

The Definition of Life

1. Some Poor Attempts to Define 'Life': What is life? From the time that we are children, we are usually taught something like, "Something that breathes, and eats, and grows" (for instance, this is the definition of 'life' according to [Sesame Street](#)). Here is a plausible definition of life, then:

(a) **Metabolism:** A thing is alive if it consumes matter, excretes matter, and grows.

Too narrow: But, then, many organisms that would normally be counted as living organisms do NOT do these things; for instance, those that lay dormant for many years (e.g., seeds, spores, "[sea monkeys](#)", and "[water bears](#)"). Perhaps we could modify the definition to talk about the ABILITY to metabolize, though.

Too broad: However, either way, the definition would remain far too permissive. For, fire is alive according to this definition! Fire does all of these things.

(b) **Reproduction:** A thing is alive if it is capable of replicating itself, or creating more things like itself.

Too broad: But, then, salt is alive! For, salt crystals replicate themselves. So, too would a robot programmed to create more robots be considered alive on this definition. Not to mention, it seems that fire would still be counted as alive according to this definition!

Too narrow: Furthermore, sterile individuals (e.g., mules) would not be counted as alive on this definition. Even a single rabbit would not be alive, according to this definition. For instance, a male rabbit cannot replicate itself—to do that, it also needs a female rabbit. (A pair of 80 year old human beings would also not count as 'living things' on this definition!) But, surely these things ARE alive.

2. The Evolutionary Approach: Perhaps the above suggestions are too simple. Scientists often accept something like the following definition of 'life':

(c) **Adaptive Evolution:** A thing is alive if it is a self-sustaining system capable of Darwinian evolution.

Adaptive evolution is understood as the ability to replicate, sometimes with randomized error, where these errors are then passed on to further generations—and over time, the individual adapts to its environments because of this. Neither fire nor salt nor (non-sentient) robots are alive on this definition, because they are not capable of this.

Too broad: However, certain computer simulations which are designed to SIMULATE or MODEL living organisms or systems would now be counted as living things.

Some philosophers bite the bullet and say, Yes, certain computer simulation processes ARE alive. However, most are not willing to say this. They say that this proposal is confused. Computers can simulate all sorts of things (hurricanes, traffic, outbreaks, etc.). But, Last week, we saw reason to believe that they are merely that—a SIMULATION or MODEL of these things. They are not the things themselves. In order to prevent simulations of life from counting as living, most scientists add that the evolutionary process must be *chemical* rather than merely *informational* (as it is in a computer program). Consider:

(d) **Adaptive Chemical Evolution:** A thing is alive if it is a self-sustaining, *chemical* system capable of Darwinian evolution.

All life that we know of relies on chemical processes in order to continue living. So, we ought to expect that ALL life exists in this way. (This is a return to the metabolic definition, to some extent.)

*Note that some biologists insist not only that the organism be **chemical** but that it furthermore be **cellular** (that is, a cell, or made of cells). This would rule out viruses as non-living things (viruses evolve, but are not cells, and can't replicate without a host cell).*

What is really meant must be that the SPECIES evolves. For, individual organisms are not THEMSELVES capable of evolution. Individuals do not evolve. Evolution is a process that spans many generations of individuals. If the definition is meant to apply to individuals rather than species, then it must be modified to specify that the thing must not ITSELF evolve, but must be CAPABLE of reproducing in a way such that evolution takes place.

Too narrow: But, then once again we obtain the conclusion that sterile individuals (e.g., mules, old people, etc.) are not alive.

Still too narrow: We might try to modify the definition once more to suggest that the individual need not be fertile, but have some (genetic?) *potential* to reproduce. But, this would rule out certain organisms that we will (very likely) one day be able to synthesize in the lab—e.g., artificial microbes engineered to be intrinsically sterile—as not alive.

Notably, we may even one day OURSELVES no longer be a species that is capable of Darwinian evolution. For instance, advancements in gene therapy suggest that one day we will not evolve in the Darwinian way (i.e., via random mutation) but rather by a carefully controlled manipulation of our DNA in the laboratory.

Side note on AI's: Artificial intelligences will likely exist one day. Will such beings be truly alive? If AI's are not alive, will they at least be evidence that there IS or WAS life (i.e., will they be evidence of US, their creators)? Will AI's be capable of Darwinian evolution? The answers to these two questions will also affect how we ought to define 'life'.

To include the possibility of future non-evolving but clearly living organisms, let us modify the definition of life one final time, as follows:

- (e) **Adaptive Chemical Supra-Darwinian Evolution:** A thing is alive if it is a self-sustaining, chemical system presently capable of Darwinian evolution, or one that evolved from a system that WAS capable of such (i.e., a "supra-Darwinian" entity).

