Science & Philosophy Volume 10(2), 2022

Scientific-Philosophical definition of life

Fröhlich, Klaus[*]

Abstract

There are about 100 different contradictory definitions of life. The definition of life based on symbiosis that is presented here differs fundamentally from them; it gives life a value. So this definition offers a basis for ethical and legal action e.g. in organ transplants. It is based on principles and is not an ad hoc model: Significant processes for life are basis for a theoretical concept. Quality criteria for definitions are employed to control the concept.
There is a graduation, not a clear division, between inanimate and animate. The graduation is based on the amount of symbiosis to be found. Life is based on symbiosis. The ideas of "ethics" and "reality" are considered in the context of this definition.
Keywords: Definition of Life; Biology and Ethic; Symbiotic.†.[‡]

[*]Klaus Fröhlich, ALS, Paracelsusweg 12, 30655 Hannover, Germany, froehlich@als-hannover.de

[‡]Received on July 07, 2022. Accepted on December 15, 2022. Published on December 15, 2022. DOI: 10.23756/sp.v10i1.801. ISSN 2282-7757; eISSN 2282-7765.

1. Definition of the term "Life"

Preliminary considerations

We use the term “life” frequently in everyday life. A definition as a common basis is required for scientific and philosophical work. This article draws on the author's earlier considerations, which have been integrated into a philosophical context and thus lead to fundamentally new aspects. This evolved text is distinguished by originality and novelty. (ref. Fröhlich, 2017)

Can you define life? The following "*objection ... has been advocated in particular by Francois Jacob (Jacob. 1982). Science has always progressed by focusing on questions of a limited amplitude - in contrast with, for instance, philosophy. By so doing scientists have been able to construct a solid form or knowledge. The question or life is too large to be a scientific one. ... But it does not mean that finding a definition of life is not a scientific objective."* (Morange, 2011)

Contradicting Jacobs theory that life cannot be defined scientifically the new definition of "life" based on symbiosis that is presented meets not only philosophical (comprehensive) but also scientific (exact and verifiable) requirements.

Sometimes the opinion is expressed that the term "life" cannot be defined. Then one should be so consistent not to use this term (in philosophical discussions). It should be borne in mind that definitions and guidelines are a requirement for legal certainty and can help with ethically difficult decisions.

Definitions determine future decisions. Therefore, the suitability is checked here with quality criteria for definitions. The definition of "life" is required for scientific work, ethical considerations in medicine and legal decisions. The following definition of the term "life" takes these areas into account.

Let us first narrow down the term: *"Living systems and Life are different concepts with different properties. ... Life is an attribute of living systems, or a theoretical concept about living systems in general.* (Poppa, 2009)

The starting point for the definition of life is a theoretical concept. First we consider which principles rule the basic processes of nature before taking scientific, philosophical and ethical aspects into account. Definitions based on principles have a higher quality than descriptive definitions, which may contain hidden assumptions. Definitions are part of models. Different models lead to different definitions. The symbiosis-based definition was developed within the framework of the scientific worldview.

Cornerstones of the definition

Significant processes in nature:
A significant processes in nature is the formation of matter (information) and the laws of nature, the formation of chemical elements from elementary systems and the emergence of biological life.
Simple unicellular organisms develop to higher unicellular organisms, eukaryotes.
All of these developments have something in common, they are based on a cooperation for mutual benefit, which is called symbiosis.
The idea that life has something to do with symbioses is not new. *"Some scientists believe that life emerged as a symbiosis (mutualism) between independently developed mechanisms. ... (Schrödinger 1944, Eigen et. al. 1981)"* (Poppa, 2004)
Symbioses are scientifically important:
Simple systems come together to form a complex system with new properties (innovations) and symbiosis creates stability.
Symbiosis is logically - philosophically important:
A coalition goes hand in hand with a leap in development in knowledge. Control systems are formed (information storage, languages, laws, natural laws). Cooperation goes hand in hand with communication. Symbiosis enables experiences to be passed on.
Symbioses are of ethical - philosophical importance:
A prerequisite for the emergence of life is the consistent application of a principle that we call "love" on an emotional level. Evolutionary development is driven by the mechanism of science, which is based on the principle of truthfulness. Symbiosis defines meaning and values. (Symmetry break)
The symbiosis definition of the term "life" is based on the unity of mind and matter in the sense of systems theory. (ref. Bertalanffy, 2009)
Stable symbiosis follows mechanical and ethical rules: There is a parallelism between ethics and mechanics. The symbiosis definition of the term "Life" is based on Ethical, logical and mechanical principles. (Monism/ Elome - concept) (ref. Haeckel, 1899)

