

Table 1. Definitions of life.

Author	Definition of Life
Bedau & Packard (1991)	<i>We propose to [...] view life from a more global, statistical perspective. No single molecule of gas has a macroscopic property like temperature; temperature is meaningful only for a large population of molecules. Similarly, no single organism exhibits indefinitely ongoing life [...]. From a global perspective, only the complex web of interacting organisms – the entire biosphere – remains “alive” in the long run, through the continual cycle of birth and death of individual organisms. [...] An organism is alive only if it is a member of an actively evolving biosphere.</i>
Harold (2001)	<i>Life is first and foremost a microbial phenomenon. [...] Living things display complex organization [...] they carry out metabolism (energy generation in particular) reproduce their own kinds, and have functional parts adapted to their environment. [...] Life is a quality or attribute of entities that meet the criteria. They come in a vast range of shapes and sizes, from Escherichia coli to the blue whale, but the minimal units that meet all the criteria are microbial cells, both prokaryotic and eukaryotic.</i>
Joyce (1995)	<i>Life is a self-sustained chemical system capable of undergoing Darwinian evolution.</i> [Definition adopted by NASA]
Kauffman	<i>Life is an expected collectively self-organized property of catalytic polymers.</i>
Korzeniewski (2001)	<i>Life [...] is defined as a network of inferior negative feedbacks (regulatory mechanisms [in the service of sustaining the identity of the individual – any deviation from some parameter sets in motion a series of steps to get back to the default value, like a thermostat]) subordinated to (being at service of) a superior positive feedback (potential of expansion [i.e. replication]).</i>
Koshland (2002)	There are seven pillars of life: a Program (an organized plan), Improvisation (a way to change the program), Compartmentalization (a means of separating self from the outside world), Energy (to fuel chemical reactions), Regeneration (to repair and replace itself), Adaptability (to respond to the environment), and Seclusion (to insulate chemical reactions from one another).
Langton	<i>Life is a property of form, not matter, a result of the organization of matter rather than something that inheres in the matter itself. Neither nucleotides nor amino acids nor any other carbon-chain molecule is alive – yet put them together in the right way, and the dynamic behaviour that emerges out of their interactions is what we call life. It is effects, not things, upon which life is based – life is a kind of behavior, not a kind of stuff – and as such it is constituted of simpler behaviors, not simpler stuff.</i>
Margulis & Sagan (2000)	<i>Living organisms are autopoietic systems.</i> [In other words, they make more of themselves]
McKay (1991)	<i>Life is a material system that undergoes reproduction, mutation, and natural selection.</i>
Morales (1998)	<i>Living things are systems that tend to respond to changes in their environment, and inside themselves, in such a way as to promote their own continuation.</i>
Nealson	<i>Life can be recognized by what it does: living organisms create hallmark molecules and create chemical disequilibrium.</i>
Pace (2001)	<i>Life is a self-replicating, evolving system based on organic chemistry.</i>
Schrödinger (1992)	Living matter is that which <i>avoids the decay into equilibrium</i> . The second law of thermodynamics says that entropy (disorder) always increases. Living things are highly ordered and seem to go against the second law of thermodynamics; however, they can only do this at the cost of increasing the entropy in the environment around them.
Trifonov (2011)	<i>Life is self-reproduction with variations.</i> [Trifonov identified the commonalities in 150 definitions of life to get to this idea]

Notes: This table contains some of the proposed definitions of life. There are many more, and instructors should consult Lahav (1999), McKay (2004), or Hazen (2006) for additional ideas. The definitions can be broadly grouped into those that favor a focus on reproduction/evolution, metabolism, thermodynamics, the biosphere (ecosystems), complexity, or “other.” The definition supplied for Ken Nealson was obtained from “Classification of Living Things” (University of California, San Diego, 2002), Kauffman’s definition was cited in Lahav (1999), and the one for Chris Langton came from Adami (1997).

the organisms fit a definition of life? How so? Students write a two-page paper wherein they espouse a clear definition of life and where they summarize the evidence that the finding is alive or not alive.

The third suggestion is a reflective assignment that consists of asking students to first research the literature for other ideas on what

constitutes “life.” Suggested texts include Erwin Schrödinger’s published lectures, *What is Life?* (Schrödinger & Penrose, 1992); Robert Hazen’s summary article on this topic (Hazen, 2006); the introductory chapters of the book *Astrobiology* by Plaxco & Gross (2006); and the book *Biogenesis* (Lahav, 1999). Students may also wish to