shows that electric and magnetic fields travel through space as electromagnetic waves
1865	Gregor Mendel (Moravia, modern Czech Republic) presents first paper on rules of heredity.

c, 1890	Santiago Ramón y Cajal (Spain) discovers definitive evidence for neuron theory, that the brain is made up of discrete neurons, and explains their form and function.
c. 1890	Ludwig Boltzmann (Austria) shows statistical significance of entropy
1896	Henri Becquerel (France) discovers radioactivity
1905	Albert Einstein (Germany) publishes papers on photoelectric effect (which would give rise to quantum mechanics) and special relativity; in 1915, theory of gravity (general relativity)
1912	Alfred Wegener (Germany) publishes theory of continental drift; it would be accepted only in the 1960s as the theory of plate tectonics
1915	Karl Schwarzschild (Germany) finds first exact solution to Einstein's field equations of gravity, predicting existence of black holes.
1918	Emmy Noether (Germany) presents her theorem on the relation between symmetry and conservation laws.
1924	Wolfgang Ernst Pauli (Austria) publishes the exclusion principle, stating that no two electrons can occupy the same quantum state; would become the basis of solid-state physics and transistors.
1925	Cecilia Payne-Gaposchkin (British-born American) relates spectral classes of stars to temperatures and shows that hydrogen is the principal element in them.
1926	Erwin Schrödinger (Austria) publishes the wave equation, the central equation of quantum mechanics
1927	Werner Heisenberg (Germany) publishes the uncertainty principle of quantum mechanics
1937	Hans Adolph Krebs (German-born British) identifies the citric acid cycle, along with William Arthur Johnson.
1953	Francis Crick (Great Britain) and James Watson (USA) use Rosalind Franklin's x-ray diffraction photos to understand the structure of DNA
1964	Arnold Penzias and Robert Wilson (USA) discover cosmic background radiation
1979	Alan Guth (USA) develops idea of cosmic inflation

Since those times, science has become bigger and more expensive, so single names do not stand out so much any more. For instance, the discovery of the Higgs boson at CERN in 2012 involved thousands of people, far too many to include in this table – or on the list of Nobel Prize winners (which is limited to three living people)!

2. Cheat sheets

Geological Time Scale (Mya = million years ago)

	Eon	Era	Period	Epoch	Mya	
Phanerozoic		Cenozoic (mammals)	Quaternary		Holocene	0.01
					Pleistocene	
			Tertiary	Neogene	Pliocene	1.8
					Miocene	5.3
				Paleogene	Oligocene	23
					Eocene	35
					Paleocene	55
		Mesozoic (dinosaurs)	Cretaceous (S. America, Africa)		65.5	
			Jurassic (Alps/Himalaya)		146	
			Triassic (Pangea)		200	
		Paleozoic (invertebrates)	Permian		251	
			Carboniferous	Pennsylvanian	299	
				Mississippian	320	
			Devonian (fish)		359	
Silurian			416			
Ordovician			444			
Cambrian (Pannotia, Rodinia)			488			
Pre-cambrian	Proterozoic (O ₂ -rich atmosphere)		542			
	Ediacaran		635			
	Archean (appearance of life)		2500			
	Hadean		3800			
					4700	

Red lines are mass

Figure 2.1: Geological time scale, by author.

extinctions, past or to come...