Scientific-Philosophical definition of life

In the words of philosophy: "Basis of life is the principle of love. Life exists where this principle rules (symbiosis)."
In the words of biology: "Basis and indicator of life is the symbiosis."
This is a partnership in which each partner is active for the benefit of the other partner.
Colloquial: "What loves, that lives."
To sum it up
Science: Life is based on symbiosis. Philosophy: Life is based on the principle of love. Symbiosis put this principle into practice. Science: Tests control whether symbioses are present.
Why love and not justice?

Because love is biased: For the self, for the family, for life, for being, etc. (The lion feeds its child with the killed zebra.)

The basis of justice is, mathematically speaking, symmetry. A symmetry break takes place in a symbiosis, both physically and ethically. (Fröhlich, 2012)

Love defines values that must be preserved. Now the law, as a protector of values, is justified. In symbioses significance, values and meaning are defined. Symbioses, based on the principle of love, form the starting point for many processes in our world: law, stability, beauty, value, perception, knowledge, and the question of meaning.

The following example shows the importance of law as a regulator: We differentiate between wild animals, pets and farm animals as well as cute and nasty animals. The break in symmetry is also evident in our emotions. Animal welfare therefore requires ethical and legal considerations.

Effective values arise in a symbiosis, i.e. values correspond to a physical effect. Life, the stability of matter and the validity of natural laws are based on the principle of love. All stable elementary systems are subject to this principle. In a symbiotic view, the world consists of a network of relationships. In a transcendent sense, one could say that community spirit and not egoism forms the basis of life.

Discussion

Do mechanical processes or ethical principles form the basis of our scientific worldview? This decision shapes our thinking and acting and is also reflected in the definition of the term life. In contrast to the technical definitions, the new definition assigns a value to life. This is important for treatment with living beings, especially in medicine.

The technical definition has evolved as follows: Out of the pre-scientific idea of what life is, a list of animate and uninhabited was created and searched for distinctive features.

In the words of Radu Poppa: *"A true life definition must exclude any material references and include all forms of life, (or things that may become alive)"* (Poppa, 2009)

This approach makes sense, but does not lead to the desired result, because the (arbitrary) division into animate and inanimate is not appropriate.

The definition of the term "Life" based on symbiosis expands the scope: Life is the basic principle of nature. The opposing pair animate / inanimate is replaced by an intermittent transition between the individual forms of life, which depends on the degree of symbioses. The diversity of living beings is greater than in the traditional definition. It ranges from the simple to the complex and holds, for example, culture as a form of life. The complexity depends on the degree of symbiosis.

The chemical elements and elementary particles have also characteristics of life. Therefore, the biological life has arisen not from inanimate, but from living matter.

Unicellular organisms differ so strongly from the chemical processes that one is inclined to see a contrast (animated / unanimated) that does not exist. However, the fine-grained transition from the chemical plane to the biological plane is difficult to recognize because the processes in biological forms of life (e.g. in unicellular organism) are based on a multitude of symbioses.

Biologists who produce unicellular organism from chemical substances, only develop existing creatures. We cannot create life, but we can develop it further and bring it to a higher level.

Varied forms of life

The division into alive and lifeless ignores the principle of the unity of nature. The definition presented here replaces this opposition with a finely graduated transition between the individual forms of life, depending on the degree of symbioses.

Symbioses can be found between the creatures of a biotope (climax), in cultures, in social cohabitation (e.g. bee-keeping), in partnerships (e.g. lichen), within one species (e.g. apoptosis in yeast), in organisms (metazoan, organ formation), in eukaryotes (endosymbiosis), for simple unicellular organism (complex control systems), in non-cellular forms of life (autocatalysis / hypercycles), in the atoms of chemistry (in shell and core), for the elementary systems (e.g., photon, electron, proton)

Living beings are: elementary systems - atoms - molecules - cells - organs - creatures - cultures. In simple unicellular organisms there are very large numbers of symbiotic processes, in chemical reactions few.

