**Current theoretical laws for the individual development of the organism.**

A biological rule or biological law is a generalized [law](https://en.wikipedia.org/wiki/Law_(science)), [principle](https://en.wikipedia.org/wiki/Principle), or [rule of thumb](https://en.wikipedia.org/wiki/Rule_of_thumb) formulated to describe patterns observed in living organisms. Biological rules and laws are often developed as succinct, broadly applicable ways to explain complex phenomena or salient observations about the [ecology](https://en.wikipedia.org/wiki/Ecology) and [biogeographical](https://en.wikipedia.org/wiki/Biogeography) distributions of plant and animal [species](https://en.wikipedia.org/wiki/Species) around the world, though they have been proposed for or extended to all types of organisms. Many of these regularities of ecology and biogeography are named after the biologists who first described them.[[1]](https://en.wikipedia.org/wiki/Biological_rules#cite_note-J%C3%B8rgensen2002-1)[[2]](https://en.wikipedia.org/wiki/Biological_rules#cite_note-2)

From the birth of their science, biologists have sought to explain apparent regularities in observational data. In [his biology](https://en.wikipedia.org/wiki/Aristotle%27s_biology), [Aristotle](https://en.wikipedia.org/wiki/Aristotle) inferred rules governing differences between live-bearing [tetrapods](https://en.wikipedia.org/wiki/Tetrapod" \o "Tetrapod) (in modern terms, terrestrial placental [mammals](https://en.wikipedia.org/wiki/Mammal)). Among his rules were that [brood size](https://en.wikipedia.org/wiki/Brood_size) decreases with adult body mass, while [lifespan](https://en.wikipedia.org/wiki/Life_expectancy) increases with [gestation period](https://en.wikipedia.org/wiki/Gestation_period) and with body mass, and [fecundity](https://en.wikipedia.org/wiki/Fecundity) decreases with lifespan. Thus, for example, elephants have smaller and fewer broods than mice, but longer lifespan and gestation.[[3]](https://en.wikipedia.org/wiki/Biological_rules#cite_note-3) Rules like these concisely organized the sum of knowledge obtained by early scientific measurements of the natural world, and could be used as [models](https://en.wikipedia.org/wiki/Scientific_model) to predict future observations. Among the earliest biological rules in modern times are those of [Karl Ernst von Baer](https://en.wikipedia.org/wiki/Karl_Ernst_von_Baer) (from 1828 onwards) on [embryonic development](https://en.wikipedia.org/wiki/Embryogenesis),[[4]](https://en.wikipedia.org/wiki/Biological_rules#cite_note-Lovtrup-4) and of [Constantin Wilhelm Lambert Gloger](https://en.wikipedia.org/wiki/Constantin_Wilhelm_Lambert_Gloger) on animal pigmentation, in 1833.[[5]](https://en.wikipedia.org/wiki/Biological_rules#cite_note-Gloger-5) There is some [scepticism](https://en.wikipedia.org/wiki/Scepticism" \o "Scepticism) among biogeographers about the usefulness of general rules. For example, J.C. Briggs, in his 1987 book Biogeography and Plate Tectonics, comments that while [Willi Hennig](https://en.wikipedia.org/wiki/Willi_Hennig)'s rules on [cladistics](https://en.wikipedia.org/wiki/Cladistics) "have generally been helpful", his progression rule is "suspect".

[Schmalhausen's law](https://en.wikipedia.org/wiki/Schmalhausen%27s_law), named after [Ivan Schmalhausen](https://en.wikipedia.org/wiki/Ivan_Schmalhausen), states that a [population](https://en.wikipedia.org/wiki/Population) at the extreme limit of its tolerance in any one aspect is more vulnerable to small differences in any other aspect. Therefore, the variance of data is not simply noise interfering with the detection of so-called "main effects", but also an indicator of stressful conditions leading to greater vulnerability

[Van Valen's law](https://en.wikipedia.org/wiki/Van_Valen%27s_law) states that the probability of [extinction](https://en.wikipedia.org/wiki/Extinction) for species and higher taxa (such as families and orders) is constant for each group over time; groups grow neither more resistant nor more vulnerable to extinction, however old their lineage is. It is named for the evolutionary biologist [Leigh Van Valen](https://en.wikipedia.org/wiki/Leigh_Van_Valen).

[von Baer's laws](https://en.wikipedia.org/wiki/Von_Baer%27s_laws_(embryology)), discovered by [Karl Ernst von Baer](https://en.wikipedia.org/wiki/Karl_Ernst_von_Baer), state that [embryos](https://en.wikipedia.org/wiki/Embryo) start from a common form and develop into increasingly specialised forms, so that the diversification of embryonic form mirrors the [taxonomic and phylogenetic tree](https://en.wikipedia.org/wiki/Tree_of_life_(biology)). Therefore, all animals in a phylum share a similar early embryo; animals in smaller taxa (classes, orders, families, genera, species) share later and later embryonic stages. This was in sharp contrast to the [recapitulation theory](https://en.wikipedia.org/wiki/Recapitulation_theory) of [Johann Friedrich Meckel](https://en.wikipedia.org/wiki/Johann_Friedrich_Meckel) (and later of [Ernst Haeckel](https://en.wikipedia.org/wiki/Ernst_Haeckel)), which claimed that embryos went through stages resembling adult organisms from successive stages of the [scala naturae](https://en.wikipedia.org/wiki/Scala_naturae" \o "Scala naturae) from supposedly lowest to highest levels of organisation.

