f34 Emergence in evolution

< death, superorganism, speech, play, jealousy, parenting, virtue >

an endless depth
Of smallness; a song, but less than a song, something drowning
Into itself, something going, a flood of sound, but less
Than a sound; the last of it, the blank of it,
The tender small blank of it filling its echo. ...

— Mark Strand: *What It Was*.[1]

Old healthy bacteria do not pop off (die); they just split in two (of heritably different cloning vigor Dan Ferber in 2005 has found).[2] But cells in a multicellular organism have suicide programs. Genetically encoded self-deconstruction of cells is called *apoptosis* (colloquially the second 'p' is sounded). In cell division, the molecules which copy the DNA work in opposite directions along the two strands of the DNA double helix. However, the DNA gets unzipped in only one direction during the duplication process. So one of the copying molecules is likened, in the description of its work by Boyce Rensberger in *Exploring the Realm of the Living Cell*, [3] to a short-legged man at a barn dance, continually dashing back to the newly unzipped part it has just danced away from. Also, like someone chewing along a corncob, these molecules need to grab on at both ends of the DNA section they are transcribing and so inevitably leave a last little bit uncopied. Nature's compromise is to stick a slew of throw away sections on the ends of the DNA helix of every chromosome. This strand of chromosomal DNA is called a *telomere* (first described in 1985).[4]

The number of divisions which a cell can undergo faithful to the original is limited. After this, cell division initiates senescence in which it, without protective telomere caps to chromosomes at the time of division, is altered. The senescent cell has missing, extra, or end-to-end fused chromosomes. In test tubes, cells stop doubling when they reach senescence. For example, skin cells (grown in test tubes) normally senesce after about 60 doublings. In the body, division of a senescent cell stops or continues through changing chromosomal states, with different patterns of gene activity, after each cell division until a limit is reached and, after various lengths of time, which can be years, the cell dies. When it does, its DNA, which would be dangerous material indeed if released unbidden into the body, is also destroyed (the more than a meter length of it unraveled) by a within-cell orchestrated cascade of enzymal activity (triggered by enzymes called *caspases*).[5] A gene called *p53* in every cell is dormant until the moment the cell becomes cancerous. Then it activates to encode a protein that binds to the cell's DNA and initiates apoptosis. (In about half of all cancer cases, this gene is mutated and its protein fails to binds to the cell's DNA—repair of this protein are therapies being designed). In a living adult human, typically are created and destroyed 10 billion cells every day.[6]

Senescence is not inevitable. In 1997, Woodring E. Write reported that after each cell division the cell-enzyme telomerase rebuilds the telomere.[7] Adult cells that retain or acquire the ability to produce this enzyme are thus immortal in the sense that for them senescence does not occur.[8] Most cancers have this feature (10 % of human cancers achieve immortality without it).[9] In adult humans, only germ cells (which give rise to sperm and eggs) normally produce telomerase. In 2000, Robert P. Lanza reported that telomeres are longer in cells of cows cloned from cells that have already survived a long time. This "may lead to animals with a long life span."[10] The implications are startling.

When a cell's exit from the scene has been graceful, genetic theory insists that its genes benefit because replicas of its genes are in the other cells of the organism that its death somehow benefits. We are reminded by George and Eva Klein that "apoptosis is more concerned with the life of an organism than with its death.[11] A caterpillar would never turn into a butterfly, nor a tadpole into a frog, without extensive apoptosis in tissues that are no longer needed. We would all die of leukaemia or lymphoma at an early age if our lymphocytes—engaged as they are in a gigantic Monte Carlo

game of immunoglobulin or T-cell-receptor rearrangement that allows us to react against a vast number of proteins—failed to eliminate the large majority that do not encounter their complementary antigen within a limited period of time." We are considering here cell-level death (not whole organisms) for which there is no (Linda Partridge and David Gems can write), "programmed process like development. No hierarchy of genetic control systems has evolved to ensure that ageing occurs in the right place and at the right time. It is a late-onset genetic disease that affects all of us, a result of damage inflicted by other, adaptive processes earlier in life" related to, say, reproduction, "because fecundity is often reduced both during the evolution of slow ageing and by single-gene mutations that extend lifespan" and food "because many of the genes that slow ageing are involved in the response to changing nutrient levels." [12]