In the Elome concept, ethics, logic and mechanics form the basis of the natural and human sciences and their terminology. Life and reality are one. The full vitality of nature cannot be equated with the traditional animistic conceptions. ("The raincloud cries because it is sad.") This model requires no humanization and no mystification.

The following processes also fit into the symbiosis concept:
From a fertilized ovum a person develops.
People consist of many living cells. Cells grow and die, but people live on.
The brain cells dies, the person is declared "dead".
In organ transplantation, the donor dies, but his cells and organs continue to live. According to the technical definition, they are referred to as *"cellularly active organs"* for legal reasons. (Vrselja, et al. 2019) The step-like structure of symbioses includes technology and ethics. This enables a value-based consideration.

For medical professionals, conscious ethical action is of significant importance. Technical definitions are useful tools; principle-based definitions also offer approaches for ethical decisions. Of conscious importance here is the principle of love contained in the symbiosis model.

Further definitions of the term "life"

How does the symbiosis-based definition fit with common definitions? Radu Poppa compiled a list of 40 definitions of life in 2002.

According to Addy Pross, these definitions can be divided into four groups: Information (software), Infrastructure (hardware / energy), Enumeration of common properties of living things and Thermodynamics.

Addy Pross gives the following examples:

"Information (software)

´Life is defined as a material system that can collect, store, process and use information to organize its activities.´ (Dyson, 1999)

Infrastructure (hardware / energy)

´Life is defined as a system of nucleic acid and protein polymerases with a constant supply of monomers, energy and protection.´ (Kunin, 2000)

List of common properties of living things

´Life is defined as a system that is capable of 1. self-organization;
2. self-replication; 3. evolution through mutation; 4. metabolism; and
5. an encapsulation based on it.´ (Arrhenius, 2002)

Thermodynamics

´Life is simply a special state of organized instability.´ (Hennet, 2002)" (Pross, 2012)

A question arises with the definitions. Why can that which is defined be called "life". Addy Pross: *"The definitions above, all relatively new and all revealing in their own way, show almost no overlap. If not all of the definitions had started with the words" life is ... ",* we would be tempted to believe that there are definitions were about completely different concepts." (Pross, 2012)

Summary

The functioning of organisms is described by various disciplines and each is referred to as a definition. This approach is controversial in the literature. The *"spiritual aspects of life"* are not taken into account. Erwin Schrödinger saw this as an essential problem in his own definition. (Schrödinger, 1944)

The symbiosis definition of the term "life" is another type of definition. It is principle-based. It gives life a value. The values in the Elome concept are effective values. They correspond to a physical effect. The symbiosis definition of the term "life" forms the basis for scientific work, ethical considerations in medicine and legal decisions. The symbiosis model includes the differentiated special models. The symbiosis-based definition is compatible with the technical definitions and goes beyond.

In the Elome concept life and reality are one. As a philosophical basis, this model requires a definition in which creatures receive the model-specific predicate "real".

Comparison of definitions with quality criteria for definitions	
TECHNICAL DEFINITION	PRINCIPLE OF LOVE (SYMBIOSIS)
Is there a definition?	
Living beings have a boundary, a metabolism, grow and reproduce. They can record, save, change, and send information. They obtain their inner order by responding appropriately to internal and external influences. *)	The basis and indicator of life is the symbiosis. Colloquial: "What loves, that lives."
Is it intuitive?	
This definition is comprehensible but not intuitive.	This definition is intuitive. (Love is only observed in creatures!)
Contains the essential idea it is based on?	
Too technical.	Yes.
Ockham's razor	
Many criteria to be met.	A single requirement.
Base	
Observed properties	Principles.
Internal consistency	
Yes	Yes