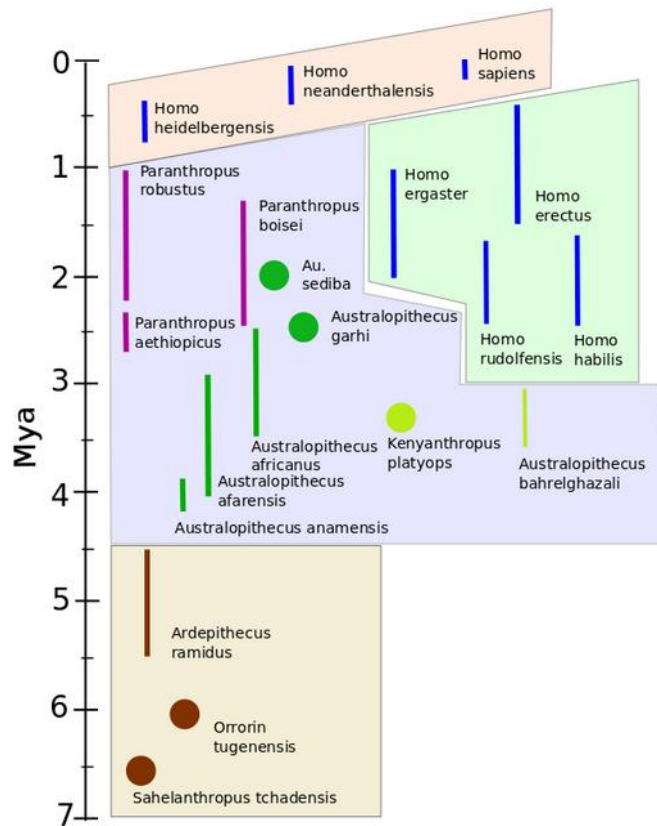


Figure 2.2: Timeline and grouping of principal fossil hominid species (by author)

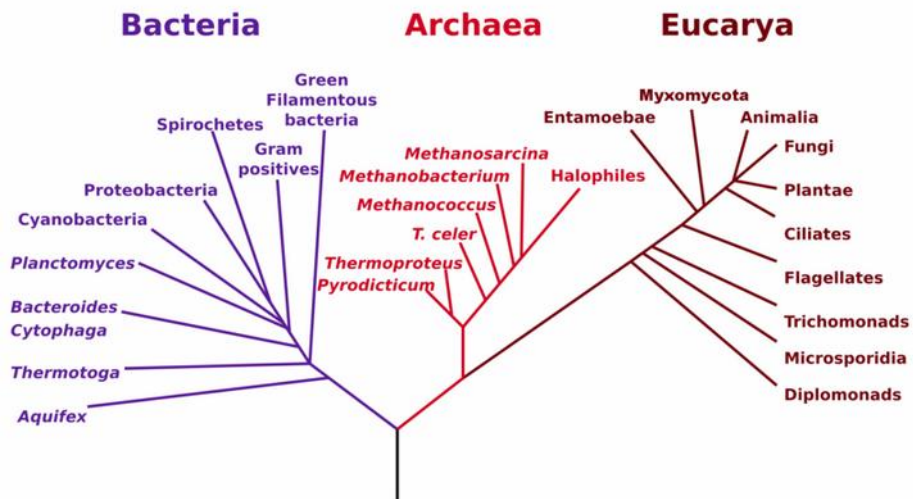


Figure 2.3: Phylogenetic tree by MPF [Public Domain], via Wikimedia Commons¹.

1 <https://commons.wikimedia.org/wiki/File%3APhylogeneticTree.png>

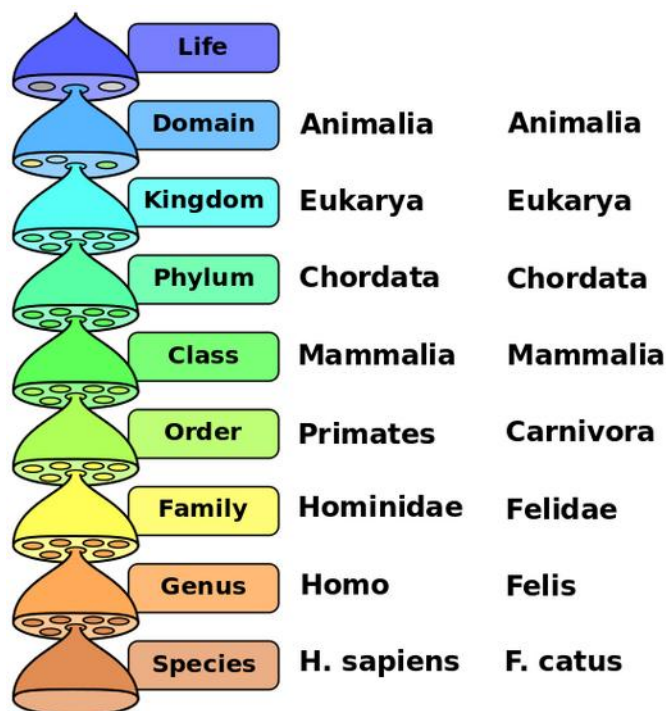


Figure 2.4: Classification of modern humans and house cats, after Wikipedia²

Group→	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
↓Period																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo
				* 57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
				** 89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Figure 2.5: The periodic table of the elements, from Wikimedia Commons³