Sex and programmed cell death (apoptosis) have an early association and division in the individual. The single-celled organism *Paramecium,* identified by its comparative simplicity as one of the earliest sexual reproducers to have evolved, also evolved the programmed destruction of DNA used for cell maintenance but not of DNA set aside for reproduction. This theme of division of labor into somatic and germline DNA is a feature common to multicellular organisms. Why has this not been selected against in sentient (decision making) creatures' interest in their self? An extreme yielding to human hard-wiring is neonaticide (normal in hunter gathering societies) when, what is akin to triaging, a mother (not without incurring emotional cost) kills her newly born in dire times or when it is malformed. "Natural selection cannot push the buttons of behavior directly; it affects our behavior by endowing us with emotions that coax us toward adaptive choices" writes Steven Pinker.[13] Also the neural plasticity (ability to change its structure and/or function) of the brain is a reality,[14] revealed, for example, by Craig Howard Kinsley's finding in 1999 that pregnancy and the presence of pups, in what is likely a two way process, literally rewires rat's brains (***Figure f34.1***).[15]

Evolutionary biologists find no evidence that individuals sacrifice their interests to those of a group. Where this appears to be the case we have a "superorganism." But even in this, the selfish interests of an individual can coincide with those of the group and we have only the illusion of altruistic behavior. Dawkins' early success was his book *The Selfish Gene* (inspired by Niko Tinbergen's notion that plants and animals can be described as survival machines for genes) in which he adroitly explains how thoughtless competition between segments of chromosomal material can easily account for emergent physical niceties and group behaviors of sexual organisms.[16] No matter how surprising these are, they are explainable *if* statistically they can be shown to increase the frequency of a gene in a gene pool.—"When I started writing in 1972, *The Selfish Gene* was an attempt to get rid of the group-selectionist view. This outright wrong idea had obtained a grip upon popular presentation of science. Time after time I'd see excellent natural-history programs on television marred by this false assumption that individuals act for the good of the species or the good of the ecosystem or the good of the world. This was an error that need exploding, and the best way to demonstrate what's wrong with it, I felt, was to explain evolution from the point of the gene." Here the individual is not important. The group of these momentary bearers of the selfish genes are behaving in a way that will improve the chances of increase of those genes in the population. For example, in herding animals, behaviors such as the giving of an alarm call at the approach of a predator, seem only to be for the good of the group until one observes that these alarm calls are given only when relatives are around or to direct attention away from the caller and towards the other (unrelated) fleeing members of the group. Ethology, the biological study of animal behavior, was pioneered by Niko Tinbergen and Konrad Lorenz (*The Study of Instinct*, 1951).[17]

Reproductive altruism is an expected behavior among the related. William Donald Hamilton (***Figure f34.2***) essayed in *Geometry for the Selfish Herd*, 1964, that in a mammal herd or bird flock seemingly random strollings and mergings is no such but is patterned to optimize the trade-offs, as between getting to the best food and placing others between oneself and possible predators.[18] Hamilton was led to his ideas ("extensive differential nepotism" observed in that assistance metered out to a wide variety of relatives is in the degree of genetic relatedness to oneself) by a remark by

Fisher as to why an insect could have a color which put it at risk of being spotted and killed by a predator. If the insect had a foul taste, the predator would learn to avoid not it but its relatives. If these were siblings that shared 50 percent of the individuals genes then "selection would go ahead at half speed." Among ants, bees and wasps genetic inheritance known as haplo-diploidy means that nonreproductive workers can actually reap higher fitness from rearing their sisters than from reproducing themselves.[19] This does not mean that reductionist neo-Darwinists such as Dawkins are genetic determinists.[20] Behavior of the individual and the group has a lot to do with the knocks of experience. Seemingly altruistic behavior among unrelated individuals is debt payment being honored. For much evolution, statistical analysis of gene frequencies and how these should fare, must err for equilibrium is rarely if ever achieved. Populations are found to be too small and too slow is their reproductive rate in comparison to the rapid shifts in environmental conditions.[21] Ecological studies would be easy were this not so and selfish genes are at the mercy of their bearers going extinct. Citing reasons as these, Steven Jay Gould (who belonged to the Darwinism school which Ernst Mayr described as "the holistic branch of the synthesis that continued the traditions of Darwin and naturalists while accepting the findings of genetics")[22] claims that reductionist neo-Darwinism fails in its ambitions. He considers how ensembles of genes fare but does not say as much; preferring to call them "body plans laid down long ago." How evolution tinkers with the details of these (*The Pander's Thumb*)[23] was a never-ending source for his marvelous, if prolix, essays.