TECHNICAL DEFINITION	PRINCIPLE OF LOVE (SYMBIOSIS)
Consensus	
No. There are many different variations.	For discussion.
Extent "fertility" (How big is its range?)	
Low. The definition describes the earthly life known to us.	Far. Life as a basic principle of nature: It covers all known biological forms of life, but also accepts, for example, culture or elementary systems as forms of life.
Comprehension (Russel's hen)	
Yes, this definition can explain most properties of living things.	Yes, because one can show that love is a necessary condition for life, and can explain how symbioses create life and create higher forms of life.
Accuracy et equality before the law: Copernican principle	
It leaves room for interpretations. What if all the criteria are not met?	Only one criterion has to be tested. There are no exceptions to these rules.
Integration into science	
No, since Wöhler's urea synthesis and Darwin's theory of evolution the subdivision into animated and uninhabited no longer corresponds with scientific knowledge.	Yes. Follows the scientific method. Corresponds to the principle of unity of nature. (Depending on the number of symbioses, a fine-tuned classification of the different forms of life is possible.)
Integration into philosophy	
No.	Yes. In symbioses comprehension, values and meaning define each other: Life is precious. Basis for legal considerations.
Practicable (including probation)	
Yes, with the mentioned restrictions.	Yes, symbioses are common to science.
Importance	
Basis for a technical model of biological life.	Basis for a scientific - philosophical model of life.
The emotional level has to be supplemented. The definition based on symbiosis does not only correspond to what we call "life" in everyday life, but it also corresponds to what we perceive as "life".	
*) Compilation of the author. (Fröhlich, 2017)	

Table 1: Comparison of definitions of life

2. Philosophical Context

Preliminary considerations: Life and Reality

In the Elome concept life and reality are one. As a philosophical basis, this model requires a definition in which creatures receive the model-specific predicate "real".

"Is is." (to Parmenides, 510-440 BC) For idealism, what is immutable and eternal is real. Every form of change is "opinion", "illusion", "deception". According to this concept, all the processes of our everyday life are not real and ultimately meaningless.

The idealistic definition is deeply rooted in religion and philosophy. Think, for example, of eternal and immutable souls, or the concept of indestructible atoms. (Fröhlich 2017)

The models of physics take the opposite position: the principle of action and reaction apply. Something unchanging, according to the state of knowledge, has no effect and cannot be perceived. It has no significance either for physics or for our everyday life. The scientific understanding of reality and the concept of reality of idealism are diametrically opposed.

"Everything flows." (to Heraclitus Ephesus, 520-460 BC) There is no consensus. *"I know that I know nothing."* (to Socrates, 463-399 BC) In other words, we don't know the basic properties of nature, we suppose we know them. The Concept of Elome supposes: Effective values are real, living beings are real and the scientific method produces the best possible explanatory models. (ref. Genz, 2002) The new biological definition expands the existing definition, the new philosophical definition stands in contrast to the traditional definition ("*paradigm shift*"). (ref. Kuhn, 1967)

Comparison of definitions with quality criteria for definitions	
IDEALISM (PERMANENCE)	PRINCIPLE OF LOVE (SYMBIOSIS)
Is there a definition?	
"Is is." With other words: "What is immutable and eternal is real." *)	"Real is where values correspond to a physical effect (symbiosis)." Colloquial: "What loves is real."
Is it intuitive?	
This definition is intuitive.	This definition is intuitive.
Contains the essential idea it is based on?	
What is essential? Permanence!	*What is essential?* Values!
Ockham's razor	
A single requirement. (Equalization)	A single requirement. (Symbiosis)
Internal consistency	
Yes, if no conclusions are drawn. No, when using logic.	Yes.
Comprehension (Russel's hen)	
Yes. - Within the framework of the specific philosophical system of idealism. No. - Unchanging things have no effect on the models of physics. No. According to this definition, stones, trees, giraffes, planets, atoms and our fellow human beings are not real.	Yes - Within the framework of everyday life, science and logic (philosophy). Yes, because one can explain how symbiosis manages to create and maintain matter (copyable information). Yes. - According to this definition, stones, trees, giraffes, planets, atoms and our fellow human beings are real, are stable through symbiosis.

IDEALISM (PERMANENCE)	PRINCIPLE OF LOVE (SYMBIOSIS)
Extent "fertility" How big is its range?	
Inhibiting! Rejection of logic, problems with veracity. Everyday problems, ethics and life are meaningless in this model. Perceptions are not possible.	Far. Reality as the basic principle of nature: Values and meaning are defined in symbioses. Basis for the pursuit of harmony, ethics and logic, law and science. Helpful to meet the demands of everyday life. Consciousness and perception are taken into account.
Accuracy et al equality before the law: Copernican principle	
No. Rules for everyday life and ethics can not be derived. Rejection of science.	Yes. To test whether an object can be assigned the model-related predicate "real", check whether a symbiosis exists. Symbioses are common to science. They can be described with mathematical models. Depending on the number of symbioses, a step-by-step graduation of different degrees of being real exist.
Integration into science; Integration into philosophy	
Basis for many philosophies and religions. Devaluation of everyday life. Was often abused.	Basis for a philosophical - ethical - scientific - practicable model of the world.
Consensus	
No! Paradigm shift.	
The emotional level has to be supplemented. The symbiosis-based definition does not only correspond to what we call "real" in everyday life, but it also corresponds to what we perceive as "real". *) Compilation of the author. (Fröhlich, 2017)	