2 https://commons.wikimedia.org/wiki/File:Biological_classification_L_Pengo_vflip.svg

3 https://commons.wikimedia.org/wiki/File:14LaAc_periodic_table_11b.jpg

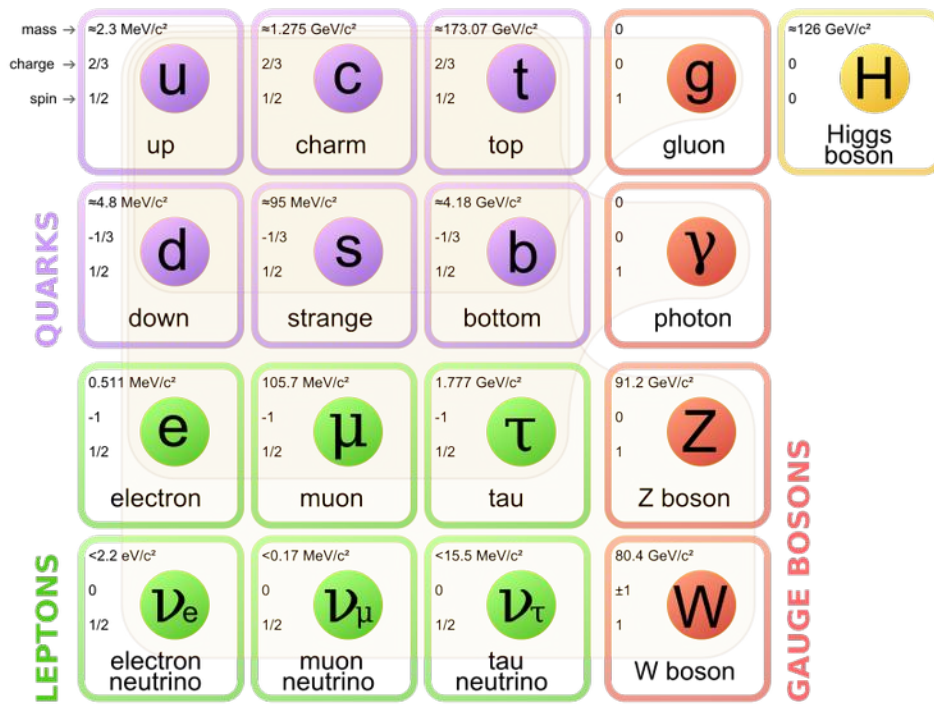


Figure 2.6: Standard model particle zoo, from Wikimedia Commons⁴

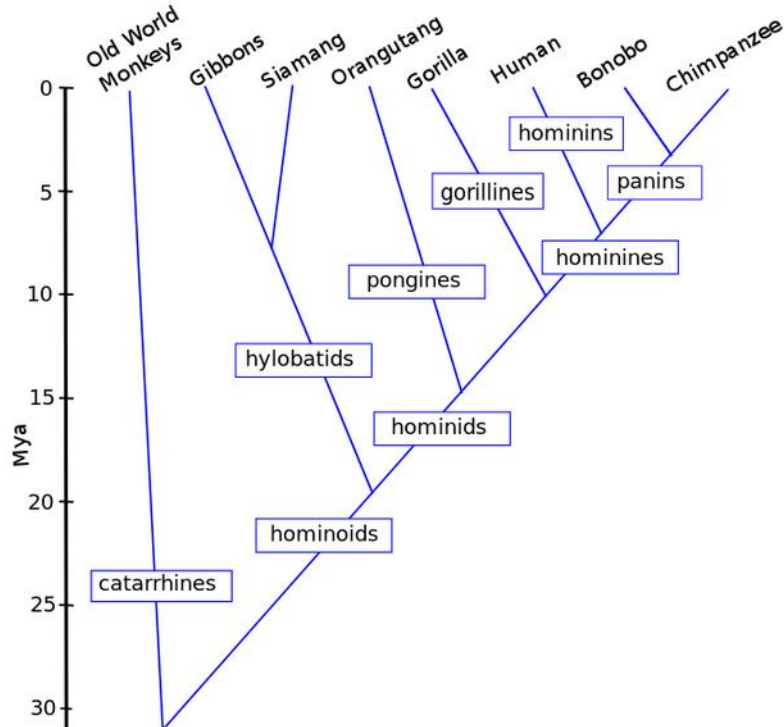


Figure 2.7: Hominoid families with dates, by ather.