Still too narrow: Both (d) and (e) include a *chemical* (or cellular) requirement for life. But, this may be a very narrow-minded way of looking at things. It excludes the possibility of alien beings who are not made of chemicals, or cells. For instance, what if we discovered that there were immortal disembodied spirits who could communicate their thoughts and emotions to us? Surely we would want to count these as 'alive'? Such beings may be incredible to imagine, but surely we should not rule them out "by definition".

Knowing you are alive: Furthermore, this last definition makes it impossible to be able to determine whether a supra-Darwinian being is alive or not (because we would not be able to know for sure without knowing about its HISTORY). Surely that will not do.

3. Life as an Emergent Property: The most recent popular definition of life abandons the metabolic and evolutionary aspects of life and instead considers life as something like "self-maintaining, organized complex system". This is called *autopoiesis* (in Greek: "auto" = "self" ; "poiesis" = "creation" or "production"). (For a nice overview, see [here](#)).

- (f) **Autopoiesis:** A thing is alive if it is a closed (or nearly closed) system of organized complexity, capable of organizing and maintaining itself.

According to Cleland,

The basic idea seems to be that at a certain level of organization novel functional properties spontaneously arise, either as a matter of fundamental physics or logic, rendering the system capable of developing increasingly greater organized complexity.

Self-causation is incoherent: The view here is that, somehow, the property of 'being alive' just SPONTANEOUSLY "emerges" from matter when it is arranged in certain ways. It is often described as "SELF-organization". This sounds a bit too much life self-causation, which is thought to be an incoherent idea (how does something cause itself?). So, is the idea of life as an "emergent" phenomenon any more sensible than the ancient & medieval idea that living things "[spontaneously generated](#)" from the dust?

Too broad: Second, the autopoietic definition of life is too permissive. It counts many things as living things that do not seem to be; for instance ecosystems, bee colonies, corporations, the entire human species, or even the entire planet Earth all seem to be

nearly closed organized, complex systems capable of maintaining themselves over time.
(Most proponents explicitly admit that Earth IS alive—this is called Gaia. Do you agree?)

4. Conclusion: There seems to be no definition of life on offer that is not subject to counterexamples. Many of these counterexamples are borderline cases (e.g., viruses, spores, computative models). There seems to be some “gray area” between the living and the non-living that makes it difficult (impossible?) to define what life is exactly.

This is known as **vagueness**. Should vagueness trouble us? Some might think that if there is vagueness then we are driven to the conclusion that either everything is alive or else nothing is. For, if there is no clear cut-off point—no clear division—between inert matter and a living organism, then we might be forced to conclude that there is no distinction to be made at all—in which case NOTHING is alive (or else, EVERYTHING is!).

Most philosophers believe that this way of thinking is wrong-headed. There are many distinctions that have vague boundaries between them, but this does not mean that those distinctions are incoherent. For instance, where is the boundary between ‘bald’ and ‘not bald’? Surely there is a difference between these two properties. Yet there is no clear dividing line between them. Is a person with 100 hairs still bald? How about 1,000?

That there is vagueness should not be troubling. After all, it is not REALITY that is vague (that would be very weird). It is LANGUAGE that is vague. Terms like ‘bald’ are just sloppy short-handed terms that we lazy, imprecise humans use to cover a whole range of properties (like, ‘having zero hairs’, ‘having 1 hair’, ‘having 2 hairs’, etc.). So, perhaps we should not find the fact that the distinction between living and not living (i.e., dead) is vague. Clearly there is a real and important difference between, say, a rock and a human being. Perhaps it is just our TERM “alive” that is vague (like the term “bald”, or many others; e.g., rich, tall, big, etc.), and the only problem is that we are trying to apply the term universally to an entire spectrum of something that comes in degrees.

5. Side Note on NASA’s Definition of Life: In 1976, NASA sent its two [Viking landers](#) onto the surface of Mars, with the purpose of detecting life. It is interesting to note what they looked for. They conducted 3 tests, designed to detect the presence of metabolic processes. (They looked for oxidization with carbon-14, the production of oxygen when exposed to sunlight and nutrients, and the ability to “fix” carbon from the atmosphere).

What they found was surprising: The Martian soil passed all three tests! However, NASA scientists ultimately concluded that there was no life on the surface of Mars after all—for, according to a fourth test, there were no organic (carbon) molecules there.

NASA’s Implicit Definition: What do we learn from this? First, that **metabolism** seems to have been treated as a necessary condition for life by NASA. Second, that the presence of certain **organic (carbon-based) molecules** is also a necessary condition for life.