[Williston's law](https://en.wikipedia.org/wiki/Williston%27s_law), first noticed by [Samuel Wendell Williston](https://en.wikipedia.org/wiki/Samuel_Wendell_Williston), states that parts in an organism tend to become reduced in number and greatly specialized in function. He had studied the dentition of vertebrates, and noted that where ancient animals had mouths with differing kinds of teeth, modern carnivores had incisors and canines specialized for tearing and cutting flesh, while modern herbivores had large molars specialized for grinding tough plant materials.

Creationists make much of the second law of thermodynamics. They say it precludes the possibility of evolution because: "There is a general tendency of all observed systems to go from order to disorder, reflecting dissipation of energy available for future transformations—the law of increasing entropy" (Lindsay, 1968). The second law has been stated in many other ways, but we have picked this definition because it contains the all-important word tendency and because it is a definition often quoted by creationists. The word tendency is very critical, since it allows exceptions to the usual implication by creationists that all systems go to disorder. (One can get into many semantic arguments with words like disordered. Technically, an "ordered" state can be described with a minimum of statements or rules. Thus a page of nothing but A's would be more "ordered" than this page of text. We really should use a phrase like high information content in place of ordered, but let's stick with ordered because it's easier to say. Perhaps that's the reason creationists often say ordered when they really mean high information content.)

Consider how different the world would be if all systems became less energetic and less organized with time. There would be no puffy clouds, thunderstorms, or weather fronts. Their organization and energy would have dissipated long ago. There would be no trees or flowers. Their seeds would just decay. And we wouldn't be here either. Each of us would have died as a withering zygote that could not undergo development. Clearly the creationist implication that all systems tend toward decay and disorder is wrong. There are many systems besides evolution that tend toward greater order. Philip Morrison (1978), for example, has shown that spontaneous increases in order are common in our world. He points out that the second law really says that increases in order must be paid for in energy. Such increases are clearly not impossible except in closed systems lacking a source of energy. Where large amounts of energy are available, as in the sun-earth system, large increases in order are possible.

Creationists, of course, deny this while claiming that organisms contain some sort of God-given precoded plan and energy conversion system that allows them to escape the death and decay dictated by the second law. On the other hand, almost all scientists accept both the second law and evolution. We need to ask, therefore, just how the second law does affect living systems. A look at gene mutation should allow an answer to this question. A given normal gene will mutate to a nonfunctional version of itself with a characteristic frequency, often on the order of 1/1,000,000. (For every 999,999 times this gene is transmitted correctly to the next generation, it is transmitted incorrectly one time.) We could call this type of mutation from functional to nonfunctional a "damaging" mutation.

It comes as a surprise to some people, but nonfunctional genes occasionally mutate back to the functional version. We could call this a "repair" mutation. If genes were likened to cars, this would be like saying that occasionally a dented car could be correctly fixed by being in a second accident! However, genes are not cars; chemical complexity is not the same thing as physical complexity. Even though an explosion in a print shop will not produce a dictionary, energy can change simple methane and ammonia into complex amino acids, as Stanley Miller and Harold Urey demonstrated in 1953. Similarly, even though a second collision probably will not undent a dented car, a second mutational event occasionally renders a gene functional again.

The effect of the second law is clearly seen when the repair mutation rate is measured. This repair rate is always less than the damaging mutation rate. In other words, it is easier to go from an ordered state (functional) to a disordered state (nonfunctional) than it is to go in the reverse direction. A typical rate for this repair type of mutation is on the order of 1/1,000,000,000. This is the most important consequence of the second law on living systems. Clearly, the second law does not prevent systems from going from disorder to order. All the law does in this case is to make such mutations rare compared to mutations going in the thermodynamically favored direction—toward disorder. If that's all there were to it, however, gene systems would still eventually all move to a disordered nonfunctional state. They obviously don't. Is this because of a mystical precoded plan, or is there another, nonsupernatural explanation?

Now we come to the essence of evolution: natural selection. All that any organism has to do to escape "degeneration in accord with the second law of thermodynamics" is to be able to produce more young than are needed to replace the parents. As long as that is true, the occasional mutants (almost all less fit than the original version) will usually reproduce poorly or even die without adversely affecting the population. Since the harmful mutations are underrepresented in succeeding generations, these mutations simply cannot build up to a level that threatens the well-being of the population. Thus, mutations are random changes, usually toward disorder, but the effect of natural selection is to remove the relatively common disordered genes and prevent the genetic system from degenerating.