Can such shamelessly selfish behavior be avoided by humans? Frans B. M. de Waal and Michelle L. Berger in 2000 describe an experiment: Two transparent food bowls, one containing apple slices, on a single weighted tray in front of same sex pairs of capuchin strangers. Each monkey can reach a pull bar connected to the tray. When the strength of both animals is required to pull the tray within reach, the monkey that got the food regularly broke up some into bits and let the cooperator grab it through openings in the screen. If each monkey pulled in a bowl of fruit pieces, or if only one had a bar to draw in the food-bearing tray, sharing rarely occurred.[24] Humans, however, think to share anyway. We honor our urge to generosity, which in all sentient animals allows for the raising of children. This "I'll scratch your back, you scratch mine" or "one good turn deserves another" quid pro quo trust in its highest abstraction is the existence of paper money (which began in 1609, Janet Gleeson in *Millionaire* mentions, when for precious coins of all sorts received, the Bank of Amsterdam gave in exchange paper notes that could be used as legal tender to trade).[25]

Emergent, beyond a herd instinct, or the swarm "logic" celebrated in Steven Johnson's book *Emergence*, 2001, that by a chemical feedback coordinates individual experiences to give coherent group action witnessed of the ant colony, slime-mold cells, brain cells, embryo cells, is behavior which is culture; defined as behavior that is socially transmitted. Giving pause to those who would claim human culture to be our defining glory is primatologist Frans de Waal's description in *The Ape and the Sushi Master*, 2001, of a long term study of seven chimpanzee sites. In these, thirty nine chimpanzee behaviors were discerned that "can only be the nongenetic spreading of habits and information" for these were not the same at the various sites. Human culture, by implication, is different by "nothing else than embellishments." [26]

Merrill Flood and Melvin Dresher in 1950 found situations in which individual and group rationality for choice making will likely be different. Well known is Albert Tucker's "prisoner's dilemma," and its glum resolution: two arrested partners-in-crime held separately for questioning will do best if neither rats on the other, but both will.[27] These thought games played in economics justify its characterization as the "gloomy science," and unfortunately become 101-boring before the stronger lesson is learned that, played repeatedly and discriminatingly, the cooperation-or-not game in society, as Matt Ridley in *The Origins of Virtue*, 1996, marshals evidence for, "always favours the good citizen.[[28]] Nice strategies like Tit-for-tat, Pavlov and Firm-but-fair win out over nasty ones." Temper this with Paul Seabright observation in *The Company of Strangers*, 2004, that "Cooperation within a group can make the group more lethally aggressive in its dealing with outsiders." So the systematic killing of unrelated individuals is so common among humans that it "cannot be described

as exceptional, pathological, or disturbed" and unhappily "what Adam Smith famously described as the human propensity to 'truck, barter and exchange' has always coexisted uneasily with a rival temptation to take, bully, and extort."[29]

According to Howard Bloom in his book *The Lucifer Principle*, 1995, reproductively inefficient human behaviors such as suicide and celibacy that is antithetical to the genetic program to enhance its likelihood of replication could have some ancient basis in promoting one's immediate relatives, if by these actions the relatives are substantially better off.[30] But it is doubtful whether people commit suicide or give up reproduction to promote a societal "superorganism." So war, Crusades, and Jihad, are aberrant indeed (in agreement with the homily: war is never good or peace ever bad).[31]

In *Descent of Man*, 1871, Charles Darwin observed: "Man has an instinctive tendency to speak, as we see in the babble of our young children, while no child has an instinctive tendency to bake, brew, or write."[32] Noam Chomsky in the journal *Language*, 1959, famously (if unoriginally) noted the same: that language is universal, complex and rapidly acquired by children without explicit prompting (so by a poverty-of-stimulus argument can the innate be recognized).[33] Behaviorists would explain human language as a reinforcement-Pavlovian response (children mimic their parents' language and receive approval when they speak "correctly"). This theme in *Verbal Behavior,* 1957, by B. F. Skinner (1904-1990)[34] was ridiculed ("the magnitude of the failure of [Skinner's] attempt to account for verbal behavior serves as a kind of measure of the importance of the factors omitted from consideration") by Noam Chomsky in *Language*, 1928. David D. Nolte in *Mind at Light Speed*, 2002, explains: "Where behaviorists ascribed to the brain complete plasticity in which all behavior is learned, cognitive approaches ascribed to the brain inherited structure that influenced how the brain functioned. ... Language provided the decisive battleground for these arguments because it is simultaneously a learned phenomenon and an instinct unique to human beings."[35] Significantly, in 1964, neurologist Eric Lenneberg pointed out that a small number of children fail to display this talent and that such deficits sometimes run in families.[36] Extensive exposure to TV and videogames wire brains to scan and shift attention at the expense of the ability to focus attention.[37] In 2001, among the first fruits of the Human Genome Project for the cognitive sciences, Wellcome Trust Centre for Human Genetics declared a gene (*FOXP2*) to be involved in the developmental process that culminates in speech and language.[32] Our ability to speak our thoughts and our appreciation of art, allows for emergent capabilities of our brain (that was evolved to orchestrate immediate needs of survival and reproduction amidst the buffeting of natural disasters, wars, parasites and infectious diseases) such as a skill for calculus. Speech allows laughter to be triggered by more than pratfalls: A poor performance has made the Coach angry, "Are you ignorant? Or just apathetic?" Tired player, "I don't know, and I don't care."[38]