Table 2: Comparison of definitions of real

Scientific-Philosophical definition of the term "real"

Based on observations in practice, theoretical considerations are made: In a dynamic world, stable objects are created in the context of symbioses. Symbioses contain values and have effective rules. These objects are given the model-specific predicate "real". The basis and characteristic of reality is the symbiosis. (Symbiosis model).

The symbiosis definition of "real" is based on beliefs and, unlike the idealistic definition, contains no claim to truth. (Good models are not "true", but helpful.)

The symbiosis-based definition presented here explains the roots of permanence. It is in harmony with science and builds upon philosophical principles: "Real is where values correspond to a physical effect (symbiosis)."

Being and not being are not opposites in the symbiosis model. Between them there is a smooth transition. (That is why one can die.) In quantum physics, "possible being" forms a level between "being" and "not being". The "degree of reality" is dependent on the number and strength of the symbioses and indirectly also on the number of perceptions and possibilities of perception. On the level of elementary systems (quantum physics), it is low, higher in individual cells, even higher in humans. Cultures possess more symbioses and more possibilities and thus have a higher degree of reality than a single person.

Further definitions of the term "real"

The following definitions can be divided into three groups: Model (Thinking); Perception; Model and Perception.

Model (Thinking):

If two terms in a statement have the same meaning (synonyms), one speaks of tautology. Parmenides of Elea believed that such statements were absolutely true:

"Is is." / "What is, that is." / "Being is." (to Parmenides, 510-440 BC)

The meaning of the two words "is" does not have to be the same (seemingly a tautology). Depending on the context into which a sentence is integrated, the meaning may be different. This must be checked individually for each context. Fist rule: Since tautologies are insignificant, the two seemingly synonymous terms differ from one another the more statements they can derive. The sentence of Parmenides has only the value of a presumption. (Fröhlich, 2017)

(Parmenides and the Eleatic school assigns the following properties to the term "is": a whole, one, similar, coherent, uniform, unlimited, indivisible, unchangeable, indestructible, undeveloped, imperishable, timeless, eternal.)

According to Parmenides, only thinking leads to truth. (Isn't thinking also something dynamic?)

The symbiosis-based definition connects the spiritual with the material. Attributes are assigned based on ethical considerations. To assign the object "real" to an object, it must be observed. According to the rules of system theory, it is checked whether symbioses are present.

Perception:

Another definition of reality is based on self-awareness: *"I think, therefore I am."* (Descartes, 1642) According to the definition of Descartes, only the reality of the observer is assured.

For Berkeley, observers and perceived are real and immaterial:

"esse est percipere"– "to be is to perceive" and

"esse est percipi" – "to be is to be perceived" (George Berkeley, 1710)

Model and Perception (Effective Values):

For Berkeley, observers and perceived must have the same properties. This is controlled in the symbiosis model. There, the definition of reality is based on abstract principles. In the symbiosis model, the observer and the perceived have comparable ethical, logical and mechanical properties.

In addition, abstract considerations and observations incorporate the definition into the scientific worldview: Symbioses can be observed and described with models, they go hand in hand with interactions, communication and perception. In the symbiosis model, perception is neither an illusion nor an image; perception has the properties of a model with a model-specific language.

Observable objects form the starting point for scientific models. Within the scope of these models, these objects are present or, in other words, "real".

Model and Perception (Prediction):

Einstein, Podolsky, and Rosen (EPR) have set a definition of "real" within the framework of the discussions on quantum physics:

"A physical quantity whose value is predictable with certainty without disturbing the system on which it is measured, is an element of physical reality." (Einstein, A. Podolsky, B. Rosen, N., 1935)

According to this definition, (only) predictable events are real. This definition has given impulses to create Bell's inequality.