⁴ https://commons.wikimedia.org/wiki/File:Standard_Model_of_Elementary_Particles.svg

Principle elements of the CNS, from caudal (tail or bottom) to rostral (top or front)	
spinal cord	visualized in four regions – cervical, thoracic, lumbar and sacral – handles I/O to and from the skin, joints and muscles of the limbs and trunk
brain stem	similarly handles sensory information from skin and muscles of the head and motor control to head muscles. It serves as information bridge between the brain and spinal cord, and regulates levels of arousal and awareness through the reticular formation .
	<ul style="list-style-type: none"> • The medulla oblongata handles vital autonomic functions such as digestion, breathing and heart rate. • The pons passes information about movement from the cerebral hemispheres to the cerebellum. • The midbrain handles sensory and motor functions such as eye movement and coordinates visual and auditory reflexes.
cerebellum	regulates movement and motor skills, connected to the brain stem by fiber tracts called peduncles.
diencephalon	in two parts.
	<ul style="list-style-type: none"> • The thalamus receives information destined for the cerebral cortex from the rest of the CNS. It is the dispatcher of the brain. • The hypothalamus regulates autonomic, endocrine and visceral functions. It is the brain's gateway to the endocrine system via the pituitary gland.
cerebrum	divided into two hemispheres, is composed of the outer cerebral cortex and deeper structures:
	<ul style="list-style-type: none"> • The basal ganglia participate in the regulation of motor performance; • the hippocampus is essential to memory storage; • the amygdaloid nuclei (or amygdala) coordinate autonomic and endocrine responses of emotional states.

3. Bibliography

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3.3. Geology

There are geology books, e.g., those by Spooner or McDougall (1998), which are excellent introductions to physical and historical geology. Benton's book is more recent than MacDougall (1998), but it is shorter and so denser and less easy to follow, although filled with interesting information. MacDougall (2011) is similar but concentrates on different points – and contains more recent information. Then there are the books of Richard Fortey. Fortey's books are not textbooks and, in this writer's opinion, not good for learning the subject. But they are simply wonderful field trips. Yes, trips. Fortey has a way of describing a tour of, say, the 250-Mya supercontinent Pangea or of the Cretaceous Era as if you were actually wandering around it with Fortey as guide and companion. He does the same for current environments, like the area around Vesuvius. It is very human, a combination of field trip and tour guide and not to be missed.

The USGS web site is a mine of information for amateur geologists. The article "This dynamic earth" is an excellent explanation of plate tectonics, explained clearly with very good illustrations.

For a general history of earth and life on it, either of MacDougall's books is excellent, including geology, climate and the origins of life and its subsequent evolution. But Emiliani's book is extraordinary. Ostensibly an earth-science book, it starts with atomic physics, cosmology, chemistry and works its way through geology and paleontology. He is not afraid of using some mathematics and the result is almost like reading a novel. An excellent book. Too bad Emiliani died shortly after the book's publication in 1992, but it is still quite useful.

Then there is the question of where to put Robert Hazen's books. He is a "mineralogist and astrobiologist", according to Wikipedia. His books span the history of the Earth and the importance of science. So for the mineral aspect, I put him in with geology. Also because he makes good companion reading with McDougall.

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3.6. More

Bryson's well-known best-seller is more of a history of scientists than a history of "everything" – and it is not short. Christian's book comes much closer to that goal, even achieves it. In fact, *Origin story* is much like this document, covering Big Bang to galaxy clusters and formation of the solar system to Homo Sapiens. But then it continues with history, hunter-gatherers on up, so it really is a big history, unlike this document which sticks with science – how things work – and ignores human history. I really liked *Origin story*.

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