Preadaptation is when structures can be coopted for functions other than those for which they evolved. Martin A. Nowak notes that "neuroanatomists describe certain areas in the brains of monkeys, for instance, that correspond to the human language areas but that are apparently not involved in producing calls or gestures. Monkeys use these brain regions to interpret sounds and control facial muscles." Whatever the structures are, emergent beyond the calls of animals, is human grammatical language. So enabled, we can, in the words of **Wilhelm von Humboldt** (1769-1859),[39] (whose accounts of travels early inspired Darwin) "make infinite use of finite means."[40]

Operating on different physiques, nature endows differently. So emergence is also a loss of control of the genes. Neuron wiring that develops in response to environmental stimulations is a competitor. In the non-equilibrium that is life's lot in a capricious inorganic setting, the curiosity "that can kill the cat" which survives mammalian play in

adulthood keeps us alert. The familiar bores, and Irish/English expressionist painter Francis Bacon (1909-1992) could rightly assert that, "In a painting that's even worth looking at, the image must be twisted if it is to make a renewed assault upon the nervous system." [41]

Do we doubt Jim Holt that better "reading maps (men) versus reading faces (women)" are not the legacy of the Pleistocene grasslands? Darwin's reading was that men received the greater dowery. Helen Fisher in *The Natural Talents of Women and How They Are Changing the World*, 1999, is anxious to plead otherwise.[42] Unhappy reading therefore for any Helen Fisher groupies is *Divided Labours* by Kingdley Browne, 1999, who baldly claims that the "glass ceiling" metaphor for an invisible barrier that prevents women from reaching the top levels of management and higher earnings and status (on average) is consistent with evolved differences between the sexes.[43]

Whatever, and forever to confuse, emergence is more rapid than natural selection can coordinate. We find ourselves too irrational, too emotional (reflexive: anger, disgust, fear, surprise, happiness, sadness; and, culture specific: humor-amusement, romantic love, sexual jealosy, envy, wonder, shame-embarrassment, peace, and heroism),[44] too ready to believe in absurd animistic causes, and too dumb when it comes to probability and statistics—or as Oscar Wilde put it: "Man can always believe the impossible, but man can never believe the improbable."[45] What of involuntary signals? Would we not have otherwise than, as Mark Twain wryly observed: "Man is the only animal that blushes, and needs to!"[46]

As for jealousy, in *The Dangerous Passion*, 2000, David M. Buss defines it as a passion that refers to the drives and emotional quests that propel us through life.[47] Courtney Weaver summarizes: "Jealousy isn't sexist: it's a state experienced by both men and women that is a response to a threat to a valued relationship. Their evolutionary theory, though not new, goes something like this: Ancestral men, unlike women, could never be certain of the paternity of their offspring, and thus jealously guarded the potential mothers of their children so as not to waste time and resources raising another man's offspring. Women, in turn, became highly attuned to female rivals who might distract a man's attention and resources, leaving her alone with her lifetime investment." But Weaver takes care to reminds us that these are "more about human nature today than the predictable evolutionary theories, such as that men just can't help wanting to spread their seed far and wide, or that women's sexual fantasies center on themes of emotional intimacy rather than anonymous rolls in the hay." [48]