I leave the reader to examine the quality of these definitions on the basis of the criteria described above.

Clarification of the term "ethics" of life

The meaning of ethics in this concept has to be understood.

The laws of mechanics describe the immediate and imperative reaction to an action. The laws of mechanics are not sufficient for a scientific description of our world.

In order to control the processes in complex systems, other rules are required. Ethics provide a basis for formulating these rules. Their effect can only be predicted as "empirically" or "usually" (statistically). However, the recommendations for ethical action do not have to be followed.

The task of ethics is to protect life. Recommendations for action can be derived from their principles in order to stabilize symbiotic systems. (As Immanuel Kant, for example, called for with the *"categorical imperative".)* (Kant, 1781)

Ethics, logic and mechanics (Elome concept) contribute to the understanding of our world. The ethics described here are relative ethics – there are no absolute truth, no absolute ethics. The supposed possession of absolute truth leads to untruth. The supposed possession of absolute ethics leads to immoral acts. Statements and actions by religious and political fanatics clearly show this. Absolute ethics cannot be derived from logic.

See: George E. Moor: *Naturalistic Fallacy* (ref. Moor, 1903)

See: David Hume: *To Be - Should - Fallacy* (ref. Hume, 1734)

The relative ethics presented here have a defined goal. It is the maintenance of a symbiotic system / the maintenance of life. Therefore, ethical principles can (and should) be logically justified. There is a parallelism of ethics and mechanics in the Elome concept: stable systems obey the laws of ethics and mechanics.

Life and evolution

Does an ethical definition of the term life fit Darwin's theory of evolution?

- Many people cannot understand how *"Struggle for Existence"* could produce butterflies and flower meadows. (ref. Darwin, 1895)

- For many people it is incomprehensible how a "*pitiless indifferent universe"* could produce values and emotions. (ref. Dawkins, 1995)

In contrast the Elome concept: Darwin's theory of evolution describes a scientific process of knowledge and innovation that is associated with values. (Freedom - Diversity - Truthfulness - Love - Justice) (ref. Fröhlich, 2017)

Evolution and the principle of science

The principle of science is truthfulness applied in practice. To successfully implement the principle in practice, scientists have developed a number of

methods over the centuries. These methods are based on the "mechanism of science". This mechanism is named differently for the different applications:

In the words of science: Setting up a model - Checking the model - Publishing the model.

In everyday language: Freedom of choice - Proven in practice - Sharing of experiences.

In the words of philosophy: Freedom - Truthfulness - Love In words of biology: Mutation - Selection - Multiplication.

Interestingly, the evolution mechanism is a variant of the mechanisms of science: the mutation corresponds to the development of a model and the selection corresponds to the testing of the model. The experience gained is passed on during propagation or through publications. There is a selection in each of the three steps. Evolution accomplishes something like science: models (knowledge) and technology (innovations). Natural laws, matter and life arise in an evolutionary process. (ref. Ditfurth, 1976)

The objects that arise in this process have spiritual and material properties. Perception also arises evolutionarily. Perception is neither an illusion nor an image; perception has the properties of a model.

Quantum physics describes the emergence and decay of the elements of nature. The mechanism described can also be found in quantum physics.

In words of quantum physics: Chance - Effect - Information (Matter)

Matter is evolutionarily acquired and preserved knowledge that is stored in an effective form (technology). Matter is something "spiritual" that has an effect.

The mechanism of science is important in the emergence and maintenance of natural laws and matter but also in emergence of biological life and the development of living things. The mechanism of science is involved in the development of our perception, our feeling and our thinking, languages, culture.

Living beings, laws of nature and matter arise in evolutionary processes according to the mechanism of science. Chance is insignificant. Here it has as little meaning as chance in the test series of the scientists. In the long run, principles prevail. The laws of nature are subject to similar principles as philosophy.

The basis of physics is formed by ethics and philosophy. (Freedom - Diversity - Truthfulness - Love -Justice - etc.) Science does not lead to an emotionless, meaningless worldview.

Statement

- Scientists combine science with philosophy and ethics.

or

- Scientists leave philosophy and ethics to the Others.