A hierarchy theory is that the lower inadequately explains the higher because genuinely new and unpredictable properties emerge at higher levels of biological organization. Life's vital activities of consciousness awareness, action, appetite, and inwardness, if ever to be understood, making such as Wolfgang von Kempelen's chess-playing Turk a truthful billing, will be in their own terms and surprise the constraints of nonliving matter and motion.[49] Which is to say that Byron Appleyard in *Brave New Worlds* (1998) worries overmuch that reductionistic bioprophets: Francis Crick, Richard Dawkins, Daniel Dennett, James Watson, and E. O. Wilson urge (which would surely surprise them) a worldview that jeopardizes "staying human."[50] As for what consciousness is, which question Crick in *The Astonishing Hypothesis*, 1995, levers from philosophy to science,[51] may for ever elude us is the conclusion Colin McGinn reaches in *Conscious Minds in a Material World*, 1999.[52] Yet we will not stop for the precise reason that Jerry Fodor in 2001 can say: "Nobody has the slightest idea how anything material could be conscious."[53] Consciousness, a state of reality of a "just so" brain, is a true surprise only to reductionists who believe that we can understand what matter is. But as long ago as 1897, B. Pascal wrote the whole truth in *Les Pensées*: "I consider it impossible to know the parts without knowing the whole, or to know the whole without knowing the parts."[54] Recommended reading is *An Anatomy of Thought* by Ian Glynn, 1999.[55]

Genes are not there in the number that would be needed to specify how every nerve brain cell should grow. In reviewing Patrick Bateson and Paul Martin's *Design for a Life: How Behavior Develops*, 1999, Marian Stamp Dawkins emphasizes the point that in building the human brain and nervous system, half of our some 30,000 genes are by estimated involved *but* a million times this number is the nerve cells count and each is with hundreds to thousands of connections to other cells.[56]

In *Mutual Aid*, 1902, Peter Kropotkin cited numerous examples where behavior counters survival of the fittest. He celebrated that at every level of the animal world is sociability, as in humans.[57] He got it wrong, Matt Ridley (***Figure f34.3***) claims in *The Origins of Virtue*, 1996: "The essential virtuousness of human beings is proved not by parallels in the animal kingdom, but by the very lack of convincing animal parallels."[28] The innate virtues that define the human species are "cooperation, altruism, generosity, sympathy, kindness, selflessness." Wrote Erasmus Darwin: "No radiant pearl ... Shine with such lustre as the tear that flows Down Virtue's manly cheek for others' woes."[58] Learnable virtues (***Footnote f34.1***) are more: André Comte-Sponville in *A Small Treatise on the Great Virtues*, 2001, after asking himself "what the dispositions of heart, mind or character are whose presence in an individual tends to increase my moral regard for him and whose absence tends to diminish it?" finds for justice, courage, prudence, and temperance (which are the four Platonic virtues), love (which he holds to be the most important, and includes charity, in its Christian sense, as a variant), politeness (which prepares the ground for morality), fidelity, generosity, compassion, mercy, gratitude, humility, simplicity, tolerance, purity, gentleness, good faith (which is, respect for truth), humor (which prevents us from taking ourselves too seriously),[59] and acceptance (When I was young, I wished I could afford to eat all I wanted. Now that I can, I can't.)[60].

In accordance, what obedience do humans have to the prompting of their genes when Susan Golombok can report that parenting in families with a child conceived through donor insemination is measurably better than that observed in well-functioning families with a naturally conceived child; and, adoptive parents show child-rearing skills equal to those of parents of children conceived with medical help?[61] If we can generalize from her study: for humans, genetic ties are less important for family functioning than is the overarching desire for (pets and) parenting.

And what of the greater field in which we play? "I live in my cat's house," quipped Marlon Brando. An holistic enquiry into evolution has long payed attention to the interaction of organisms (Darwin used the apt metaphor of a 'tangled bank' for the seeming Gordian knot of mutualistic and antagonistic interactions between species).[62] Reductionist molecular biology of neo-Darwinism narrowed the focus and is "a bit frayed and dowdy ... with all its best insights behind it." That; by J. Scott Turner in *The Extended Organism: The Physiology of Animal-Built Structures*, 2000. What is emergent beyond the interaction of organisms, he reminds us, is that organisms do manipulate the inorganic realm. An organism's phenotype involves and evolves the inorganic world.[63] ❑

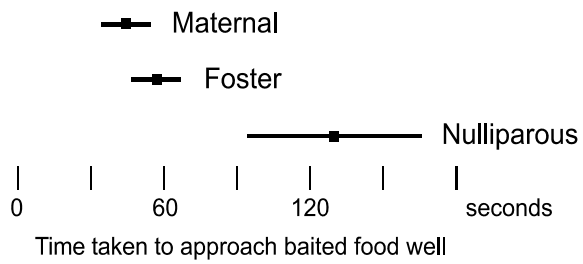


Figure f34.1 Changed spatial learning efficiencies exhibited by three groups of female rats after different life experiences.