References

Arrhenius, Gustav, 2002 "Short definitions of life." In Fundamentals of Life, edited by G. Palyi, C. Zucchi, and L. Caglioti, Elsevier, New York, pp 17-18; in: Pross, Addy, 2012, What is Life? How Chemistry becomes Biology: 40, Oxford Landmark Science

Berkeley, George, 1710, A Treatise Concerning the Principles of Human Knowledge new edition: Forgotton Books; Turbane (1957)

Bertalanffy, Ludwig von, 1949, "General System Theory." In: Biologia Generalis. 1/1949: 114–129

Darwin, Charles, 1859, The Origin of Species, London:, retrieved by John Murray 22 February 2009

Dawkins, Richard, 1995, River out of Eden, Basic Books, New York

Descartes, René, 1641, Meditationes de prima philosophia translated by Andreas Schmidt, Reclam Verlag, Dietzingen, 2020

Ditfurth, Hoimar von, 1976, Der Geist fiel nicht vom Himmel, Hamburg, Hoffmann und Campe Verlag

Dyson, Freeman, 1999, Origins of Life, Second Edition, Cambridge University Press; in: Pross, Addy, 2012, What is Life? How Chemistry becomes Biology: 40, Oxford Landmark Science

Einstein, A., Podolsky, B. and Rosen, N., 1935, "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?" In: Physical Review, 47: 777-780.

Fröhlich, Klaus, 2017, Definition of "Life" Based On Symbiosis Model: 4-9, Raleigh

Fröhlich, Klaus, 2017a, Anregungen zum Nachdenken über Wissenschaft, Philosophie, Religion und Recht, Raleigh

Genz, Henning, 2002, Wie die Naturgesetze Wirklichkeit schaffen. München, Wien

Haecke, Ernst, 1899, Die Welträtsel. Gemeinverständliche Studien über Monistische Philosophie; new edition Verlag Hofenberg; Bonn; 2016

Heraclitus Ephesus, 520-460 BC, as quoted by Plato in Cratylus; standardebooks.org/

Hennet, Remy, 2002, Short definitions of life. In: Fundamentals of Life, Elsevier, New York: 3; in: Pross, Addy, 2012, What is Life? How Chemistry becomes Biology: 40, Oxford Landmark Science

Hume, David, 1734, A Treatise of Human Nature; Google Books

Jacob, Francois, 1982, The Logic of Life: A History of Heredity; in: Morange, Michel, 2011, "Problems raised by a definition of life" In: Origin and Evolution of Life - an Astrobiology Perspective; Cambridge: 5-6

Kuhn: Thomas Samuel, 1967, Die Struktur wissenschaftlicher Revolutionen. Frankfurt a. M.

Kant, Immanuel, 1781, Kant, collected writings (1900). Prussian Academy of Sciences (New Edition)

Kunin, Viktor, 2000, "A system of two polymerases – A model for the origin of life." Orig. Life Evol. Biosphere 30: 459–466, in: Pross, Addy, 2012, What is Life? How Chemistry becomes Biology: 40, Oxford Landmark Science

Moor, George E. 1903, Principica Ethica; New Edition CreateSpace Independent Publishing Platform (2017)

Morange, Michel, 2011, "Problems raised by a definition of life" In: Origin and Evolution of Life - an Astrobiology Perspective; Cambridge: 5-6

Parmenides, 510-440 BC, On Nature; new edition on the order of nature; Aurea Vidya Collection

Pawlowski, Tadeusz, 1980, Begriffsbildung und Definition, Berlin, New York

Poppa, Radu, 2009, The Complexity-Independence of the Origin of Life: 5; pdxscholar.library.pdx.edu

Poppa, Radu, 2004, Between Necessity and Probability: Searching for the Definition and Origin of Life: 141; Springer Verlag

Pross, Addy, 2012, What is Life? How Chemistry becomes Biology: 40, Oxford Landmark Science; Oxford

Schrödinger, Erwin, 1944, What is Life? The Physical Aspect of the Living Cell, Cambridge University Press; Cambridge

Socrates, 463-399 BC, as quoted by Platon in Apology of Socrates, 21d; new edition Friedrich Schleiermachen Taschebuch, 2004

Vrselja, Z., Daniele, S.G., Silbereis, J. et al., 2019, "Restoration of brain circulation and cellular functions hours post-mortem. "In: Nature 568, 336–343