Figure f34.2[64] **Hamilton's Rule** is an extension of individual selection to kinship selection: When (*Relatedness* x *Benefit*) – *Cost* > 0, selection can favor genes for reproductive altruistic behavior whereby the number of offspring is more for the recipient and less for the giver. Simplistically: [65]

Relatedness has the value 1 for Maternal twins (clones), 0.5 for Full siblings, 0.5 for Parent-offspring, 0.25 for Half-siblings, 0.125 for First cousins, and so on and so for the average person you meet (or between members of a species in general) the value of R will be very low indeed.

Benefit is the additional number of offspring that the receiver is likely to have as a result of the altruistic behavior.

Cost is the number offspring that the giver is no longer likely to have as a result of the altruistic behavior.

In natural systems in which ability to disperse is limited, competition that arises between relatives as these become perforce more related can thwart increasing altruism among them. In *The Undiscovered Mind*, 1999, John Horgan summarizes: "Kin selection revealed the evolutionary logic underlying the behavior of such highly social creatures as ants, termites, and mole rats. It could also explain the extraordinary risks and sacrifices that human mothers or fathers will make to ensure the survival of their children or other close relatives. Asked if he would lay down his life for his brother, the British biologist J. B. S. Haldane quipped, 'No, but for two brothers or eight cousins.'"[66] (At Eton, Maynard Smith recalled, schoolmasters would speak with real hatred of the biologist J. B. S. Haldane, whom they reviled as an atheist, a divorcé, and a Marxist. "I remember," he told an interviewer, "thinking: 'anybody they hate so much can't be all bad. I must go and find out about him.'") [67]

Figure f34.3

"Anthropologists routinely interpret rituals or practices in terms of their promotion of the good of the group, not the individual. They do so mostly in blithe ignorance of the fact that biologists have thoroughly undermined the whole logic of group selection. It is now an edifice without foundation. Like anthropologists, until the mid-1960s most biologists talked glibly about the evolution by natural selection of traits that were good for the species. But what happens when something is good for the species but bad for the individual? What happens, in other words, in a prisoner's dilemma? We know: what happens. The individual's interest comes first. Selfless groups would be perpetually undermined by the selfishness of their individuals."
—Matt Ridley, *The Origins of Virtue*,1997.[28]

Matt Ridley

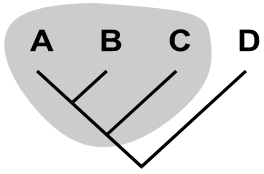
Footnote f34.1 "The human genome encodes the instructions for the assembly of what is after all a learning organism, not for what it then learns [False [68]]. Mental states are the product of social interaction from birth; in principle, any brain can have any thought." —Robert Pollack.[69]

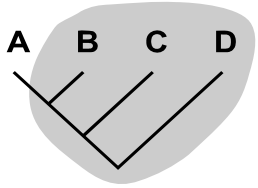
Figure f35.1 Terms used to describe types of assemblages are: *monophyletic, paraphyletic,* and *polyphyletic*. Also:

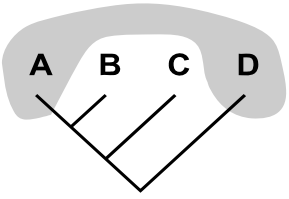
An *evolutionary clade* (synonym: lineage) consists of the first member of the group and all of its descendants.

A *family tree* consists of a nested set of clades.

An *evolutionary grade* is a level of evolution (for example: warm bloodedness, four chambered heart, limbs, etc.).







PHYLETIC ASSEMBLAGES

Monophyletic (or single lineage) assemblage: the *clade*, A, B, C, includes all organisms descended from the first of A, B, and C. In cladistics, a *clade* is defined as a phylogenetic group inclusive of *all* descendants of a single ancestor; the most derived characters of which defines it in comparison to an outgroup D.

Paraphyletic assemblage: an evolutionary *grade* which is the most recent common ancestor of B, C, and D, that excludes a descendant, namely A. For example: Amphibia, which excludes reptiles, mammals and birds; and, Reptilia, which excludes mammals and birds.

Polyphyletic assemblage: A and D are found not to have a common ancestor of B and C but belong to a group that can be defined. For example, the old grouping Haemiothermia, which linked mammals and birds. Also, each of the (at least ten) phylogenetic lines of lichen (orders) have originated independently by a combination of different fungi with different algae while algae themselves are symbiotic combinations of diverse flagellates with diverse cyanophytes (as Constantin S. Merezhkowsky correctly claimed as long ago as 1920).[1]